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SCIENCE IN THE GENERAL EDUCATIONAL DEVELOPMENT (GED) CURRICULUM:
ANALYZING THE SCIENCE PORTION OF GED PROGRAMS AND EXPLORING ADULT
STUDENTS' ATTITUDES TOWARD SCIENCE

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

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ABSTRACT

The General Educational Development (GED) tests enable people to earn a high school equivalency diploma and help them to qualify for more jobs and opportunities. Apart from this main goal, GED courses aim at enabling adults to improve the condition of their lives and to cope with a changing society. In today's world, science and technology play an exceedingly important role in helping people better their lives and in promoting the national goals of informed citizenship. Despite the current efforts in the field of secondary science education directed towards scientific literacy and the concept of "Science for all Americans", the literature does not reflect any corresponding efforts in the field of adult education. Science education research appears to have neglected a population that could possibly benefit from it. The purpose of this study is to explore: the science component of GED programs, significant features of the science portion of GED curricula and GED science materials, and adult learners' attitudes toward various aspects of science. Data collection methods included interviews with GED students and instructors, content analysis of relevant materials, and classroom observations.

Data indicate that the students in general feel that the science they learn should be relevant to their lives and have direct applications in everyday life. Student understanding of science and interest in it appears to be contingent to their perceiving it as relevant to their lives and to society. Findings indicate that the instructional approaches used in GED programs influence students' perceptions about the relevance of science. Students in sites that use strategies such as group discussions and field trips appear to be more aware of science in the world around them and more enthusiastic about increasing this awareness. However, the
dominant strategy in most GED programs is individual reading. The educational strategies used in GED programs generally focus on developing reading skills rather than the internalization of knowledge or influencing attitudes. An interesting finding is that GED science materials do attend to the relevance of science in everyday life but students' appreciation of this depends on the strategies employed.
To

My Family
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I also wish to thank all the GED teachers who willingly welcomed me into their programs and the students who were willing to share their thoughts and feelings with me.

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CHAPTER 1

INTRODUCTION

Education is a social institution and shares directives common to other social institutions including providing for the needs and continued development of individuals and fulfilling the requirements and aspirations of a democratic society (Bybee, 1987). Like all other social institutions, education has seen profound changes in its history, progressing through the ecclesiastical scholasticism of the Middle Ages and the classical studies of the Renaissance to a system based on the practical concerns of the day (Bybee & DeBoer, 1994). This century itself has witnessed major shifts in the emphasis of education in general and science education in particular. The emphasis in science education has shifted from disciplining the intellect at the beginning of the century, through a utilitarian view, through preparing future scientists, to finally the concept of scientific literacy for all students. Recent reform efforts in secondary science education such as Project 2061 of the American Association for the Advancement of Science and the National Science Education Standards of the National Research Council focus on this objective of preparing a scientifically literate populace for effective functioning in society.

In secondary science education today we see the emphases on the societal aspect of science and science education, the role of science education in empowering individuals and promoting effective citizenship, the relevance of science education to the lives of students and to society, scientific literacy for all students, and the importance of both the cognitive and affective aspects of science education (American Association for the Advancement of Science [AAAS],
We also see an abundance of research efforts directed toward assessing the current status of science education and improving contemporary science education. It is noteworthy that these efforts are generally directed towards a traditional K-12 program of study. Obviously lacking in the educational literature are efforts to improve science education in other settings such as in the Adult Basic Education (ABE) or General Educational Development (GED) programs. GED programs prepare adult students for the GED tests that enables them to earn a high school equivalency diploma and helps them qualify for more jobs and opportunities. Currently one out of every six high school diplomas is a GED. Thus science education reform efforts seem to be neglecting approximately 17% of the population that it is supposed to serve. There is a need in today's educational scene for resources and efforts to be directed toward enhancing the science education of adults in GED programs. In contrast to the abundance of documentation of the current status of secondary science education in terms of philosophies, content, and educational strategies, there does not exist any such documentation of the state of GED programs. Furthermore, there is no easily accessible information regarding content or instructional strategies that GED teachers could use to enhance their practice. This research effort is an initial attempt in the direction of closing this gap.

Currently the GED Testing Service is developing new GED tests that will be in use at the turn of the century. The implementation of these new tests will necessitate the development of new curricula and educational strategies. Thus we are at a unique time in the history of the GED program where substantial changes can be made. Recent reform efforts in science education can be used to guide these changes. Research efforts can be directed to the field of adult science education to explore various aspects of the field. The results of these research efforts can then be used to guide the enhancement of this mode of science education. A broad variety of aspects of adult science education that can be researched includes topics such as attitudes of adult students toward science, attitudes of teachers of adults toward science, relevance of the
knowledge and skills acquired, the role of the GED educational experience in promoting scientific literacy, effects of different educational strategies on attitudes and achievement, change in attitudes and perspective as a result of the programs, and long-lasting effects of the GED programs on students lives. This research effort attempts to document the different approaches to science education in GED programs and is intended as an exploratory effort to elicit students' attitudes toward science and the science education aspect of GED programs which can then be used to enhance future programs.

Overview of Theoretical Framework

An important goal of science education is to foster more positive attitudes toward science and the scientific enterprise (MacMillan & May, 1979). The importance of attitudinal goals in science education has been well documented in the educational literature and is also evident in the quantity of research done in that area (Koballa, 1988). Attitudes toward science have been shown to affect, among other things, participation in science-related social issues, application of scientific skills and knowledge in everyday life, learning and achievement, enrollment in science, and career choices. Various theoretical frameworks have been used to underlie different research efforts. For the purpose of this study, different aspects of existing models were combined with the researcher's insights to the characteristics of the particular population under consideration to develop a framework that underlies the study. This model is based on the assumption that attitudes toward science will predict an individual's tendency to engage in science-related behavior and positive attitudes toward science would incline an individual toward seeking out more scientific information, following the doings of the scientific enterprise, exercising their democratic rights on social issues related to science and technology, using science knowledge and skills in their daily lives, functioning efficiently in the realm of science, considering
further science education, and considering science related careers. Another assumption of this model is that attitudes are susceptible to change and once negative attitudes have been identified, the right strategies can be used to foster more positive attitudes toward science. According to this model, attitudes are influenced by a wide array of variables that make up an individual's life and can be divided into three broad categories: personal, social, and educational. An important aspect of this model is that attitudes toward science are comprised of different dimensions including scientific attitudes, attitudes toward the subject science, attitudes toward the teaching and learning of science, attitudes toward the scientific enterprise, attitudes toward the relevance of science in everyday life, attitudes toward the importance of science in society, attitudes toward current science-related social issues, attitudes toward scientists and people who use science, attitudes toward science-related careers, and attitudes toward one's capability of functioning in the realm of science or self-efficacy. This research effort explores GED students' attitudes toward these various aspects of science and science education with the hope that these will be taken into consideration in efforts to enhance the science portion of GED programs.

In spite of the abundance of research on attitudes toward science in the secondary science education literature, corresponding efforts are noticeably lacking in the field of science education for adults. One of the conclusions drawn from the Third Assessment of Science was that adults seem to be more negative in all categories concerning their perceptions of science teachers, classes, and course content than do students currently enrolled in schools (Yager & Bonnstetter, 1984). Yager & Bonnstetter further assert that this may be partially explained because the adults sampled tended to be non-college persons who remained in their local communities as part of the labor force. This is the population that is generally served by adult education programs like the GED. This highlights the importance of conducting research to explore the attitudes of this population. Even though passing the GED exam is the major objective of most GED courses of study, it must be recognized that we have here an audience
that is easily within reach, and if we can foster in them positive attitudes toward science, we may be able to help them better their lives, improve their self-confidence, and enhance their active participation in society.

Purpose of the Study

This research effort is aimed at documenting different approaches to science education in GED programs and exploring GED students' attitudes toward various aspects of science and science education with the hope that the information obtained and the understandings generated will be used to enhance the science education of adults in GED programs.

Research Questions

(1) What are the different educational strategies employed in the science education aspect of GED programs?
(2) What is the experience of students preparing for the GED science test in GED programs?
(3) What are GED students' attitudes toward various aspects of science including the subject science, science teaching and learning, science evaluation, relevance to life, importance in society, science-related issues, scientists and people who use science, science-related careers, and self-efficacy in the domain of science.
Overview of Methodology

Various methods have been used to assess attitudes in secondary science education, most of them using quantitative measures. However, inadequacies of these instruments have been widely discussed in the educational literature (Blosser, 1984). In addition, since this is a population that is very different from students in secondary science programs in terms of characteristics and life contexts, it may not be appropriate to use attitude instruments developed for secondary science education with this population. Preliminary qualitative work including interviews and observations needs to be conducted in order to develop attitude instruments for use with this population. Since this is an exploratory study and no previous research has been conducted in this area, a qualitative approach is appropriate for this study. Moreover, attitudes toward science fall in the affective domain and therefore interviews are an effective way of exploring them since the emphasis of interviews is on uncovering participant perspectives. Other data collection methods, to facilitate greater understanding and increase the trustworthiness of the findings, included classroom observations and document analysis. In keeping with the flexible and emergent nature of qualitative research, the methodology evolved on the basis of insights gained during the study.

Organization of the Document

The chapters that follow include a literature review of relevant science education and adult education literature, a chapter detailing the methodology that was used in the study, a chapter discussing the findings from the study, and a final chapter highlighting important findings and implications of the study.
An important aspect of science education today is the emphasis on the importance of student attitudes toward science and the understanding of the impact of these attitudes on students' lives. Adults in General Educational Development (GED) courses stand to gain significantly if this aspect of science education is highlighted in the GED science curriculum. Positive attitudes toward science and technology could enable them to cope with the demands of today's technology-driven society and to function as responsible citizens in our democratic society. The purpose of this literature review is to discuss goals of science education, elaborate on themes currently emphasized in secondary science education, explore the place of science in the GED curriculum, discuss the importance of attitudes toward science, and highlight the importance of conducting research concerning GED students' attitudes toward science.

Goals of Science Education

Education is a social institution and shares directives common to other social institutions including providing for the needs and continued development of individuals and fulfilling the requirements and aspirations of a democratic society (Bybee, 1987). In the case of science education this translates into education about the knowledge, application, skills, and values relative to science and technology which profoundly influence an individual's interaction with and
impact on society. The understanding of science by the general population is largely a result of science education through formal and informal experiences. This implies that science education has a crucial role in renegotiating the contract between science and society (Bybee, Harms, Ward, and Yager, 1980). This aspect of science education was not deemed important in the early history of science education even as recently as the 1960s, as evidenced in statements of goals which included aspects such as procedures of scientific inquiry, scientific attitude, procedures of science, and scientific knowledge (Sears & Kessen, 1964) while neglecting other aspects such as relevance to daily life and impact on society.

Like all other social institutions, education has seen profound changes in its history. This system has progressed through the ecclesiastical scholasticism of the Middle Ages and the classical studies of Renaissance to a system based on practical concerns of the day (Bybee & DeBoer, 1994). This century itself has witnessed major shifts in the emphasis of education in general and science education in particular. A major educational force at the beginning of this century was the Committee of Ten which made various recommendations for the improvement of education based on the belief that as long as subjects disciplined the intellect they would be useful both as preparation for life and for college admission (Bybee & DeBoer, 1994). The 1920’s saw a shift in emphasis from the development of the intellect and the usefulness of knowledge for knowledge sake to the utilitarian aspect of knowledge. In this period little attention was given to the processes and thinking skills used in establishing scientific knowledge and the overemphasis on the practical uses of science led to a view of science that was considered distorted and far removed from the view of science held by practicing scientists (McCormack, 1992).

The utilitarian view of science education lost impetus with the launch of Sputnik in 1957. The fact that the United States was not the first to put an artificial satellite into orbit led to widespread discontent with the educational system prevalent at the time. A lot of resources and
effort were poured into education and development of new curricula that focused on reflecting the nature of science as seen by practicing scientists and on learning by inquiry and discovery (McCormack, 1992). The goals of science education shifted to producing more efficient scientists and engineers in order to maintain the nation's competitive edge in science and technology. This led to science education which emphasized accretion of knowledge and scientific concepts and mastering the processes of science in order to produce students who thought and acted like scientists.

In the 1960's the goal of science education was to produce more competent scientists and engineers. The next decade saw a dramatic shift in this focus which was apparent when the NSF Advisory Committee for Science Education in 1970 called for more emphasis to be placed on the understanding of science by those who are not professional scientists and technologists (Hurd, 1991). Some of the trends in science education during this time period were the movement towards teaching science process skills along with inquiry and problem-solving techniques, incorporating environmental education into science teaching, and integrating disciplines across the curriculum. However, a major criticism of the curriculum projects of the 1970's was that there was too much attention to theory and pure science to the exclusion of real-world applications and that they lacked relevance in terms of the social, historical, and humanistic dimensions of science (McCormack, 1992). These and other criticisms led to the conceptualization of movements in the 1980's that focused on the interconnectedness of science and society and emphasized the role of science education in improving the individual and in improving society. Social efficiency and effectiveness was highlighted as one of the goals of science teaching which includes maintenance of a stable social order, economic productivity, and the preparation of citizens who feel comfortable in a technical world and understand issues such as environmental conservation, disease prevention, industrial development, and computer literacy (Bybee and DeBoer, 1994). The emphasis of science education shifted from the concerns of the
scientific community to the concerns of society (King, Galvez, & Subbarini, 1995). A major
distinguishing characteristic of this phase of reform that differentiates it from previous efforts, is
the shift in the emphasis from cognitive objectives to objectives in the affective domain.

Public perceptions of science, technology, and the social studies have undergone a
dramatic change in the past four decades. In the first half of this century science used to be
primarily equated with laboratory investigations, technology with the application of science to
ensure progress, while social studies used to be viewed as relating to history, geography, and
government (Heath, 1992). In today's world, however, these disciplines are increasingly being
perceived as more complex, sophisticated, and increasingly relevant in developing a knowledge
and skill base for enabling people to better the condition of their lives and the condition of the
world around them (Heath, 1992). This has led to the realization of the connections and links
between disciplines that were originally viewed as disparate and distinct. This change in
perspective has led to a range of reform efforts in science education and a shift in emphasis from
teaching science as a means of developing cognitive skills and advancing knowledge, to viewing
science and technology as a means for improving society, building affective and ethical
understandings, and promoting systemic thinking and decision-making skills (Hofstein & Yager,
1982).

While discussing priorities for improving science education in the United States at the
beginning of the last decade, Harms & Yager (1981) stressed the need for a major redefinition
and reformulation of goals for science education. They argued that the goals must "take into
account the fact that students today will soon be operating as adults in a society which is even
more technologically-oriented than at present; they will be participating as citizens in important
science-related societal decisions" (p. 129). In recent reform efforts we do see an emphasis on
enhancing students' understanding of the impact of science on society as an important goal of
science education. While discussing research on goals for the science curriculum, Bybee and DeBoer (1994) state the following student outcome goals:

1. to acquire scientific knowledge;
2. to learn the processes or methodologies of the sciences; and
3. to understand the applications of science especially the relationships between science and society and science-technology-society.

Under this organization, the students should have some knowledge of the products of science, should have some experience with and understand the methods of science, and should understand how science is a force in their world (p. 357).

This statement of goals highlights the importance of understanding the impact of science on society.

A reform effort that has gained impetus in recent years is Project 2061 of the American Association for the Advancement of Science (AAAS). The goal of *Science for All Americans* (1989), the first phase of the 3-phase plan of Project 2061 was "to establish a conceptual base for reform by spelling out the knowledge, skills, and attitudes all students should acquire as a consequence of their total school experience from kindergarten through high school" (AAAS, 1989, p. 3). According to Project 2061, a central goal of education is scientific literacy which includes an awareness that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understanding of the key concepts and principles of science; familiarity with the natural world and recognition of both it's diversity and unity; and using scientific knowledge and scientific ways of thinking for individual and social purposes (AAAS, 1989). The criteria that AAAS used in establishing a common core of learning includes utility, social responsibility, the intrinsic value of knowledge, philosophical value, and childhood enrichment. In the *National Science Education Standards* (1996), the National Research Council spells out a vision of science education that will result in a scientifically literate populace. The
goals for school science that underlie the National Science Education Standards are to educate students who are able to:

- experience the richness and excitement of knowing about and understanding the natural world;
- use appropriate scientific processes and principles in making personal decisions;
- engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- increase their economic productivity through the use of the knowledge, understanding, and skill of the scientifically literate person in their careers. (National Research Council [NRC], 1996, p. 13)

In discussing the history of ideas in science education, DeBoer (1991) outlines the goals of science teaching including "the intellectual goals of thinking and reasoning, the personal goals of appreciation and understanding, the practical goals that will help us in our life's work and in our role as intelligent citizens, and the futuristic goals of innovation and creativity (p. xiii)". In their attempt to examine goals of science education, the National Science Teachers Association's Project Synthesis divided science education goals into four broad categories: personal needs, social issues, academic preparation, and career education (Koballa, 1986). In his foreword to Duschl's book dealing with the connections between the development of theories and the development of students' understanding of the world, Bybee (1990) enumerates the important goals of science education: "to clarify what science is and what science is not; what science can do and what it cannot do; what science can explain and what it cannot explain; what rules and procedures scientists obey; what happens when individuals do not obey the rules; and finally, what individuals and society ought to expect from science and which expectations are appropriate" (p. x).
In all these statements of the current goals for science education we see attention given to the importance of science education to the lives of students and society and to both the cognitive and affective components of science education. The next section highlights themes currently considered important in science education.

Important Themes in Science Education

Science and society

Cutliffe (1990) has stated that science and technology are "complex enterprises taking place in specific social contexts shaped by, and in turn shaping, human values as reflected and refracted in cultural, political, and economic institutions" (p. 363). Therefore, science and technology cannot be studied independent of the sociocultural context which itself is of a constantly evolving nature. This concept of a social approach to science education was discussed in the educational literature as far back as 1945 when the Harvard Committee, in a Harvard University report titled General Education in a Free Society, argued that the facts of science become more subtle and abstract and must be learned in a cultural, historical, and philosophical context in order to give lasting value to the scientific information and experience for the general student (Buck, 1945). The importance of the context of scientific knowledge has been discussed by many other authors including Jones and Zucker (1986) who point out that the application of scientific knowledge can be made difficult by teaching facts apart from the human and social context as this may leave serious gaps in understanding.

Although the connections between science and society have been discussed in the educational literature for a good portion of this century, Gallagher (1971) was one of the first to
formally propose that science education be oriented around a Science-Technology-Society theme. According to Gallagher:

For future citizens in a democracy, understanding the interrelationships of science, technology, and society may be as important as understanding the concepts and processes of science. An awareness of the interrelations between science, technology, and society may be a prerequisite to intelligent action on the part of a future electorate and their chosen leaders (p. 337).

The STS theme received a major impetus when it was advocated by the National Science Teachers Association (National Science Teachers Association [NSTA], 1982), as evidenced in their position statement:

The goal of science education during the 1980's is to develop scientifically literate individuals who understand how science, technology, and society influence one another and who are able to use this knowledge in their everyday decision-making. The scientifically literate person has a substantial knowledge base of facts, concepts, conceptual networks, and process skills which enable the individual to continue to learn and think logically. This individual both appreciates the value of science and technology in society and understands their limitations (NSTA, 1982).

Project 2061 of the American Association for the Advancement of Science (AAAS) stresses the role of science education in equipping students to participate thoughtfully with fellow citizens in building and protecting a society that is open, decent, and vital (AAAS, 1989). In the content standards of the National Science Education Standards (NRC, 1996), the personal and social aspects of science are emphasized increasingly in the progression from Science as Inquiry standards to the History and Nature of Science standards. The science content standards include the Science in Personal and Social Perspectives standards which are geared toward helping students develop decision-making skills.
The importance of the societal aspect of science and technology is evidenced from these statements as is the importance of the affective domain of science education.

Empowerment and citizenship

The notion of empowering students through education is seen in the work of many educational theorists such as Dewey who defined education as "that reconstruction or reorganization of experience which adds to the meaning of experience, and which increases the ability to direct the course of subsequent experience" (Dewey, 1966, p76). Empowerment is generally viewed as being connected to efficient citizenship. Tanner and Tanner (1980) write about the importance of education in promoting democratic citizenship. They argue for the need for an interdisciplinary and social-problem-focused curricula in a society that holds to the democratic ideal of an enlightened citizenry. Bybee (1985, p. 93) states that "citizens have a genuine need to understand the impact of science and technology on our society and the social issues they must evaluate" while "educators have a responsibility to meet this need". This aspect of education along with other aspects such as development of critical thinking and problem-solving skills are strongly emphasized in recent reform efforts which are geared toward linking the disciplines and demonstrating their interconnectedness while advocating critical thinking, problem solving, and human values as necessary ingredients to assess the human perspective (Kowal, 1991). Kowal argues that an understanding of the realms of science and technology, along with their limits and linkages, not only provides citizens with a better understanding, but also ultimately leads to more effective solutions to problems. Rubba (1987) posits that the goal of education is social responsibility and it should "help students develop the ability to make decisions in a responsible manner on science and technology-related issues, and to take action based upon those decisions toward the resolution of the issue" (p. 182). Science education should encourage students to become investigators of the social, economic, legal, political, and environmental
ramifications of scientific issues and to become active decision makers regarding the applications of scientific discoveries (McCormack, 1992).

Aikenhead (1992) states that the ultimate goal of teaching science is to improve the science literacy of all students, which empowers them to interact meaningfully and reasonably with their environment. This requires a balanced approach encompassing several aspects of science including key facts, principles and concepts, intellectual processes, manipulative skills, interactions between disciplines, the nature of science and values that underlie science, and personal interests and attitudes toward scientific and technological matters (Hart, 1987). This is important since the public misunderstanding of science and attitudes toward science can work its way through the political process and emerge in detrimental policies such as “wide fluctuations in science funding, political rather than scientific criteria for setting research priorities, unrealistic demands for quick practical results, and misguided regulations or accounting procedures” (Prewitt, 1983, p. 51).

Project 2061 of the AAAS stresses the role of science education in equipping students to participate thoughtfully with fellow citizens in building and protecting a society that is open, decent, and vital (AAAS, 1989). One of the criteria they used to select content was whether the proposed content was likely to “help citizens participate intelligently in making social and political decisions on matters involving science and technology” (p. 21).

However an important point to consider is that students are apt to actively seek out information about science and technology-related social issues and engage in the evaluation of those issues only if they hold positive attitudes toward science in the first place. If students do not believe that science is important in society and that they can confidently reason and evaluate
social issues, it is unlikely that they would effectively participate in the democratic process with respect to these issues.

**Relevance**

An important aspect of reform efforts of the 1980's which counteracted some of the criticisms of earlier curricular movements was the issue of the relevance of science education to the everyday life of students. The reform efforts of this era aimed at designing curricula that would enhance the quality of life of students and help them in dealing with everyday life as well as being relevant socially. Hofstein and Yager (1982) proposed that the knowledge considered to be important is that which supposedly will be useful and relevant to the solution of societal problems. Penick and Meinhard-Pellens (1984) point out that one of the strengths of the STS movement in curriculum development was that it put science and technology into a realistic perspective in that it recognizes that science and technology are meaningful only within a societal framework. This leads to the importance of determining what attitudes students have toward the relevance of their science education, do they believe that it is relevant to their everyday lives and to society?

An important aspect of science education is the enhancement of the individual development of the student. In developing a rationale for STS education, Hurd (1986) takes the stand that this approach is designed to put knowledge into action through application of what is learned and it reflects the position that science courses should serve the common good of society and also promote personal development (Hurd, 1986). Subject content should be applied toward the comprehension and potential resolution of personal-social issues and problems as this would enable students to see the connections between individual experience, the subject matter, and social ideals and realities (Wraga and Hlebowitsh, 1991). The Scope Sequence and Coordination (SS&C) curriculum advocated by the National Science Teachers Association (NSTA) incorporates
practical applications of science by engaging students in early grades with science problems and issues of personal concern and in the later grades with more global science considerations (NSTA, 1992).

Recent reform efforts reflect this importance of the relevance of education. Project 2061 is based on the conviction that "all children need and deserve a basic education in science, mathematics, and technology that prepares them to live interesting and productive lives" (AAAS, 1989, p. 11). The science content standards of the National Science Education Standards aim at directly influencing students' abilities to understand and act on personal and social issues (NRC, 1996). However, without positive attitudes toward science, students are unlikely to apply their science-related knowledge. Therefore to promote application of knowledge it is important to first foster positive attitudes toward science.

Scientific literacy

Another aspect of science education that has gained importance is "scientific literacy". Literacy generally implies a set of cognitive, affective, and behavioral outcomes needed for a citizen to live in our technologically oriented world (Welch, 1985). Hurd (1958) first used the term "scientific literacy" to describe an understanding of science and its applications to our social experience. Hurd argued that science instruction could no longer be regarded as an intellectual luxury for a select few since effective citizenship requires more than a casual acquaintance with scientific forces. The science education literature contains an abundance of perceptions and definitions of scientific literacy. Smith (1974) defines scientific literacy as an understanding of the events around us, the ability to verify the truth of claims made by laypersons in the popular media about science, and the ability to evaluate the relevance and importance of scientific developments and projects to the needs of society. King, Galvez, & Subbarini (1995) state that scientific literacy
has three components: a knowledge component; the nature of science component which includes components such as scientific discoveries, the nature of inquiry, the characteristics and limitations of scientific explanation, and the characteristics of the scientific community; and the social applications component which includes being able to apply scientific concepts and processes in daily living. In their guidebook to active meaningful science learning, the Midwest Consortium for Mathematics and Science Education (1994) states that scientifically literate citizens will be able to understand key concepts of science and technology, use this knowledge in everyday life, understand complex public policy issues such as environmental and health concerns, and grasp the complexities of rapid change such as the restructuring of our economy and shifting population trends. Project 2061, sponsored by the American Association for the Advancement of Science, suggests that the basic dimensions of scientific literacy are as follows:

- Being familiar with the natural world and recognizing both its diversity and its unity
- Understanding the key concepts and principles of science
- Being aware of some of the important ways in which science, mathematics, and technology depend upon one another
- Knowing that science, mathematics, and technology are human enterprises and what that implies about their strengths and limitations
- Developing scientific habits of mind
- Using scientific knowledge and ways of thinking for individual and social purposes (AAAS, 1989).

The National Science Education Standards (NRC, 1996) present a vision of a scientifically literate populace and outline what students need to know, understand, and be able to do to be scientifically literate at different grade levels with the goal of enabling students to use scientific information to make choices that arise in everyday life, to engage intelligently in public discourse and debate about important issues that involve science and technology, to share in the excitement and personal fulfillment that can come from an understanding of the natural world, and to contribute to skills that they will need in the workplace. In these references to scientific literacy
we see the importance of the affective domain, of students awareness and appreciation of the place of science in society, and of the strengths and limitations of the scientific enterprise.

The concept of scientific literacy is strongly correlated with democratic citizenship. There is a growing recognition that in the industrialized world scientific literacy is an important component of long-term economic growth and of effective citizenship (Miller, 1989). However, studies have indicated that relatively few citizens in the United States and other industrialized nations understand basic scientific terms or can make sense of conflicting arguments from experts on issues like nuclear power (Miller, 1989). This highlights the pressing need for using science education to educate the population to be responsibly functioning members of society. Miller (1989) views functional scientific literacy as the level of understanding of science and technology needed to function minimally as citizens and consumers in our society. Scientific literacy demands an understanding of the processes of science, a basic vocabulary of scientific and technical terms, and an understanding of the impact of science and technology on society. Positive attitudes toward science could engender citizens to strive towards this goal of scientific literacy.

Prewitt (1983) makes the distinction between the personal and public aspects of scientific savvy. Scientific illiteracy not only denies people the personal benefits of the advancements in science and technology and denies them employment opportunities, it also affects the citizen's involvement in public life. Since the economic and political life of society rests largely on a scientific-technical base, it is important to have scientifically savvy citizens who would be involved in the political process, policy-making, and social change (Prewitt, 1983). For a democratically involved populace, citizens need to be aware of the nonscientific purposes of science, the commercial, strategic, and bureaucratic purposes. This understanding has to stem from informed opinion and not from biased views to which the citizen has been exposed. People need to be
The utilization of learning skills can be achieved by active participation in information gathering, problem solving, and decision making while the development of values and ideas about science and technology in society can be achieved through a study of local issues, public policies, and global problems (Bybee, 1987). However, a positive attitude toward science and technology is important to make this a reality. The next section discusses various approaches used to translate these important themes in science education into everyday practice.

**Approaches to Science Education**

**Interdisciplinary approach**

In their guidebook to active meaningful science learning, the Midwest Consortium for Mathematics and Science Education (1994) highlights the role of the science curriculum in developing ideas that extend beyond individual facts and concepts and transcend disciplinary boundaries. The Scope Sequence and Coordination effort of the NSTA promotes linkage and integration within and among the sciences with the goal of making students aware of the interdependency of the sciences and their place within the larger body of human experience (McCormack, 1992). Project 2061 is based on the premise that core studies should include connections among science, mathematics, and technology, and between those areas and the arts, humanities, and vocational subjects. One of the recommendations of AAAS is that curricula must be changed to "reduce the sheer amount of material covered; to weaken or eliminate rigid
subject-matter boundaries; to pay more attention to the connections among science, mathematics, and technology; to present the scientific endeavor as a social enterprise that strongly influences human thought and action; and to foster scientific ways of thinking (AAAS, 1989, p. 5). The National Science Education Standards advocate an interdisciplinary approach by emphasizing connections through conceptual themes such as systems, evolution, cycles, and energy (Close, Miller, Titterington, and Westwood, 1996). The Unifying Concepts and Processes Standard describes some of the integrative schemes that are aimed at bringing together students' many experiences in science education (NRC, 1996). Thus we see a growing consensus that an interdisciplinary approach is what is needed in science education to reach its goals.

Active learning and cooperative learning

According to the Midwest Consortium for Mathematics and Science Education (1994) students become more active learners when "teachers function as facilitators, asking provocative questions, providing open-ended experiences, monitoring student progress, challenging assumptions, encouraging alternative solutions and explanations, and providing a psychologically safe classroom environment for sharing viewpoints without fear or ridicule" (p. 9). Project 2061 stresses the importance of students having many opportunities for hands-on activities and for the reflective thinking that enables them to make sense of their experiences (Rutherford, 1996).

In discussing the current status of U.S. science education, Bentley (1995) states that cooperative learning methods are being widely incorporated and hands-on activities are still regarded as essential. Slavin (1983) has defined cooperative learning as techniques in which students work in heterogeneous groups and earn recognition, rewards, and sometimes grades based on the academic performance of their groups. Cooperative learning methods have roots in social and psychological research and theory that focuses on cooperation versus competition.
(Manning and Lucking, 1992). In outlining strategies for effective teaching, Project 2061 advocates the use of a team approach because group activity can reinforce the collaborative nature of scientific and technological work. One of the assumptions on which the science teaching standards of the National Science Education Standards is based is that student understanding is actively constructed through individual and social processes and that students develop an understanding of the natural world when they are actively engaged in scientific inquiry, individually and cooperatively (NRC, 1996).

Less is more

This is based on the belief that if students study fewer topics in greater depth over a longer period of time, they will acquire a far deeper and more useful understanding of science. Project 2061 is based on the premise that the common core of instruction should omit what does not contribute to science literacy goals so that students have time to learn what does (Rutherford, 1996). The emphasis is on the 'big ideas' and a depth of understanding with content organized around conceptual themes (Bentley, 1995). The basis for this concept is that since the entire body of science content knowledge cannot be taught to students, the goal should be to "help students see the big picture and work with important constructs, models, and theories to develop both critical reasoning skills and deeper understanding of the processes as well as the essential content of science" (Close et al., 1996, p. 1).

Constructivism

A perspective on learning that has gained importance in recent reform efforts is the constructivist view of learning (Bentley, 1995). The basis of the constructivist theory is that the prior knowledge students bring to each learning experience intimately affects how and what they
will learn (McCormack, 1992). Constructivism pays attention to students' prior learning and ideas and uses this to actively construct new knowledge. It is a dynamic and interactive model of learning in which students redefine, reorganize, and elaborate their existing concepts through interaction with peers, objects, and events in the environment (Midwest Consortium for Mathematics and Science Education, 1994). Thus it embodies aspects of cooperative learning and active learning.

The amount of effort and resources poured into science education at the K-12 level is obvious in today's educational scene. What is also apparent is the lack of any corresponding effort in the enhancement of other modes of science education such as science education in adult education settings like Adult Basic Education or the General Educational Development (GED) programs. The next section will elaborate on GED programs while highlighting the science education portion of these programs and focusing on the adult learners involved.

**General Educational Development (GED)**

The assumption that a free and enlightened electorate could be accomplished through education during childhood has created a child centered education approach and has contributed to the need for adult compensatory education programs. The realization that learning is a continuous, life-long process has led to the establishment of programs that provide education for adults (Evanson, 1977). One such program is the General Educational Development (GED) program.

The General Educational Development (GED) Tests enable people to earn a high school equivalency diploma and helps them to qualify for more jobs and opportunities. According to the
Commission on Educational Credit and Credentials of the American Council on Education (ACE),
the GED tests were developed to “enable persons who have not graduated from high school to
demonstrate the attainment of developed abilities normally acquired through completion of a high
school program of study” (American Council on Education [ACE], 1993a, p. 2.3). The American
Council on Education, the sponsor of the GED, works closely with adult education programs,
schools, libraries, state governments, and local governments to help people earn a high school
equivalency diploma so that they can qualify to attend college, enter training programs, and get
better jobs. Although no formal education is required for the GED, many people attend adult
education classes offered by local school districts, colleges, and community service agencies that
are usually free. The GED tests are designed to assess those intellectual (including analytical and
organizational) skills, major generalizations and concepts, and application of knowledge generally
associated with each academic area at the high school level. Recall of facts is tested through a
number of discrete items, mostly in social studies and science, but is not emphasized (New York
State Education Department, 1981). According to the ACE, GED tests are designed to measure
those major and lasting educational skills and concepts that contribute to functioning successfully
as adults in our society (ACE, 1993b). Thus we see an emphasis on the societal aspect of
education.

The GED tests encompass the following parts: Writing Skills, Social Studies, Science,
Interpreting Literature and the Arts, and Mathematics. The test questions require general
knowledge and thinking skills and are all multiple choice, except Part II of the Writing Skills Test.
These tests are not concerned with specific details and definitions, but are more concerned with
broad concepts and with the ability to use knowledge meaningfully in problem solving (Toews,
1988). The tests used in today’s GED testing program are the “third generation” of such tests.
The first GED tests were developed by the ACE for the United States Armed Forces Institute to
measure outcomes of high school instruction to provide military personnel and veterans who had
not completed a high school program the opportunity to demonstrate a level of achievement comparable to that of high school graduates (ACE, 1993b). These first tests, used from the inception of the program in 1942 until 1978 were built on a model focusing solely on the major and lasting outcomes of a traditional high school program of study. The second generation of GED tests, introduced in 1978, retained their emphasis on high school outcomes, but introduced life-like contexts into many of the test items to increase their relevance (Whitney, 1983). These tests had some important features including: (1) they demanded more highly developed levels of critical thinking and problem solving; (2) they reflected the many roles of individuals such as worker, family member, consumer, and citizen; (3) they acknowledged the sources of change affecting individuals and society such as rapid introduction of computers, shifting political practices, and scientific advances; and (4) they contained settings that adult examinees recognize as relevant to daily life. The current version of the GED tests was developed on the basis of a five-year review process that began in November 1982 (ACE, 1993b). On the basis of the review process, the Test Specifications Committee recommended that the new GED tests should: require examinees to demonstrate their high-level thinking abilities and problem-solving skills, include a clear emphasis on the relationship of the skills tested to aspects of the world of work, represent an awareness of the impact of computer technology, address certain consumer skills, and use settings that the adult examinees recognize with stimulus materials relating to aspects of everyday life (GED Testing Service, 1984). Thus, in these tests we see features similar to those considered important in contemporary science education reform such as critical thinking and problem-solving (Kowal, 1991), informed citizenship and participation in society (Bybee, 1985), being comfortable with the rapid advances in science and technology (NSTA, 1985), and the issue of relevance to the everyday life of the student (Wraga and Hlebowitsh, 1991). An important point to consider is whether there is a translation of these concepts into the actual curricula that is implemented in the GED courses.
The GED science test measures the ability to use knowledge and information about fundamental scientific concepts (ACE, 1993b). It has an equal balance of items from both the life sciences and the physical sciences. Most items are not designed to test factual knowledge directly but require examinees to use information provided in the test items or acquired through life experience, with the focus on abstract reasoning and problem-solving ability. Basic knowledge of scientific principles, concepts, and methods is essential not only to demonstrate an understanding of the information but to use or manipulate the information or ideas that are provided. Test items relate to major conceptual themes that cut across all disciplines of science including the constant rate of change, conservation of mass and/or energy, interactions within or between natural systems, and the relationship of time and space to natural phenomena (Toews, 1988). They also measure the examinee's understanding of how science relates to one's personal life, the natural environment, the potential and limitations of science in explaining natural phenomena, and the relationships between science educational skills and work (Toews, 1988). Thus the GED science tests do incorporate important aspects of contemporary secondary science education such as an interdisciplinary approach (AAAS, 1989; McCormack, 1992), relevance of science to peoples' lives (AAAS, 1989; NRC, 1996), the understanding of the potential as well as the limitations of science and technology (NRC, 1996), and the applications of science and technology outside the classroom.

GED programs have become increasingly important in the educational scene because the GED diploma or its equivalent is considered one of the most valuable indicators for potential success and is increasingly critical for higher paying jobs in the industry, civil service, and armed forces, and also for self improvement and a feeling of satisfaction in obtaining an educational goal (New York State Education Department, 1981). According to a 1987 GED Statistical Report, the GED program accounted for 15.9% of the diplomas issued in the United States (ACE, 1988a). Currently, one in every six high school diplomas is a GED (ACE, 1995). The growth in GED
testing appears to be the result of increased marketing and publicity activities as well as tightening job markets in some regions. These tests are increasingly being perceived as gateways to better jobs, better careers, more enriched personal lives, and more efficient citizenship. Therefore, it is important that the curriculum in GED preparatory courses should reflect these objectives and that students leave these courses with attitudes that will enhance the application of their knowledge and skills in their daily lives. In order to enhance the discussion of the science portion of the GED curriculum, it is important to address the concept of curriculum as it applies to adult education.

The concept of curriculum in adult education

According to the German Education Council, curriculum means the organized arrangement of learning processes and content with regard to certain aims and objectives that can be defined either as behavior or as type and degree of certain skills and aptitudes or knowledge (Knoll, 1990). Before the 1970's, curriculum, curriculum revision, and curriculum development were only discussed in terms of school-based education, but since the mid-1970's there have been various attempts, models, and projects which aim at applying the concept and content of curriculum to adult education. Curriculum development is concerned with determining desirable educational goals and with a structure for achieving these ends (Peters, 1974). It provides a framework for achieving objectives and is a dynamic, continuous process that should be constantly evolving to meet the needs of the people in a changing society (Rand, 1976). In keeping with the constantly changing nature of the understanding of science, its applications to society, and the rapid technological advances in society, the curriculum for the science education of adults should reflect this constantly evolving nature. However, there is no real evidence of this in the educational literature. Unlike curriculum development efforts in secondary school science which constantly explore ways to improve the standard and quality of education and try new approaches to enhance learning, such efforts in adult education have been few and far between.
Siebert (1975) assigns curricular strategies to four dimensions: (1) Deductive strategies in which concrete aims and objectives are derived in a linear fashion from general norms, aims, or social theories; (2) Inductive strategies where empirically acquired data regarding necessary qualifications, educational needs, and areas of application form the elements of the curriculum; (3) Analytical strategies where existing curricula and curricular theories are analyzed, criticized, evaluated, and revised; and (4) Educative strategies where curricular decisions are not made before but during lessons and are discussed and justified together with experts, teachers, pupils, and parents (Knoll, 1990). However, before developing a curriculum, it is important to consider what exactly the curriculum encompasses.

In the past, curriculum has generally been identified as the content of the teaching program. However, from the 1970's onwards the trend has been to define it in terms of the whole learning situation which includes the entire range of educational practices or learning experiences (Lawton, 1973). More recently, educators have become aware that curriculum is a very complex issue. The written syllabus is the specified content of what should be taught in the teaching and learning transaction. There also exists a hidden agenda that is not hidden from the teacher and can range from empowerment to awareness of political issues. This factor can be exceedingly important when dealing with adults who are generally returning to obtain high-school equivalency diplomas in order to enhance the quality of their lives. This concept is especially important in the science education aspect of these courses since the emphasis in science education today is on promoting scientific literacy in order to achieve the goals of empowerment and ability to make decisions about socio-political issues (Kowal, 1991). Incorporating the themes currently emphasized in secondary science education into the science education of these adults could help achieve this goal since promoting scientific literacy is an important aspect of current secondary science education reform efforts. In addition to the hidden agenda, another consideration is that
the student can reflect on the content presented and reject it or modify it before assimilating it. Thus there exists an overt and a covert aspect to the curriculum (Jarvis, 1990). In adult education the hidden curriculum is important as it can be used to empower adults for social action. This could not only equip the adult students for effective citizenship, but in doing so could also enhance their self-confidence and feeling of active participation in society.

An important question that arises is what knowledge should be included in a particular curriculum. According to Paterson (1979) a curriculum for adult education is designed to enlarge the student's awareness and put him in more meaningful touch with reality by building up in him rich and coherent bodies of worthwhile knowledge. Paterson goes on to pose the important question about what principles can be used to decide which items of knowledge ought to be included and which kinds of knowledge ought to be assigned priority. The content of the curriculum is subject to a variety of external influences and depends on the educational needs which prevail within a given educational system and which are composed of the correlation between individual demands and those made by society (Knoll, 1990). While talking about the content of the curriculum in adult education, Jarvis (1990) makes an important point that the content which is taught embodies an element of social control while that which is learned may result in either conformity to or freedom from the social structures within which the education occurs. Knowledge that is included in the curriculum generally tends to be abstract, literate, and individualistic and achieves high status within relevant social groups while that which is omitted tends to reflect daily experience but is automatically relegated to low status (Young, 1971). MacDonald and Clark (1973) insist that curriculum development is a continuous process of making human value judgments about what to include and exclude, what to aim for and avoid, and how to go about it. This aspect should be given special consideration in the development of curricula for GED courses because of the diversity in the culture, background, and experiences of the adult students involved. The curriculum of adult education programs has to anticipate future
life situations in order to design teaching methods based on these projected needs, enabling the learner to cope with future life situations. This is important in the case of the science curriculum because it has to help the learner feel comfortable with recent technological advances and their applications in the workplace. An effective curriculum should not only impart the technological skills required by today's work force, it should also give learners an understanding of the potential as well as the limitations of these advances so that they can function as reasonably confident members of this work force. These are important aspects of scientific literacy which is the goal of the current science education reform efforts. Cock (1977) argues that cognitive skills should not be ignored in the development of curricula for adult students, but in addition to these, improvement of interests, attitudes, and values of adult learners must be also considered. Thus we see the need for paying attention to the cognitive as well as the affective outcomes of the curriculum.

Although it is generally assumed in adult education that it is either the teacher or the learner who chooses the curriculum content, Jarvis (1983) argues that this view is limited and it is possible for different levels including the learner, the teacher, the teacher-learner transaction, the educational institution, the prescribing agency, and the government to have influence over the selection of content. However, since most adults learn better by self-direction, the concept of the teacher and student negotiating the curriculum is gaining importance. In designing the curriculum it is important to keep the following goals in perspective: intellectual, social, economic, aesthetic, and physical (McCall and Schenz, 1969). This is important in the case of science which has traditionally been considered an intellectual pursuit. In designing a curriculum, the knowledge and factual basis of science should be balanced with other aspects such as it's impact on society, economic applications, and potential for advancing the personal growth of the individual. These are aspects of science that are generally considered in the development of secondary science curricula.
From the above discussion it is evident that the teaching and learning transaction occurs as the result of a complex interrelationship of a variety of institutions in society and all elements of curriculum design reflect that social process (Jarvis, 1990). The content of the curricula also reflects a number of factors including economic pressures, objective educational needs, the philosophy behind the educational system, the views of adult educators, the participants' outlook on life, organizational issues, and the participants' expectations. In discussing science curricula for GED courses, it is important to consider the goals of adult education intermeshed with the goals of science education while at the same time keeping the adult learner at the center of the discussion and focusing on the unique characteristics, needs, and aspirations of the adult learner.

The curriculum and adult learners

Historically, as tests developed to help identify individuals whose educational skills can be demonstrated to be at a level which justifies the award of an academic high school equivalency credential, the GED tests have relied extensively on the high school curriculum as a source of educational skills to be tested (Whitney, 1983). However, in designing curricula for GED courses it is important to keep in mind the fact that adult learners are very different from high school students and it is necessary to tailor the curricula to fit their needs, experiences, and expectations. In designing curricula for adult education programs it is important to consider the characteristics of the adult learners that influence the teaching and learning outcomes. Some factors that should be considered include: (1) age, which has implications in vision, hearing, and physical endurance; (2) background and experience of the adult learner; (3) adults are goal-oriented and therefore learning must be oriented to concrete outcomes; (4) adults do not comprise a captive audience and always have the option to leave the program if not satisfied; (5) adults are mature individuals and resent being talked down to; (6) adults form a more heterogeneous group than children; (7)
adults have a greater variety of motives for attending classes than children; and (8) the student could be in the program voluntarily or could be brought in by a public agency (Brewer, 1977).

The concept of building a curriculum on an analysis of the requirements of adult living is embedded in a tradition which extends at least a century into the past (Griffith & Cervero, 1976). But after the decision has been made to build a curriculum around an analysis of the requirements of daily living, the problem arises as to how these requirements of daily living are to be identified and employed as a foundation upon which a structure of educational objectives and tasks may be erected. One of the ways of accomplishing this is to design a curriculum that fits the needs/wants of the individuals based on the results of a survey of students, continued teacher input, and research of various curricula implemented in other programs (Pima County Schools, 1986). However, such research pertaining to the science education aspect of adult education is not obvious in the literature. An important consideration is that adult learners are a diverse group and are at different cognitive levels in different topics. The literature reveals different approaches to address this issue. A viable option is developing individual prescriptions jointly by the student and the instructor detailing the steps and materials necessary to master each unlearned skill within a given time-frame. In order to hold the adult learners' interest it is important that no student receive instruction in skill areas already mastered and all students receive instruction at a level they are comfortable with (New York State Education Department, 1981). When deciding about the need to develop individual instructional plans, care must be taken not to equate literacy level with cognitive level. Although all adult learners in a classroom may share approximately the same literacy level, differences in chronological age, aptitude, level of motivation, state of health (physical and mental), and life experience all combine to make each student unique. An instructional program capable of responding to this range of differences must be individualized so as to make the best use of time and maintain student interest. Assuming an identifiable learning hierarchy, it should then be possible to adjust the instructional sequence in terms of the rate at
which concepts are introduced, the level of abstractness at which they are presented, the
instructional mode employed, and the kind of practice available to each learner (Schmidt, 1972).
The Texas Education Agency proposed the technique of layered instruction to aid in the
introduction of new content or concepts to classes containing multiple ability groups. In this
technique, students are classified by skill levels, and learning activities aimed specifically at the
needs of each skill level group are introduced. Although each group works independently, the
activities for each group are variations of the same activity (Texas Education Agency, 1990).

An important factor in curriculum design is the arrangement of the curriculum. Although
the arrangement of curriculum into subject fields seems to increase the ease of relevancy for the
participant, organizing it in terms of broad areas that cut across subject fields seems to make the
transfer of knowledge, skills, or attitudes to daily living an easier one (Rand, 1976). This would
help adult learners in coping with different life situations and enhance the real-life applications of
their learning. This is similar to the trend in science education towards an integrated curriculum
that spans different disciplines but at the same time focuses on the applications of these
disciplines (Hurd, 1986).

Another aspect that has to be considered in development of a science curriculum for GED
courses is that science is a subject which intimidates many adult students because scientific
language is not only filled with technical jargon, but is also exclusive of other kinds of language,
such as that of religion, spirituality, or philosophy. It also tends to deal with empirical facts and
attempts to define reality using a very limited set of experiences which may sometimes come into
conflict with what is real or important to the teacher or students (Buckingham, 1986). To bypass
these problems the curriculum should be designed in such a way that it draws on students'
knowledge of the world and issues relevant to the students' lives. Such a curriculum could
encompass real life applications of acquired knowledge as well as the application of this
knowledge in thinking critically about socially relevant issues and informed participation in society. These are themes currently being emphasized in secondary science education. Therefore incorporation of these themes into the adult education curriculum could help in achieving some of the aims of the curriculum in adult education. In all these discussions of curriculum in adult education we see the importance of the affective domain.

In order to gain an understanding of the current status of science in the GED curricula, existing curricula in the Educational Resources Information Center (ERIC) database were reviewed and analyzed. This gives some indication of what currently exists in practice and the correlation of actual practice with the stated program goals. Such an analysis throws light on issues that need to be addressed and changes that could be made to improve the quality of science education in the field of adult education.

**Review and analysis of GED curricula**

In the GED test preparation program of the Memphis City School System (Memphis City School System, 1969) one of the benefits listed is preparing students to be informed and thinking citizens prepared to meet the practical demands of a changing society. This is also one of the aspects of education emphasized in current secondary science reform efforts. However, the science curricula outlined only contains lists of science topics with no mention of connections to society or current issues. In most programs this would be up to the teacher to incorporate into the instruction. However, an important aspect of GED courses is that many of the teachers are volunteers and even if they are not volunteers, they generally have no formal science education background and therefore have no experience in incorporating these issues into their teaching. One way to ensure that the students do achieve the stated program benefits would be to include them in the curriculum guidelines. This curricula was implemented in the post-Sputnik era in
science education where high school science curricula were designed to focus on science process skills and scientific habits of mind. These characteristics, however, were not evident in the adult science curricula being implemented at that time.

In some more recent curricula, analysis revealed no apparent influence of reform efforts in education. For example, the Adult Basic Education Curriculum Guide of the Cincinnati Public Schools outlines the curriculum for GED preparation courses (Cincinnati Public Schools, 1988). The outline lists objectives/skills, content/teaching strategies, and evaluation. An examination of this curricula reveals that the objectives are specific science content without any emphasis on the social value or transferability of this content or on the impact of those content areas on everyday life and on society or on current issues. The teaching strategies listed revolve around teacher explanations and students reading materials while the evaluation techniques are tests similar to the GED science test. In curricula like these we do not see any influence of the reform efforts in science education such as relevance, connections to technology and society, student-centered instruction, hands-on activities, and authentic assessment.

However examination of other curricula indicate that the reform efforts that have been seen in high-school science are gradually finding their way into some curricula for adult students. The Mercer County Vocational-Technical School recently published a hands-on science curriculum for their GED preparatory program (Handerhan & Smoker, 1994) designed to provide adult learners with hands-on activities and demonstrations to develop skills in physical science. Each unit in the guide contains some or all of the following: behavioral objectives, list of supplies needed for the unit, definitions of vocabulary, concepts covered in the unit, background information needed for the activities, activity sheets, and answer keys. The design is such that the teacher has the flexibility to use a variety of methods and strategies in the presentation of the
science concepts so that the presentation can be altered depending on the characteristics and needs of learners in any group.

Another trend in science education is the concept of building on student's preexisting knowledge structures. Some recent adult curricula reflect this trend. While talking about approaches for teaching GED classes, Desmond Reid (Wolfe, 1987) argues that in designing actual lesson plans it is important to build on the student's prior knowledge. Because of the wide variety of backgrounds and experiences, the knowledge present in an adult classroom ranges from geography to economics, history, anthropology, science, and mathematics. These experiences can be shared with other students to help students realize the interconnectedness of knowledge and the fact that they have acquired a storehouse of knowledge upon which to build. One of the ways of achieving this is to determine from students what they already know about a certain topic and then pool the information. This activity will increase curiosity, raise questions, and make use of student expertise (Wolfe, 1987). This is an example of how the concepts of constructivism, integration, and collaboration might be used in GED science curricula to enhance the science education of adult students.

In today's technology-driven world, high technology is consistently being incorporated into educational curricula and classroom instruction. A review of GED curricula reveal that this is not true for many of the GED courses. However, some programs are introducing technology into the curriculum. An example is the Laser Disc Technology project of the TIU Adult Education and Job Training Center that uses laser disc software to enhance social studies, science, and literature and the arts in GED classes. The program evaluation reported that the introduction of this technology enhanced the instruction and also provided a means for students to be comfortable and not intimidated when exposed to high technology (TIU Adult Education and Job Training Center, 1993). Since technical skills can be directly applied in the workplace, training in such
skills has a direct impact on an adult's functioning on the job and improving self-confidence. Thus we see some emphasis on the affective domain here.

Some projects such as the Appalachian Employability Skills Project which provides adults with courses for preparing for the GED and also for training, employs a wide range of reform ideas in its curriculum including problem-solving, cooperative learning, constructivism, real-life applications, active learning, and the utility of knowledge. It utilizes a "problem-centered structured inquiry" model. The instructional sequence for each unit consists of four stages: stimulus, evocation, objective inquiry, and application (Eyster, 1979). One of the tenets of this project is that basic skills instruction is a disservice unless accompanied by instruction which leads to the application of these newly acquired skills in information seeking, problem solving, and/or employability skills.

A review of existing curricula indicate that some trends in secondary science education do not seem to have a big impact on adult science education. These include integration, applications to other subject areas, environmental awareness, and current socio-political issues. An important issue that needs to be considered is the need for integrated culture-based and culturally relevant curriculum since a large proportion of adult learners belong to cultural minorities (Reyhner, 1991). It is likely that they are taken into consideration by individual instructors, but guidelines in curriculum packages would enhance their implementation. This would be especially useful for the volunteer-teachers who do not have formal education background. Detailed curriculum packages that include technological applications, relevance, and societal issues would help them achieve the goals of adult education. With different curricula and different approaches to adult education, it is important to consider the student's attitudes which have a profound impact on their use of the knowledge and skills gained through their adult education experience.
To hold adult students' attention and interest, the curriculum should promote active learning. Some strategies that can be used in the implementation of any given curriculum to promote active learning include:

(1) foster student control over the educational process, rather than dependency on teachers or curricular materials;
(2) encourage collaborative work by the students;
(3) promote active learning, encourage students to pose their own questions rather than just answering the questions of others;
(4) encourage students to bring to the class materials they are comfortable with, which they find relevant to the work there;
(5) provide students with real reading materials like books and newspapers which are what students want to read;
(6) use writing as one way of learning about the self, and about content material;
(7) encourage discussion connected to reading and writing;
(8) develop a community of learners/teachers in the classroom;
(9) understand that students see GED classes as a way to achieve their educational goals;
(10) use GED materials and tests as a beginning point for learning as well as an initial goal;
(11) provide students with practice in analyzing the types of questions in the GED, not simply practice in answering them; and
(12) examine the issue of power in the classroom as a vehicle for student/teacher reflection about the world (Wolfe, 1987).

Many of the above strategies are those encouraged in current secondary science education reform efforts.

GED science education

Most of the literature, when discussing intervention strategies to address the problem of scientific illiteracy in the American public, focuses on school-age population. Various improvements and reforms are being discussed and implemented including changes in teacher
preparation, additional course requirements in science and mathematics, scholarships and prizes to reward scientific and engineering accomplishments, improved educational resources, and tailoring teaching strategies to meet the students' needs (Prewitt, 1983). However, a population that appears to be neglected in these efforts is adult students who are participating in adult education programs. The research conducted in secondary school science education needs to be extended into adult education science programs so as to achieve the goal of scientific literacy with this population and enable them to become important contributing members of society.

Adult Education programs pose a challenge to educators because of the special characteristics of the program participants and the wide range of contexts, philosophies, and goals of these programs. Knowledge of the theories and philosophies of adult education can guide the educator in designing and implementing an appropriate curriculum. Because of the wide variety of programs, educators should draw from different planning models and literature on the development of actual GED curricula to assist him/her in designing and implementing a curriculum that is meaningful and useful to all the individuals involved in the program. When dealing with the science education aspect of adult education, it could be advantageous for adult educators to draw from research already done in the field of secondary science education and tailor findings from this to suit the characteristics and needs of adult learners.

In today's rapidly advancing technological world, the products of technology, together with their accompanying sociological and environmental implications, are essential features of daily life (Hofstein and Yager, 1982). Technology introduces changes in society which may impose certain social costs such as undermining social values, harming some social interests, and penalizing some social groups (Prewitt, 1983). This is especially important in the case of adult learners in GED courses whose reasons for being in these courses may range from increasing their employability to personal satisfaction and increasing self-confidence. Helping these adult learners
to be comfortable with the technology in use in today’s workplace could help them in achieving their goals.

A more central societal concern currently is teaching science for scientific enlightenment; the knowledge considered to be important is that which supposedly will be useful and relevant to the solution of societal problems (Hofstein and Yager, 1982). The specialized information required to be knowledgeable about almost any given political issue is increasing rapidly (Miller, 1983). It is important for citizens to be able to apply scientific knowledge and technical vocabulary toward consideration of social-scientific problems or issues (Wraga and Hlebowitsh, 1991). Teaching science to adults should focus on imparting the necessary knowledge and developing the necessary critical thinking skills and attitudes to knowledgeably discuss science and technology related societal issues and participate fully as informed citizens in a democracy.

In addressing the question of what determines a needed area of research in science education, Welch (1985) states that a need could grow out of a personal interest area, a discrepancy between a wish and a have, an intriguing question, a national priority, or a combination of these. In developing a rationale for the need for research to be done in the science education aspect of adult education, it is important to focus on the importance of achieving universal scientific and technological literacy. Science literacy is crucial for an informed electorate in the increasingly technological society in which we live. In secondary education, public concern about the decline in science literacy has prompted increased citizen involvement in educational decision-making (Welch, 1985). However a corresponding effect in adult education is not apparent in the literature. This highlights the need for research to be conducted in this area.

With the development of new GED tests, new GED curricula will have to be developed to meet the changing needs of the adult students. These new GED tests will be in use by the turn of
the century. Thus we are at a unique time in the history of the GED program where substantial changes can be made. Recent reform efforts in secondary science education can be used to guide the development of these new tests and curricula. Research done in this field can be used as the basis for their development. Due to the paucity of research in this area, there are many aspects that need to be studied. These include attitudes of adult students toward science, relevance of the knowledge and skills acquired, the role of the GED educational experience in promoting scientific literacy, and the effects of hands-on or other educational approaches in achieving adult learning outcomes including cognitive and affective ones.

This research effort focuses on the affective domain of adult science education in the GED courses. Therefore the next section will elaborate on this domain.

Attitudes Toward Science

The attitude concept

While tracing the history of the concept of attitude, Koballa (1988) states that it was first used as a psychological concept by Thomas and Znaniecki in 1918 to describe the acculturation of Polish peasants in urban America. The concept of attitude then progressed through stages where it was used to describe the physical posture of immobile figures to describing the movement among actors and dancers to its current description as "a learned predisposition to respond in a consistently favorable or unfavorable manner toward an attitude object" (p. 116). Thurstone (1931) has defined an attitude as the degree of positive or negative affect associated with some psychological object. According to Edwards (1957) "an individual who has associated positive affect or feeling with some psychological object is said to like that object or to have a
favorable attitude toward the object" while "an individual who has associated negative affect with the same psychological object would be said to dislike that object or to have an unfavorable attitude toward the object" (p. 2).

There is some confusion in the literature between beliefs, values, attitudes, and behaviors. While discussing the relationships between beliefs, attitudes, behavioral intentions, and behavior, Ajzen and Fishbein (1980) suggest that a person's beliefs about an object determine how the person feels toward the object or the person's attitude toward the object. This attitude, mediated by values, determines the person's behavior intentions which influence how the person actually behaves toward the object (Koballa, 1988). Another distinction between attitudes and other psychological concepts is made by Shrigley & Koballa (1984) who highlight emotional intensity as the quality that distinguishes the attitude concept from other related psychological concepts. They define emotional intensity as the readiness to respond favorably or unfavorably towards psychological objects.

The attitude concept in science education

While discussing trends in science education, McCormack (1992) states that new perspectives on learning offer central places for both thinking skills and knowledge and also give appropriate recognition to the domains of attitudes, creativity, and applications. The last few decades has witnessed a shift in emphasis placed on the outcomes of science education. From a system that emphasized only the cognitive outcomes we have progressed to one that places equal emphasis on the affective outcomes of science education (MacMillan & May 1979). This shift stems from the belief that affective variables are as important as cognitive variables in influencing learning outcomes, career choices, and use of leisure time (Koballa, 1988). While
discussing a taxonomy for science education, McCormack & Yager (1989) highlight the attitudinal domain as one of the five domains of science education.

**Attitude Research**

An important goal of science education programs today is to foster more positive attitudes toward science and the scientific enterprise. The importance of attitudinal goals in science education has been well documented in the educational literature (Abraham, Renner, Grant, & Westbrook, 1982; Koballa, 1988; Koballa & Crawley, 1985; Mitias, 1970; Schibeci, 1982; Schulman & Tamir, 1973; Towse, 1983; Voss, 1983; Yager & Penick, 1984). There is also evidence of the importance of student attitudes in the quantity of research done in that area (Krynowsky, 1985). Major reviews of attitude research in science education have been conducted by Ormerod and Duckworth (1975), Gardner (1975), Haladya & Shaughnessy (1982), Munby (1980), and Schibeci (1984). Numerous research studies have been conducted to determine the relationship of science attitudes with various aspects of education including classroom individualization (Fraser & Butts, 1982); community context (Charron, 1991); new curriculum materials (Starr, 1972); the teacher (Nielsen & Thomsen, 1988); teaching methods (Byrne & Johnstone, 1988); classroom learning environments (Mason, Kahle, & Gardner, 1991); extracurricular science activities (Hofstein, Maoz, & Rishpon, 1990); course content (Sundberg, Dini, & Li, 1994); self-concept (Handley & Morse, 1984); gender (Kahle, 1984); attitudes toward self, family, and school (Talton & Simpson, 1986); new instructional approaches (Shepardson & Pizzini, 1993); television viewing (Gerbner, 1985); and students' background (Schibeci & Riley, 1986)
Some findings from attitude research in science education include:

1. The more students are exposed to science, the less they like science (Shepardson & Pizzini, 1993)

2. Students attitudes toward science declines from the junior to the senior high school years (Harms, Bybee, & Yager, 1979)

3. Most students feel that support should be given to scientific research but are less enthusiastic concerning their personal involvement in scientific projects and activities (Huftle, Rakow, & Welch, 1983)

4. Students perceive that science and scientific research are important but they do not extend such appreciation to science studied in school (Hofstein & Welch, 1984)

5. Enrollment in science courses is declining and that decline is affected by affective variables (Milner, Ben Zvi, & Hofstein, 1986)

6. Science classes are reported to be interesting by elementary school students, significantly fewer secondary school students find their science classes interesting (Yager & Bonnstetter, 1984).

National and International Attitude Research

The first time science attitudes were assessed on a national scale was the Third Assessment of Science, conducted in 1977, that was part of the National Assessment of Educational Progress (NAEP). This assessment included an extensive battery of items dealing with the affective domain and provided valuable insights concerning student and adult perceptions of science teachers, classes, and course content (Yager & Bonnstetter, 1984). A more recent national effort is the 1990 NAEP science assessment that investigated the importance of science education to schools and students, whether students enjoy or dislike science, and the extent to which school provides relevant experiences (National Center for Education Statistics [NCES], 1990).
The results of this inquiry indicated that 80% of fourth graders reported that they liked science, but affinity for science decreased from elementary to secondary school with less than two-thirds reporting liking science at grade 12. On an international level, the largest international educational comparative study to date is the Third International Mathematics and Science Study (TIMSS) which studied classrooms around the country and around the world. Some of the data collection instruments used in this study paid attention to the affective domain. For example, the questionnaires asked students their opinions about math and science and the case studies highlight students' attitudes toward school (NCES, 1996).

Gender Issues

Some research studies have reported that males have more positive attitudes toward science than females (Handley & Morse, 1984). But the research literature also documents conflicting conclusions (Moffat, 1992). The meta-analysis by Steinkamp & Maehr (1984) arrived at the conclusion that in some subjects such as chemistry and biology, girls tend to like science more than boys. However, the meta-analysis by Fleming and Malone (1983) concluded that except for the junior high school years, girls liked science less than boys. In their study of the relationship of adolescents' self-concept and gender role perceptions to achievement and attitudes toward science, Handley & Morse (1984) concluded that students' self-concepts/gender role perceptions were related to both achievement and attitudes toward science, but more related to attitudes than achievement.

Self-Efficacy

An important aspect of attitudes is self-efficacy. According to Bandura (1978), self-efficacy theory postulates that different modes of influence alter coping behavior by creating and
strengthening expectations of personal efficacy. Schunk (1984) states that although self-efficacy was originally utilized to help explain coping behavior in fearful situations, it has been extended to other contexts including cognitive skill learning. Perceived efficacy influences choices of activities and environments and also determine how much effort people will expend and how long they will persist in the face of obstacles (Bandura, 1978). In his discussion on the centrality of the self-efficacy mechanism in human agency, Bandura (1982) states that "perceived self-efficacy helps to account for such diverse phenomena as changes in coping behavior produced by different modes of influence, level of physiological stress reactions, self-regulation of refractory behavior, resignation and despondency of failure experiences, self-debilitating effects of proxy control and illusory inefficaciousness, achievement strivings, growth of intrinsic interest, and career pursuits" (p. 122). Factors influencing the cognitive processing of efficacy information arise from enactive, vicarious, exhortative, and emotive sources (Bandura, 1977). In their causal model of career choice, Hackett and Betz (1981) portray perceived self-efficacy as a major mediator in determining career choice.

Student attitudes have also been used as an evaluation tool to assess teaching methods and new curricula (Ato & Wilkinson, 1982). However, it must be noted that most of this research is confined to the K-12 educational system. Outside this realm, some research has been done on the general public's attitudes toward science. Yager & Penick (1986) concluded that noncollege adults hold science in lower regard than do younger age groups. Noticeably lacking in the research on students' attitudes toward science is the attitude of students in non-traditional educational settings such as Adult Basic Education courses or General Educational Development courses.
The concept of attitudes toward science

In the psychological literature attitude is defined as the "affect for or against a psychological object" (Thurstone, 1931, p. 261). According to Haladya & Shaughnessy (1982) concepts in the affective domain remain inconsistently defined in the science education literature. There is some confusion on the educational scene between attitudes toward science versus scientific attitudes (Shrigley & Koballa, 1984). Different researchers and science educators have given different meanings to these concepts. A review of the literature on attitude research in science education reveals that these concepts have sometimes been used interchangeably. However, there is some sort of general consensus on the meaning of scientific attitudes. Scientific attitudes have been described as those that consider the supposed characteristics of scientists at work (Munby, 1980); an adherence to knowledge of the scientific method (Aiken & Aiken, 1969); the adoption of a particular approach to solving problems, assessing ideas and information, or making decisions (Gauld, 1982); or desired attitudinal outcomes such as regard for evidence, thoroughness, and attention to detail (Ormerod & Duckworth, 1975).

Attitude toward science, on the other hand, has had diverse connotations in the literature (Krynowsky, 1988). While discussing problems in assessing student attitude in science education, Krynowsky (1985) records the diverse meanings that attitude toward science has in the educational literature including: feelings, opinions, beliefs in and about, and appreciations which individuals have formed as a result of interacting directly and indirectly with the various aspects of the scientific enterprise (Hasan & Billeh, 1975); emotional reactions of students toward science (Gardner, 1975); how an individual feels about science (Dutton & Stephens, 1963); and feelings, beliefs, and likes toward an attitudinal object in the field of science (Munby, 1980). To Ormerod & Duckworth (1975) attitudes toward science and scientists refer to the disposition of mind for or
against scientists and scientific activity while Koballa & Crawley (1985) used the term to refer to a general and enduring positive or negative feeling about science.

In this study attitude toward science is considered to be the general feelings about various aspects of science including the subject science, science teaching and learning, the scientific enterprise, scientists, relevance of science to everyday living, importance to society and citizenship, science-related issues, science-careers, and feelings of efficacy in the realm of science.

Attitudes and Democratic Citizenship

In the past few decades the role of science education has changed from one of producing an elite minority of scientists, technicians, and engineers for industrial growth to one of promoting scientific literacy and critical thinking ability among the whole population (Brophy & Pillay, 1986). Therefore the importance of positive attitudes toward science should not be restricted to those who could possibly pursue scientific careers, they are important for the general population. Hofman (1977) talks about the importance of science attitudes for students not likely to become scientists and states that if their attitudes toward science are negative, it is unlikely that they will benefit from the study of science that is necessary for their survival. It is generally accepted that attitudes influence a person's ability to participate actively in a democratic society. Payne (1977) stresses the role of positive attitudes in responsible citizenship. Positive attitudes toward science leads to interest in scientific and technological matters which provides citizens with important background in participating and acting on issues of social concern involving science and technology. Positive attitudes engender a tendency to delve deeper into the underlying issues and gather information to make rational decisions about issues that affect society and the environment.
Attitudes and Everyday Life

MacMillan and May (1979) argue that the objective of any science curriculum includes fostering favorable feelings toward science as well as imparting cognitive knowledge. Some educators go a step further and argue that feelings, attitudes, and values that are imparted by science courses may ultimately be more important in the students' lives than anything else in the science curriculum (Simpson, Renz, & Shrum, 1976). If students do not hold positive attitudes toward science and do not believe that science is something they can use in their everyday life, they will not be able to relate concepts and skills taught in the science curriculum to their lives and this undermines the relevance of their science education. While discussing instructional goals in eighth-grade science classes as part of the science assessment done by NAEP (NCES, 1992), it was concluded that there is a consensus about the importance of students' abilities to apply science content to situations they know and care about, including applications in daily life, in technology, and to issues of social concern. Students' abilities to apply science in their everyday life is contingent to whether they think that science does have applications in everyday life and in society.

Positive attitudes toward science could also foster positive attitudes toward technology, a tool of science. In today's technology-driven world, we see the growing use of technology in every aspect of life. People in all careers, whether science or non-science-related, need to become proficient in the technological tools of today's society in order to function well in their occupations. Positive attitudes and feelings of efficacy in using and manipulating technological tools can be extremely beneficial to people in all aspects of their lives.
Certain educational programs state attitude development among their explicit aims. For example, an STS-focused junior secondary science program developed and implemented in British Columbia, was designed to provide opportunities for students to develop positive science attitudes in line with the program objectives of showing how science can be helpful in solving many everyday problems, fostering an appreciation of the impact of technology on the world, and developing a more responsible attitude towards self and society through the examination of social and environmental issues (Ebenezer & Zoller, 1993).

**Attitudes, Learning, and Achievement**

Educational research documents a strong correlation between student attitudes toward science and actual learning of science content (Osborne, 1976), achievement in science courses (Germann, 1988; Cannon & Simpson, 1985), or choosing science related careers (Mason et al., 1991). Positive attitudes toward science would stimulate genuine interest in the subject and the active engagement of the learner's mind in the learning activity. Positive attitudes also lead to engaging in strategies to enhance existing knowledge. Attitudes also play an important role with regard to relevance of knowledge acquired. Byrne & Johnstone (1988) argue that almost all attempts to make science relevant are concerned with attitude change as well as cognitive gain. Mager (1968) states that the likelihood of the students putting his/her knowledge to use is influenced by his/her attitude for or against the subject. Educators can use their awareness of student attitudes to stimulate interest in science as well as raise the general level of scientific literacy and achievement (Eichinger, 1992). Although there has been some debate about whether the relationship between attitudes and achievement is causal or correlational (Schibeci & Riley, 1986; Shrigley, Koballa, & Simpson, 1988), attitude has been generally accepted as a valuable index for achievement (Eichinger, 1992).
Attitudes are important factors to consider in education because they determine whether students are prepared to learn (Omerod, 1973). Tolpin (1971) urged educators to be concerned with attitudes and emotions of the student toward science because in his opinion curiosity and drive for continued learning are dependent on attitudes and emotions. Students are unlikely to be motivated to engage in learning experiences and activities towards which they hold negative attitudes. When compelled to engage in such experiences, their negative feelings would come in the way of meaningful learning. Ato & Wilkinson (1982) state that a measure of general attitude toward science samples a variety of attitude dimensions and should be a reliable predictor of pupil's overall interest and commitment to scientific type activities.

**Attitudes and Enrollment in Science**

Student attitudes toward science have also been found to be important factors in enrollment in science. In studies conducted in Israel, Milner et al. (1986) concluded that enrollment in science courses in secondary schools is influenced by various affective variables including students' interest in scientific information and activities and their feelings toward school science. Akpan (1986) investigated factors influencing the choice of science subjects in Nigerian secondary schools and concluded that attitude toward science was the most important factor in science choice. In order to increase students appreciation of and interest in science, educators and curriculum developers need to take into account students feelings and interests.

**Attitudes and Career Choices**

Mason et al. (1991) document the correlation between positive attitudes toward science and the choice of science-related careers. With the wide array of career choices available to students today, it is highly unlikely that students would choose one toward which they have
negative feelings or one in which they feel they are incapable of functioning competently. To
maintain the nation's competitive edge in science and technology, it is important to attract
students to science-related careers which is not possible without paying attention to students
attitudes toward science and technology. Another important factor is students' attitudes toward
scientists or people who use science. Students often have a stereotypical image of a scientist as
a genius who enjoys working alone and does not have much social contact. If students do not
perceive themselves similarly they are unlikely to pursue a scientific career (Mason et al., 1991).
In order to encourage students into scientific fields they must be encouraged to view scientists
and other people who use science as normal people and they must be encouraged to perceive
themselves as capable of achieving the skills and knowledge for functioning as in a scientific way.

With this discussion on the various aspects and importance of attitudes toward science, it
is now important to lay down a theoretical framework as a foundation for this study.

Theoretical Framework

Germann (1988) while discussing flaws in attitude instruments emphasizes that attitude
research must define the construct being investigated and must describe the place of this
construct within a larger theoretical framework of relevant variables. Before launching into issues
of methodology, it is important to consider the theoretical framework which underlies the study. A
framework should specify the constructs, variables that may be subsumed under each construct,
and statements about the causal relatedness of these constructs. In the literature on attitude
research we see a few examples of theoretical frameworks.
According to Koballa (1988), a belief associates some attribute or characteristic with an object and a set of beliefs form the basis for attitudes. Therefore if beliefs are strongly evaluated negatively, the attitude toward the object will be negative (Mason et al., 1991). Thus the only aspects considered in their theoretical framework were individual's beliefs and their corresponding attitudes.

Various researchers have attempted to study variables that influence attitude. Haladyna & Shaughnessy (1982) classified the variables that influence attitude as exogenous variables which are outside the immediate influence of the educational process such as age, family, and cultural factors and endogenous variables which exist within the system and are under the control of the educational process and its agents, such as teachers, parents, and school administrators. This model gives a systems approach to the concept of attitudes and attempts to consider the big picture.

One of the goals of attitude research is to determine strategies for fostering more positive attitudes. Johnstone & Reid (1981) have proposed a model of attitude change. According to this model, everyone possesses a set of attitudes, many of which arise from upbringing, and deep-seated cultural influences including morality or political stance. These 'personal' attitudes are strongly held and help to protect us from the many cognitive and affective inputs which we constantly receive. Cognitive attitudes, on the other hand, can be changed through presentation of new evidence. The emphasis of this model is that the more amenable an attitude is to cognitive input, the easier it is to change.

A theory that appears to have significant influence in providing a theoretical foundation and frame of reference for attitude research is the Ajzen and Fishbein (1980) theory of reasoned action. The goal of this theory is to predict and understand an individual's behavior while taking
the position that an individual's attitude toward the behavior is one of the underlying variables which may determine the actual behavior exhibited. Intention to perform or not perform a behavior is viewed as an immediate determinant of action. Intentions in turn are determined by both personal and social influences. The personal influence is the individual's positive or negative evaluation of performing the behavior or the person's attitude toward the behavior. Positive attitudes foster stronger intentions toward the particular behavior. Social influences or pressures, called the subjective norm, in turn, interact with the personal ones, in determining intentions. According to this theory, beliefs play an important role in determining attitudes and consequently behavior. A positive belief regarding the outcome of the behavior will lead to a positive attitude toward the behavior. Apart from these behavioral beliefs, normative beliefs which are related to the individual's subjective norm, also influence attitudes and behavior. Normative beliefs include the individual's perception of what others in society believe about the particular behavior being considered (Krynowski, 1988).

For the purpose of this study, different aspects of existing models were combined with the researcher's insights into the characteristics of the particular population under consideration, to develop a framework that underlies the study.

For this model it is important to enumerate some important characteristics of the population being studied:

(1) The population is comprised of adult students of varying ages
(2) Reasons for being in the course of study differ from student to student
(3) These adults have not completed the traditional high school course of study
(4) Their reasons for not completing high school vary considerably
(5) Students may exhibit a low level in reading abilities
(6) Some students may have learning or other disabilities
This model works on the assumption that attitudes predict behavior. Therefore attitudes toward science will predict an individual's tendency to engage in science-related behavior. Positive attitudes toward science would incline an individual toward seeking out more scientific information, following the doings of the scientific enterprise, exercising their democratic rights on social issues related to science and technology, using science knowledge and skills in their daily life, functioning efficiently in the realm of science, considering further science education, and considering science and technology-related careers.

Another important assumption of this model is that attitudes can be changed. According to Koballa (1988) attitudes are susceptible to change because they are learned. Once negative attitudes have been identified, the right strategies could be used to foster more positive attitudes toward science. These strategies would include among others: cognitive input; fostering self-direction in seeking out science-related cognitive input; interaction with people working in the realm of science; effective instructional strategies that engage the students actively; instructional strategies that build on the learner's experiences and foster feelings of efficacy; and highlighting aspects of science that engender positive attitudes including the fun of doing science and using one's creativity, imagination, and persuasion.

However, the attitudes toward science itself is comprised of different dimensions. An individual may have a general positive or negative attitude toward science, but this may not be uniform for all aspects of science. For example, an individual may believe that science has contributed significantly to the advancement of society and our standard of living, but at the same time feel that science as it is taught in educational settings is generally dull and boring or not applicable to his/her life. Therefore, apart from studying general attitudes toward science, it is equally important to study various aspects of this attitude. Different aspects of attitude toward science include: scientific attitudes, attitudes toward the subject science, attitudes toward the
teaching and learning of science, attitudes toward the evaluation of science knowledge, attitudes toward the scientific enterprise, attitudes toward the relevance of science in everyday life, attitudes toward the importance of science in society, attitudes toward current science-related social issues, attitudes toward scientists, attitudes toward science-related careers, attitudes toward one's capability of functioning efficiently in the realm of science or self-efficacy.

Attitudes stem from beliefs. A belief about the positive effects of science on society will lead to a positive attitude towards the relevance of science in society. Beliefs in turn are mediated by a whole array of variables that make up the individual's life. These variables can be divided into three broad categories: personal, social, and educational with overlap and interaction possible between categories. Personal variables include age, gender, ethnicity, cultural background, and family background. Social variables include significant others, friends, colleagues, employers, subordinates, and neighbors. For GED students, the education category is further divided into prior traditional educational experiences, current Adult Basic Education experiences, informal educational experiences (e.g., the media, visits to museums, zoos, planetariums), and work-related educational experiences including vocational education, job training, and workplace training.

Figure 2.1 is a diagrammatic representation of the theoretical model.
Figure 2.1: Proposed model for attitudes toward science
The Need for Attitude Research

The emphasis on obtaining the perspectives of participants in a setting has antecedents in several social science disciplines including anthropology, social psychology, and developmental psychology (Charron, 1991). Without information on the attitudes of participants in any given situation, the understanding of that situation, at best, would be incomplete. This is especially true in the educational system. With the shift in emphasis from cognitive outcomes to cognitive and affective outcomes in education, the need to study student attitudes has become apparent.

According to Byrne & Johnstone (1988) the ways in which positive attitudes can be developed are inadequately understood even by social psychologists, and "educational writing usually skirts the issue, doing little more than offering vague exhortations which provide very little help to practicing teachers" (p. 43). However, knowledge of the students' attitudes can help teachers in their efforts to create more positive attitudes by making them aware of what positive or negative attitudes students hold. Once the teacher is aware of students' attitudes toward a particular psychological object such as science, they can tailor their instructional materials and techniques to create a learning experience that will foster more positive attitudes. Since poor attitudes are directly related to lower achievement levels and to lower enrollments in science courses, factors contributing to negative attitudes must be understood and ameliorated (Kahle, 1984). On the other hand, low achievement levels in science could itself be a contributing factor towards poor attitudes. Thus there exists a correlation between attitudes and achievement.

Attitude research is especially important in the field of science education. Aiken & Aiken (1969) argued that the growing impact of science on our daily lives necessitates the continued study of ways in which to assess and improve attitudes toward it. The last couple of decades has
seen an unprecedented increase in the impact of science and technology on everyday life. This warrants the need for attitude research that can be used to identify negative attitudes and attempt to modify them. Koballa & Crawley (1985) enumerate the reasons why attitude toward science has become an important concept: attitudes toward science are thought to fulfill basic psychological needs such as the need to know and the need to succeed, attitudes toward science are thought to influence future behaviors, and results of nationwide assessments of attitude toward science indicate that as early as Grade 3, 50 percent of the students no longer are interested in studying science. According to Yager & Penick (1986), if science is taught dynamically as it exists in the real world, and not as a static subject in the texts and the minds of teachers, we may see a change in students' perceptions of science.

In spite of the abundance of research on attitudes toward science in the secondary science education literature, corresponding efforts are noticeably lacking in the field of science education for adults. One of the conclusions drawn from the Third Assessment of Science was that adults seem to be more negative in all categories concerning their perceptions of science teachers, classes, and course content than do students currently enrolled in schools (Yager & Bonnstetter, 1984). Yager & Bonnstetter further assert that this may be partially explained because the adults sampled tended to be non-college persons who remained in their local communities as part of the labor force. This is the population that is generally served by adult education programs like the GED. This highlights the importance of determining the attitudes of this population. Even though passing the GED exam is the major objective of most GED courses of study, it must be recognized that we have here a captive audience, and with the exertion of some effort, if we can foster in them positive attitudes toward science, we may be able to help them better their lives, raise their self-confidence, and enhance their active participation in society. Students in GED courses have cited "feeling better about themselves" as one of their reasons for
joining the GED program. Fostering positive attitudes to science and feelings of self-efficacy through successful experiences can contribute to this goal.

Methodology Issues in Attitude Research

Instruments used in attitude research

With increased emphasis on the affective domain of education, methods to determine students' attitudes have become important. One method of collecting information about students' attitudes has been direct questioning of students in interviews. Apart from directly questioning individuals about their behavior, another approach has been to observe the behavior of individuals with respect to the psychological object (Edwards, 1957). A disadvantage of both the method of direct questioning and the observation of behavior is that they do not conveniently lend themselves to an assessment of the degree of affect individuals may associate with a psychological object. Therefore, with these methods the individual's responses cannot be scaled in order to quantitatively determine any change in attitude. With interest in the measurement of achievement of objectives in the affective domain growing (Schibeci, 1982), data collection instruments that can be quantitatively analyzed have become important in attitude research. In Gardner's (1975) review of the research on attitudes in science he noted the methods that had been used to assess attitudes including differential scales, rating scales, summated rating scales, semantic differential scales, interest inventories, preference rankings, projective techniques, enrollment data, and anthropological observation.

Many scales developed to assess student attitude are based on Klopfer's (1973) classification scheme for science education in which aims related to the nature of science are
clearly distinguished from affective aims. Klopfer's categories of affective aims include: manifestation of favorable attitudes toward science and scientists, acceptance of scientific inquiry as a way of thought, adoption of scientific attitudes, enjoyment of science learning experiences, development of interests in science and science-related activities, and development of interest in pursuing a career in science. Different instruments have measured different aims and have used different scales and subscales. The following is a brief review of some of the instruments used to assess attitudes that have been used in science education.

A scale commonly used to measure students' attitudes toward science is the Test of Science-Related Attitudes (TOSRA) (Fraser & Butts, 1982; Khalili, 1987). This 70-item test in the Likert type format consists of seven scales with ten items for each: Social Implications of Science, Normality of Scientists, Attitude toward Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure interest in Science, and Career Interest in Science (Fraser, 1978; Fraser, 1981). TOSRA has many uses including monitoring student progress toward achieving attitudinal aims, measuring the status of individual students or groups, or providing information about changes in student attitudes over a period of time. Another instrument that has been used to measure attitudes is the Lesotho Attitude to Science Test (LAST). Student and teacher interviews were used in the development of this test. These interviews revealed four general areas of concern: interest, difficulty, influence of the teacher, and social implications of science (Towse, 1983). The LAST assesses interest and enjoyment in science and awareness of the contribution of science to the social and economic life of the community. Schibeci (1982) examines a semantic differential instrument that measures student reactions to eight concepts: science in society, science lessons, science career, science hobbies, scientific attitudes, scientists, science teacher, and school. In their investigation of the stability of attitudes towards science between junior and senior high school, Hofstein & Welch (1984), used an instrument that contained 121 items clustered into six scales: attitude toward science classes, students' attitude
toward their science teacher, students' attitude toward a career in science, students' attitude toward the value of science, socio-scientific responsibility, and science activities. The Attitude Toward Science in School Assessment (ATSSA) developed by Gemmann (1988) aims at measuring a single dimension of a general attitude toward science, specifically, how students feel about science as a subject in school. The scale used by Ato & Wilkinson (1982) consisted of the following subscales: enjoyment of science and science lessons, social implications of science, attitudes toward scientific inquiry, attitudes toward scientists' normality of scientists, career interests in science, and leisure interests in science. Munby (1983) categorized attitudes toward science as: scientific attitudes, attitudes to science instruction, attitudes to science itself, and attitudes to science careers. In their meta-analysis of attitude research Haladyna & Shaughnessy (1982) classified studies according to different aspects of science attitudes: scientific attitudes, attitudes toward scientists, attitudes toward a method of teaching science, scientific interests, attitudes toward parts of the curriculum, and attitudes toward the subject science.

Thus the literature contains a wide array of instruments that measure attitude toward science with each instrument measuring different aspects of attitude and using different scales, subscales, or categories to differentiate these aspects.

Inadequacy of instruments

Inadequacies of instruments used to study attitudes have been widely discussed in the educational literature. Krynowsky (1988) summarizes problems with instruments used to collect attitudinal data including the need for specification of some theoretical foundation to underlie the instruments and the clear definition of the construct to be measured, and the verification or establishment of reliability and validity of attitudinal instruments. According to Gardner (1975), Schibeci (1982), Munby (1983), and Blosser (1984), attitude instruments in use in science
education are of poor psychometric quality and do not provide appropriate psychometric evidence of reliability and validity. Munby (1983) identifies a considerable amount of difficulty in the area of measuring attitudes toward science: "reviewers are not satisfied with instruments, the results are ambiguous if not unsettling, the overall picture of society's support of the enterprise is somewhat difficult to pierce, and there is some question about what sort of thing measures an attitude to science". (p. 37). Fraser (1977) emphasizes the importance of multidimensionality in the development of attitude scales. Gardner (1975), in his review of attitude scales indicates that test developers unthinkingly lump distinct attitudinal dimensions together to form a single scale representing a confused mixture of variables.

Since attitudes toward science fall in the affective domain, interviews or written narratives should be an effective way to explore them (Krajkovich & Smith, 1982). In a study on sixth-formers' views of their science education, Watts & Ebutt (1988) interviewed students and analyzed their transcripts in terms of categories that attempted to cast the responses in a positive light. In their analysis, they extrapolated from students' negative comments toward some of the positive features of science education that they seemed to be seeking. Thus they used attitude research to aid in attempting to improve students' experiences of science education. However, it is apparent from the literature that interviews are used in the development of attitude measuring instruments, but not as instruments themselves to assess attitudes.

The educational literature does not reveal any attitude research done with adult students in ABLE or GED courses. Since this is a population with unique characteristics and life contexts, it is not appropriate to use attitude instruments developed for secondary science education with this population. Preliminary qualitative work including interviews and observations would have to be conducted in order to develop new attitude instruments for use with this population. In this situation, a qualitative approach is suitable to meet the needs of the research. A qualitative
approach allows the researcher to investigate a new area without specifying the majority of salient dimensions in advance (Charron, 1991), and so may be preferable in such circumstances. While conducting the interviews an important consideration is flexibility so that both parties can raise new issues or explore previously identified ones.

Another important factor that has to be taken into consideration in the selection of a method to explore GED students' attitudes, is the reading abilities of this particular population. Unlike traditional secondary school programs, high school equivalency tests place a significant emphasis on reading skills because this population seems to be lacking in reading and writing skills. GED programs therefore expend a lot of effort in improving these skills of their students. Therefore questionnaires used with high school students may not be appropriate for GED students with low reading abilities. Another characteristic of adult basic education students is the high incidence of learning disabilities such as dyslexia (ACE, 1988b). Questionnaires would not be appropriate for use with these students.

With all these considerations, a qualitative approach seems appropriate for exploring the science education aspect of GED programs and GED students' attitudes toward science.

The next chapter details the methodology that was used in the study and the rationale behind it.
CHAPTER 3

METHODOLOGY

This chapter details the methodology used to explore the science portion of GED programs and GED students' attitudes toward various aspects of science. The first section describes the rationale for the research methodology and the particular research methods used. It highlights the processes used in the interviews with students and teachers. The next section describes the pilot study including the data collection methods used and is followed by a section that focuses on the sampling strategy employed. Following this are sections on interviewing and additional data collection methods including observations and document analysis. The next section describes the procedures involved in the analysis of the data and is followed by brief discussions on transferability of findings, ethics, and limitations of the study.

Rationale and Data Collection Methods

This research effort aimed at documenting different approaches to science education in GED programs and exploring GED students' attitudes toward various aspects of science and science education with the hope that the information obtained and the understandings generated will be used to enhance the science education of adults in GED programs.

Since the aim of this study was exploration and description, qualitative methods were suitable for this study since the goals of qualitative research are to explore, describe, or explain (Marshall & Rossman, 1994). Various phrases are used to describe different approaches to
qualitative research and their overlap increases the confusion associated with assigning a name to the paradigm selected (Jacob, 1988). This study uses a combination of an ethnographic approach and naturalistic inquiry, both of which are described below.

The first part of this study attempts to describe the various approaches to science education in GED programs. Ethnography is the paradigm used for describing a culture in its natural setting (Bogden and Bilken, 1992). Ethnographic studies begin with no a priori assumptions and generate well-elaborated, detailed, valid, and situation specific descriptions (White, 1985) that are generally referred to as rich data. The aim of the first part of this study is to generate such rich descriptions of the teaching and learning of science in GED programs. Although these descriptions are supported by classroom observations and document analysis, they rely primarily on the participants' perspectives uncovered during interviews.

The second part of the study attempts to explore GED students' attitudes toward various aspects of science. The paradigm used in this exploration is naturalistic inquiry where the "researcher frequents places where the events he or she is interested in naturally occur" (Bogdan & Bilken, 1992, p. 3). Lincoln and Guba (1985) enumerate the axioms associated with the naturalistic paradigm:

1. Realities are multiple, constructed, and holistic. These realities will in turn diverge as more becomes known. This makes prediction and control difficult and unlikely.
2. The inquirer and the 'object' of inquiry are interactive and inseparable.
3. One aim of naturalistic inquiry is to develop a body of knowledge which may help to form a working hypothesis. This knowledge is 'idiographic' and is bound by time and context.
4. It is impossible to distinguish effects from causes since all entities are in a state of mutual simultaneous shaping.
5. Rather than considered 'value free', the naturalistic paradigm is value-bound through the influences of the inquirer, the choice of paradigm, the choice of
substantive theory utilized to guide the collection and analysis of data, and the values inherent in the context of the study (Lincoln & Guba, 1985, pp. 37-38).

Lincoln and Guba (1985) advocate carrying out inquiry in natural settings because in their opinion, the phenomena under study, whether they are physical, chemical, biological, social, or psychological, take their meaning from themselves and their contexts. According to Lincoln and Guba, naturalistic inquiry is more adapted to a description of the multiple realities encountered at any given site. One of the important tenets of naturalistic inquiry is that the research design is emergent. While discussing the flexible and emergent nature of qualitative inquiry, Lincoln and Guba (1985) write:

It is inconceivable that enough could be known ahead of time about the many multiple realities to devise the design adequately; because what emerges as a function of the interaction between inquirer and phenomenon is largely unpredictable in advance; because the inquirer cannot know sufficiently well the patterns of mutual shaping that are likely to exist; and because the various value systems involved (including the inquirer's own) interact in unpredictable ways to influence the outcome (p.41).

The flexible nature of the design does not imply a nonexistent design (Bogden and Bilken, 1992). Rather, the researcher goes into the study with certain flexible ideas about the methodology, but at the same time keeping an open mind about changing the nature of the process as and when the need arises. Understandings generated during the data collection process are used to formulate new designs and procedures. This emergent design is explored more in detail in the section “Sampling Strategy”.

This study used a multi-site approach that addressed the same research questions in a number of settings using similar data collection and analysis procedures in each setting and provided the possibility of cross-site comparisons without sacrificing an in-depth understanding of particular sites (Firestone & Herriott, 1984). The process of simultaneously exploring multiple
sites provided the researcher with the opportunity to compare and contrast the data as they were being collected.

Since the purpose is to describe the current situation in the field, interviews proved to be a good data collection technique. Standard social research textbooks generally describe interviewing as a survey technique for gathering information from individuals about thoughts, sentiments, and activities (Gubrium, 1994) which is the type of information sought from this study. However, as opposed to survey techniques, interviews have the important dimension of the personal interaction involved between the interviewer and the interviewee and the 'meaning of the interview statements depends on the nature of this interpersonal context' (Kvale, 1992). These interpersonal musings were recorded in a reflective journal.

Because the study aims at gaining a better understanding of students' attitudes toward science, interviewing is a useful tool since "Interviewing is one of the most powerful ways we use to understand" (Fontana & Frey, 1994). Interviews can be broadly classified as structured and unstructured, the former aims at capturing precise data of a codable nature in order to explain behavior within preestablished categories, whereas the latter is used in an attempt to understand the complex behavior of members of society without imposing any a priori categorization that may limit the field of inquiry (Fontana & Frey, 1994). This study utilized unstructured interviews for the pilot study and semi-structured interviews for the actual study.

The Pilot Study

Pilot studies are generally conducted to give the researcher a first hand impression of the situation in which he/she is going to be immersed and to aid him/her in establishing protocols for data collection techniques and in establishing personal contacts. Glesne and Peshkin (1994) have suggested piloting interviews in situations and with people as close to the realities of the
actual study as possible and state that ideally the pilot study should be drawn from the sample selected for the actual study. The purpose of the pilot study was to learn about the research process, the interview format, the observation techniques, and the researcher (Glesne & Peshkin, 1992).

The pilot study conducted in the actual field was a very small scale version of the actual study. In keeping with the nature of qualitative research, flexibility was allowed for in various aspects of the design. This flexible nature was intended to elicit a broad picture of the participant's perceptions as well as to define the boundaries of the study and to plan the use of resources wisely (Fetterman, 1989). Since the pilot study was an information gathering process intended to help in the formulation of questions for the in-depth study, the Interview Guide approach was used for the pilot interviews (Patton, 1990) where certain topics and issues were outlined but decisions about the sequence and wording of the questions were made in the course of the interview. This format allowed for flexibility in following up on the leads obtained during the actual interview. In the pilot interviews the respondents were probed for more explanation, clarification, description, and evaluation depending on the researcher's assessment of what best followed from what the respondent said (Glesne & Peshkin, 1994). By doing this, logical gaps in the data could be anticipated and closed.

Topics covered in the pilot interviews with students included the following:

1. Educational/work experience background of the respondent
2. Current position in the program
3. Reasons for enrolling in the program
4. Description of the science portion of the program
5. Positive/negative aspects of the science course
6. Attitudes toward:
   a) Subject science
   b) Science teaching and learning
c) Science evaluation
d) Relevance to life
e) Importance in society
f) Science-related issues
g) Scientists and people who use science
h) Science-related careers
i) Self-efficacy in the domain of science

7. Suggestions for improving the GED science course
8. Future goals and expectations

Topics covered in the pilot interviews with teachers included the following*:

1. Teaching experience of the respondent
2. Description of the science portion of the program including materials used
3. Positive/negative aspects of the science course
4. Suggestions for improvement of the program
5. Positive/negative aspects of the GED science test and suggestions for improvement
6. Their perception of students' attitudes toward:
   a) Subject science
   b) Science teaching and learning
   c) Science evaluation
   d) Relevance to life
   e) Importance in society
   f) Science-related issues
   g) Scientists and people who use science
   h) Science-related careers
   i) Self-efficacy in the domain of science

(*See appendix for interview protocols)
The main purpose of the interviews was to uncover participant perspectives realizing that the subjective view is important (Marshall & Rossman, 1994). All interviews were audiotaped and transcribed immediately. The transcripts were analyzed to help in designing the interview format for the actual study and to uncover new leads. Feedback was solicited from the participants in the pilot study regarding techniques used and their feelings about and reactions to the interview. This information was used to guide the actual study.

Another portion of the pilot study was classroom observations. Observations of science classes were conducted to assist in the formulation of questions for the actual study and to guide the classroom observations in the actual study. Factors that were considered in the observations included science content, instructional strategies, and apparent attitudes. All observations were documented using pages divided into two columns: actual observations and researcher musings.

The third part of the pilot study included document analysis. Documents selected included curricula and instructional materials used. The criteria for the analysis of the documents were determined on the basis of understandings gained from the interviews and classroom observations and were helpful in formulating criteria that were used in the actual study.

Sampling Strategy

The sampling strategy used in this study was purposeful sampling, the goal of which is to maximize information, not to facilitate generalizations (Lincoln and Guba, 1985). Since the goal of the study is to document different approaches to science education in GED programs and to explore students' attitudes toward various aspects of science, such an approach that facilitated collection of maximum information proved appropriate. The type of purposive sampling selected was 'maximum variation sampling' (Patton, 1990) that sought to explore different approaches to
science education and different attitudes toward science in similar programs located in different contexts.

Since the goal of the study is to gain a better understanding of the situation from both students' and teachers' perspectives, both students and teachers were interviewed. The population selected was the GED programs in the greater metropolitan area of a midwestern city. For the pilot study, one GED program was randomly selected. After gaining access to the program by contacting the administrators, one teacher and two students were randomly selected and interviewed. Classroom observations and preliminary document analysis were also conducted at this site. On the basis of understandings gained during the pilot study and from the literature, location and sponsorship of the program appeared to be important variables for the population under consideration. Stratification means thinking in terms of the important variables related to the problem (Glesne & Peshkin, 1994).

GED courses are available in different settings such as educational (high schools, colleges, and vocational centers), community organizations (churches, and community centers), government (human services departments), and industrial settings. The programs also have different sponsorships including government funds, community support, and student fees. In addition, programs differ on the basis of their being voluntary or mandated. Since this was an in-depth exploratory study, it initially aimed at exploring programs in different settings and with different sponsorships.

However, in accordance with the flexible nature of qualitative inquiry, the methodology for this study evolved as the study progressed. Students currently preparing for the GED science test or those who had recently completed the test along with their instructors were selected for the study. The initial sampling strategy sought to include approximately 25 students from approximately 5 different sites. Qualitative inquiry has no rules for sample size which generally depends on the purpose of the inquiry, what's at stake, what will have credibility, and what can be
done with the available resources (Patton, 1990). The decision about the number of students and sites for the actual study were initially made on the basis of insights gained during the pilot study. However, as the study progressed, new insights brought to the fore issues of what would have credibility, what was at stake, and what could be done in the situation with the resources available to the researcher.

After obtaining a list of all the sites that offer GED programs in the selected region, 5 sites were chosen that represented the range of different locations and different sponsorships. However, in the course of data collection at these sites, it became apparent that sites which have different locations and different sponsorships could be very similar in terms of instructional strategies employed and instructional materials used, while sites with similar sponsorships and locations appeared very different during an in-depth look. In order to cover the spectrum of variations in programs in the location selected, the initial sampling strategy was reviewed. All the GED sites in the location were contacted by telephone and access was gained by explaining the objective of the study and its implications. At each site, teachers and administrators were informally interviewed regarding the population served, funding, instructional strategies employed, instructional materials used, important aspects of their program, and their perceptions of how their program differed from other programs. Preliminary classroom observations were conducted at the different sites along with a brief review of the GED support materials present in each location.

On the basis of these findings, 8 sites were selected that represented the range of types of programs with regard to instructional strategies employed and important aspects of the program. This represented the 'maximum variation sampling' targeted at the inception of the study, but encompassed a different axis of variation than that originally intended.

Table 3.1 illustrates the range of strategies and materials used in the 8 sites selected for the study.
<table>
<thead>
<tr>
<th>Site</th>
<th>Strategies</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>*Individual reading, Computer software</td>
<td>Steck-Vaughn, Contemporary</td>
</tr>
<tr>
<td>Site 2</td>
<td>*Computer software, Individual reading</td>
<td>Steck-Vaughn, Contemporary, Plato</td>
</tr>
<tr>
<td>Site 3</td>
<td>*Testing</td>
<td>Steck-Vaughn, USA Basics</td>
</tr>
<tr>
<td>Site 4</td>
<td>*Group work, Individual reading, Direct instruction</td>
<td>Steck-Vaughn, Contemporary, News media</td>
</tr>
<tr>
<td>Site 5</td>
<td>*Individual reading, Direct instruction, Individualized attention</td>
<td>Steck-Vaughn, Contemporary</td>
</tr>
<tr>
<td>Site 6</td>
<td>*Individual reading, Direct instruction, Experiments and demonstrations</td>
<td>Steck-Vaughn, Contemporary</td>
</tr>
<tr>
<td>Site 7</td>
<td>*Group discussions, Experiments and demonstrations, Field trips</td>
<td>Steck-Vaughn, Contemporary, News media, Books</td>
</tr>
<tr>
<td>Site 8</td>
<td>*Group work, Individual Reading</td>
<td>Steck-Vaughn, Contemporary</td>
</tr>
</tbody>
</table>

* = Dominant strategy.

Table 3.1: Range of strategies and materials across sites.

At each site, 2-3 students and 1-2 teachers were interviewed. Student interviewees were selected based on whether they had any science preparation for the GED test. At some sites, only 2-3 of the students had had any science preparation, so those that had it were selected. At sites that had more students who had science preparation, 2-3 were randomly selected from those that had it. After gaining entry, the approach used to locate participants who would fulfill the criteria of the sampling categories was snowball sampling (Patton, 1990) otherwise called ‘networking’ (Glesne & Peshkin, 1994) where a contact is established at each site selected, and through this contact, connections with other people in the program who fulfill the sampling criteria.
can be made. This snowball or chain sampling is an approach for locating sources that can provide a lot of information (Patton, 1990). Such a strategy satisfied the general requirements of fitting the 'purpose of the study, the resources available, the questions being asked, and the constraints being faced' (Patton, 1990).

In addition to students who had some science preparation, 6 students who had recently joined the programs and had not had any science preparation were selected randomly from the 9 sites. These students, referred to here as non-science students, were interviewed to explore any differences that may exist between their attitudes toward the various aspects of science and science education and the attitudes of their peers who had some science preparation.

Table 3.2 illustrates the distribution of students and teachers across the sites sampled.

<table>
<thead>
<tr>
<th>Site</th>
<th>Students</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>P1, P2</td>
<td>P3</td>
</tr>
<tr>
<td>Site 2</td>
<td>S1, S2; SN1, SN2</td>
<td>T2</td>
</tr>
<tr>
<td>Site 3</td>
<td>S3, S5; SN3, SN4</td>
<td>T4</td>
</tr>
<tr>
<td>Site 4</td>
<td>S8, S11, S12</td>
<td>T6</td>
</tr>
<tr>
<td>Site 5</td>
<td>S7, S13; SN5</td>
<td>T7</td>
</tr>
<tr>
<td>Site 6</td>
<td>S4, S9, S10; SN6</td>
<td>T1, T5</td>
</tr>
<tr>
<td>Site 7</td>
<td>S6, S14</td>
<td>T3, T5</td>
</tr>
<tr>
<td>Site 8</td>
<td>S16, S17, S18</td>
<td>T8</td>
</tr>
</tbody>
</table>

S = Student, SN = Non-science student, T = Teacher, P = Pilot interviewees, T5 = Tutor.

Table 3.2: Site, student, and teacher chart.
Thus the sampling strategy that was employed was purposeful sampling (Patton, 1990) because the subjects had to fulfill the criteria of currently preparing for the science test or having recently taken the test or of not having had any science preparation. According to Patton, the logic and power of purposeful sampling lies in selecting information-rich cases for study in-depth. Since the goal of the study was to gain a better understanding of students' experiences and attitudes and not to make generalizations, purposeful sampling does not diminish the credibility of the study.

Participant Interviews

Interviews are the most commonly used tools for data collection in qualitative research. The primary purpose of interviews is to uncover participant perspectives (Marshall & Rossman, 1989). According to Patton (1990, p. 278) "Qualitative interviewing begins with the assumption that the perspective of others is meaningful, knowable, and able to be made explicit." For this study, GED students were interviewed regarding their perceptions of the science part of the program they were in and their perceptions about various aspects of science. Teachers were interviewed regarding the strategies they employ in the science education portion of their programs and their perceptions about student attitudes towards science and the science course in their GED program.

Each interviewee was interviewed 1-2 times. The time allotted for each interview was approximately one hour. The time and place selected were of the respondent's choosing. All respondents were assured anonymity. The respondents were assigned code numbers, all tapes and transcripts used the code numbers and these along with the code assignment were kept secure at all times. Participation in the study was voluntary and the participants had the option of dropping out of the study if they so desired.
On the basis of insights gleaned during the pilot study, standardized open-ended interviews were used in the actual study where the exact wording and sequence of questions were determined in advance. However the questions were worded in a completely open ended format (Patton, 1990). This approach was used in order to facilitate organization and analysis of large amounts of data. All the interviews were audiotaped and transcribed immediately. A reflective journal was maintained by the researcher throughout the process.

Additional Data Collection Methods

Observations

Although interviews were the primary data source, multiple data collection methods were used to contribute to the trustworthiness of the data (Glesne & Peshkin, 1994). Patton (1990) describes triangulation as the combination of methodologies in the study of the same phenomena or programs. This process of triangulation not only facilitates greater understanding but also increases the confidence in the research findings (Denzin, 1988). Morse (1994) advocates the use of more than one method within a project to enable the researcher to gain a more holistic view of the setting because different perspectives result from the use of different methods.

This study aimed at achieving this holistic view by the use of multiple methods including classroom observations. Marshall and Rossman (1995) write that "Observation entails the systematic noting and recording of events, behaviors, and artifacts (objects) in the social setting chosen for study" (p. 79). According to Patton (1990), data from observations enables the researcher to gain insights into a program to an extent not entirely possible through interviews. Patton also emphasizes that participation in and observation of complex situations facilitate an understanding of the complexities involved. In addition, observations served the function of increasing the scope of the study to more participants, supporting the findings of the interviews.
and giving the researcher additional insight into the situation which helped in interpreting the data. Science classes were randomly observed at the sites selected and this also helped in identification of additional interviewees. In addition to observing routine classes, classes that were non-routine such as field trips or activities were also observed.

According to Patton (1985) there exists an observer-participant continuum which describes the extent and quality of the observer's participation in the research setting.

The first and most fundamental distinction that differentiates observational strategies concerns the extent to which the observer will be a participant in the setting being studied. This is not really a simple choice between participation and non-participation. The extent of participation is a continuum that varies from complete immersion in the setting as full participant to complete separation from the setting as observer. There is a great deal of variation along the continuum between these two extremes (p. 206).

For this study, the researcher primarily played the role of a non-participant observer or what Adler and Adler (1992) describe as a researcher in a peripheral membership role. However, in some situations the researcher reciprocated the teacher's enthusiasm and help in the study by helping students solve problems they encountered when the researcher was in the class and the teacher was busy with other students. In one situation, the researcher was requested to help in tutoring a student who was experiencing problems with science topics.

Initial observations were used to inform and shape subsequent observations. Multiple observations were conducted at the sites selected and they both preceded and followed participant interviews. Both descriptive and analytical notes were recorded during observations. These notes also included informal conversations with the students and the teachers during the classroom visits and a field trip. These notes were relied upon in providing glimpses of the different programs sampled.
Document analysis

As Glesne and Peshkin (1994) state, the more sources tapped for understanding, the more believable the findings. Therefore other triangulation techniques were employed. Document analysis was the third data collection technique used in this study. Documents are generally used as supplementary sources of information to provide additional historical and contextual dimensions to the study (Glesne & Peshkin, 1994).

The documents selected for analysis were:

1. Statement of purpose of the GED program
2. Syllabus for the science course
3. Educational resources used including texts and software
4. Sample tests
5. Evaluation materials

The analysis of these documents provided background information and facts about the course that facilitated describing the program. The method of analysis used was content analysis i.e. establishing categories and then finding those instances in the text (Silverman, 1993). The categories were established on the basis of findings from the interviews and the classroom observations. After salient information was extracted from the documents, the data were analyzed and correlated or compared with that obtained from the interviews and observations. According to Schrag (1988), curriculum documents prescribe a selection, from the infinitely large corpus of what is known, certain portions are identified as worthy of inclusion. So this document analysis was designed to lead to insight about what is considered worthy of inclusion in the course as well as insight into the implicit and explicit aims portrayed in the documents.
The categories that were initially used to guide the analysis of the documents are as follows:

1. Subjects/Topics covered (content)
2. Connections made to real-life and societal applications
3. Emphasis on the affective domain
4. Direct application to life
5. Rigidity/Flexibility of syllabus
6. Specified details for each topic
7. Curricular goals
8. Science issues
9. Skills emphasized

However, the design was flexible and on the basis of insights gained during the interviews the categories focused on were: content, examples from everyday life, direct application to life, science issues in society, and skills emphasized.

Table 3.3 illustrates the data collection methods used in the study.
<table>
<thead>
<tr>
<th>Method</th>
<th>Duration</th>
<th>Products</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews</td>
<td>5 months</td>
<td>Interview transcripts,</td>
<td>Description of programs,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Researcher journal</td>
<td>Attitudes toward program,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attitudes toward science</td>
</tr>
<tr>
<td>Observations</td>
<td>6 months</td>
<td>Observation logs,</td>
<td>Description of programs,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Researcher journal</td>
<td>Attitudes toward program and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>instructional strategies</td>
</tr>
<tr>
<td>Document analysis</td>
<td>6 months</td>
<td>Analysis notes</td>
<td>Description of programs</td>
</tr>
</tbody>
</table>

Table 3.3: Data collection methods used in the study.

**Data Analysis**

According to Glesne and Peshkin (1994) data analysis is the process of organizing and storing data in light of the researcher's increasingly sophisticated judgments, that is, of the meaning-finding interpretations that the researcher is making about the shape of the study. According to Patton (1990, pp. 371-72), the challenge of qualitative analysis is to "make sense of massive amounts of data, reduce the volume of information, identify significant patterns, and construct a framework for communicating the essence of what the data reveal."

This study used the constant comparison method of data analysis which involves identifying initial patterns or issues in the data that relate to the research purposes; adding, deleting, or modifying patterns as warranted by incoming data; interpreting both pattern-validating and discrepant data, and continuing to sample and organize data until a core group of patterns
well-supported by the data emerges (Glaser & Strauss, 1967). LeCompte and Preissle (1993) have suggested that the researcher develop an analytical framework which indicates how the results are built upon a foundation of categorized data and elaborated by the relationships among categories. The constant comparison method used in this study provided such a framework. According to Fetterman (1989) the process of analysis takes place throughout the ethnographic endeavor, right from the selection of the problem to the final stage of writing. These on-going analysis processes were recorded in a reflective journal. However, the identifiable stage of data analysis was initiated shortly after data collection began because periodic reviews of the data help the researcher in noting gaps in the data, discovering directions to pursue, or changes to make in the data collection plan (Chism & Blake, 1986). The processes of analyses was also documented.

After review of the collected data, a tentative list of categories and boundaries was defined. The flexible categories are in tune with qualitative research involving more 'loose' inductively oriented data analysis (Miles & Huberman, 1994). After coding a number of interviews using these tentative categories, a permanent list of categories was defined and all the data were coded again using these categories. The NUD*IST computer program was used to assist in data management. The data were coded into categories sometimes with multiple codes assigned to a single piece of data.

The categories used in the analysis are as follows:

1. Background
   1.1. Demographics
      1.1.1. Age
      1.1.2. Gender
   1.2. Reasons for being in a GED program
      1.2.1. Reasons for planning to take the GED exam
      1.2.2. Reasons for being in a particular program

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1.3. Previous education
1.4. Work experience
1.5. Current position in the program (duration of participation in the program, areas of the GED in which they had previous preparation)
1.6. Future plans
1.7 Teaching experience (for GED teachers)

2. GED Science
2.1. General feeling about the GED science test
2.2. Format of the test
2.3. Content of the test
2.4. Preparation for the science GED test
   2.4.1. Preparation required
   2.4.2. Preparation obtained (students' perceptions)
   2.4.3. Feeling about the preparation (students' perceptions)
   2.4.4. Changes they would like to see (teachers and students)
   2.4.5. Preparation given (teachers' perceptions)
   2.4.6. Assessment
   2.4.7. Materials used in the preparation
   2.4.8. Problems
2.5. Anxiety
2.6. New tests
2.7. Professional development
2.8. Program issues
2.9. Learning Disabilities
2.10. Impact
2.11. Objectives of the science test

3. Science
3.1. What science is
3.2. General feeling about science
3.3. Subject science (teaching and learning of science)
3.4. Applications in society
3.5. Relevance to life
3.6. Science careers
3.7. Science tests
3.8. Traditional schooling
3.9. Home environment
3.10. Science issues in society
3.11. Science and citizenship
3.12. Importance of science
3.13. Discoveries and inventions
3.14. Scientists
3.15. Self-efficacy
3.16. Science outside school
3.17. Gender

4. Other factors
   4.1. Interaction among teachers and/or students
   4.2. Career awareness/development
   4.3. Policy
   4.4. Funding
   4.5. Other skills
   4.6. Workforce training
   4.7. Reform efforts
   4.8. Media
   4.9. Personal characteristics
These descriptive categories were used for the initial coding of the data. This first level of coding, called open coding by Strauss and Corbin (1990), involves a close examination of the data to name and categorize all the elements involved. After the data had been assigned to categories, the categories were reviewed to determine category boundaries and fit and to get a feeling for certain themes and patterns across categories (Chism & Blake, 1986). These themes that emerged from the data were used to develop a second level of categories which were used to synthesize and summarize the findings from the data. Strauss and Corbin (1990) refer to this second level as axial coding in which connections are made between identified categories and sub-categories. These connections were also used in an attempt to generate a model grounded in the data.

Transferability of Findings

In qualitative research, the transferability of the study findings from one site to another is the responsibility of the reader. However this transfer is contingent upon the researcher providing enough information to make this possible. According to Firestone (1993):

This is because the researcher’s theories about the conditions that affect the applicability of study conclusions are less important than those of the reader. One cannot know the situations in which the readers are likely to consider applying study findings. Therefore one must describe a broad range of background features, aspects of the processes studied, and outcomes so readers have enough information to assess the match between the situation studied and their own, especially since their situations may be quite different (p.18).

This study aimed at providing such multi-dimensional ‘thick descriptions’ to enable readers to determine the transferability of the findings to their own situations. The study also
encompassed a wide range of program settings and different data collection methods in order to increase the completeness of the picture painted.

Ethics

All attempts were made to ensure adherence to ethical standards during the study. Bogdan and Bilken (1992) suggest guidelines for qualitative researchers regarding ethical issues which encompass the areas of anonymity, respect, negotiation of access, and truthful reporting of findings. All participants were informed about the scope and purpose of the study and the scope of their participation. All respondents were assured anonymity and every precaution was taken during the study and in the reporting of the findings to maintain this anonymity. All participants were treated with respect with due consideration to their schedules and convenience. In negotiating access to the sites, the details of what the study would entail and its goals were clearly communicated to the administrators and the teachers. In reporting the findings, every attempt was made to capture the participants' perspectives.

Summary

Thus, this study utilized a combination of research methods with the aim of generating descriptions of the science portion of GED programs and exploring GED students' attitudes toward science. In concurrence with the nature of qualitative research, the sampling strategy evolved over the course of the study. The flexible nature of the design facilitated the emergence of the final design on the basis of insights gained during the study itself.

The next chapter reports on the findings generated by the combination of research methods reported in this chapter.
CHAPTER 4

RESULTS

This chapter discusses findings and themes that emerge from the data. The first section deals with perceptions about what knowledge and skills are required to be successful on the GED science test. This is followed by a section on the preparation needed to be successful. Following this is a section that provides glimpses of the different programs sampled. This is followed by a discussion on various themes across different programs. The final section explores GED students' attitudes toward various aspects of science.

Perceptions About the Knowledge and Skills Required to be Successful on the GED Science Test: Science Knowledge vs. Reading Strategies

Reading skills

The dominant perception about what is necessary to be successful on the science portion of the GED test was that students need good reading skills. Emphasis was placed on the ability to comprehend passages and use information from those passages to answer the questions on the test. Most students and teachers believed that the students do not need prior science knowledge in order to be successful on the test. Some student responses that illuminate this perception include the following:
S2: You just have to know how to read the questions and how to let it sink in.

S1: It's just mostly on reading the paragraph correctly.

S8: I'd have to go from the questions. I don't know if I can remember the facts because it's really nothing much that they gave you firstly, so you just have to go from the facts in the questions that they are giving you at the time.

S13: It's just a lot of reading, and if you can read, you should have no problem with the test.

A student who had recently taken the test, found the science section easy because in her opinion it involved just reading and comprehension.

P1: It was easy, reading and comprehend the paragraph, and answering the questions, it was easy, just reading and comprehension.

For some students, this perception has been obtained from instructors or from peers who have taken the GED test previously. Some instructors use this strategy of getting students to understand that it is basically a reading test to alleviate their fears about the science content on the test.

S10: I'm more scared about the math and English because that's what is required most, and I was told that for science you just basically read the passage and then you have your answers from there.

T4: Sometimes they are a little wary about taking the test and sometimes they are quite comfortable because I usually try to get them to look at it in a different way. They really don't have to know the actual factual information but you have to know how to answer the questions, interpret the questions.
Science knowledge

Student responses in terms of what and how much science knowledge is required to be successful on the test covered the entire range from no prior knowledge required to some basic familiarity required to some basic knowledge required.

Some students were of the opinion that they do need to have a basic familiarity with the science content and vocabulary to be successful on the test while a few talked about the need to actually know some science to be successful.

S6: The words are complicated. Sometimes you lose the whole thing because of 2 or 3 words in there.

S2: If you read the material that you need to read for the test that you studied before you take the test, if you read that and know it, then the test will be easy.

S3: If you comprehend it, if you read the question thoroughly and understand it, you will be fine as far as the reading. Sometimes you may require some advanced knowledge .. to answer the question.

A student who had already taken the test stated that she would have done better on the science test if she had studied it as much as she did the other subjects, indicating that some familiarity with science was needed over just reading strategies.

S4: I studied however much I could, but you know, you can never study enough. I guess if I would have studied it a maybe a little more than I studied some other subjects, I might have done better.

Responses indicate that while a few students believed that all they need to be successful are reading strategies, most students were of the opinion that they need some degree of science knowledge or familiarity with science to be successful.
Teachers' perceptions

Reading Skills

Teachers' perceptions of what is required to be successful on the science test were not very different from student perceptions. Most of the teachers believed that students who have good reading skills tend to be successful on the science test based on their reading skills alone.

T2: It seems to be based more on the reading skills that they have rather than on their knowledge of science.

T1: The students that we administer the science test seem to be successful in the science based solely on their reading comprehension and other reading skills that they bring into class.

T4: I really think that if their comprehension skills are up to par .... that's what it leans towards more ... instead of actually knowing factual information about science, that's how I look at it. I think that if a student has their comprehension skills intact then they'll do fine on the science portion of it.

T5: It's all comprehending, interpreting the passage that you read and as long as you can do that, you will be fine in taking the test.

T3: As I understand it a learner does not need to have a great deal of science knowledge or background, if they are able to read and reason their way through the questions.

T8: I think that for an above average reader, maybe beyond the 9th or 10th grade level, they could take the science test without having knowledge of the science material.

T2: My perception is that if a student is reading at at least a 10th grade level, preferably 11th or 12th grade level, they are going to be successful on the science test.... I think that my students who have strong reading skills feel pretty confident because I emphasize that
the science portion of it is related to their reading ability and as long as they have the test taking skills and strong reading skills, I feel that they think they will be successful.

Science Vocabulary

However, most of the teachers sampled stressed the importance of being familiar with the vocabulary of science in order to be successful on the test. They emphasized reading strategies in the content area of science in order to achieve this.

T1: Well, basically most of your GED testing, from the literature and arts to science and social studies, all consists of reading and then answering the questions. But .... you still have to go in .. before you take the test, you still have to be familiarized with the terminology of it.

T3: I know people who have taken the test and are really above average readers and do fine on it and I know people who come back and say "I need to be more prepared in all the different areas (of science)".

T7: Everything they need to answer the questions is given to them in the passages. They tend to have the most trouble with the science reading part of the test than they do with the social studies or with the literature and the arts. But I think it's only because it's more technical, or because they have not had enough science before they left school.

T6: If the student has good comprehension or reading skills they will get through. The difficulty is vocabulary, if they are contextual readers they will get through it.

Exposure to Science

A common perception is that if students have had some exposure to science in their school years, they have a basic understanding of science and all that is needed beyond that is good reading skills. However most of the teachers believed that their students did not have much science in school. Responses from the students concerning what science they had in high school
supported this assumption with most of the students stating that they did not have any science in high school or had very little of it.

T3: My perception is that it (the test) assumes that people know some things with in my estimation, my students don't know. It assumes a working knowledge of some vocabulary and some ideas about science and the scientific method that in my perception of the students is that they have had very little contact with science in their school years, so they are not aware of these things.

T8: It depends on how long they've been in high school, what level they're going to be at. But I think it's important that they have to know the content as well as be good readers. They need to be problem-solvers, they need to look beyond what's actually in the passages.... I think they need to have a basic understanding of each area (of science).

An important consideration with GED programs is that many of the students in these programs have been out of school for a very long time. Most administrators in the programs sampled estimated the number of students in the 18-30 age group to be approximately equal to the number of students in the above 30 age group. Therefore approximately half the population of GED students went through some part of high school over 10-12 years ago. For many students this number is closer to 20 years. It is common knowledge that science has made tremendous strides in the past 2 decades and students in the GED classes who had been through some part of high school a long time ago have never been exposed to these new concepts, facts, and ways of thinking about science. As one 54-year old student aptly put it: "Some of the questions that they're giving us now are things I probably never went into back when I was going to school, you know, because everything's changed".

**Higher Order Thinking Skills**

One teacher was of the opinion that the test did not require a lot of the higher order thinking skills, that the tests are supposed to promote.
It does not require a lot of higher critical thinking skills, integration, and synthesis. Maybe more in literature and the arts than in other sections. The rest is the reading and pointing out the factual things and a few conclusions. Not much inference.

**Satisfaction With Current Emphasis**

Most teachers were satisfied with this emphasis on reading strategies rather than science knowledge. Some were of the opinion that by reading content in science at their reading level, adults would become familiar with science and their expectations did not go much further than that.

P3: I like it the way it is applied towards reading skills, because this is how the adult works. If it is understandable to them at their reading level, they are going to learn science through osmosis basically.

**New GED Tests**

Some teachers evinced concern at the prospect of the emphasis of the tests shifting from reading strategies to science knowledge. This would, in their opinion, frighten away students many of whom have already encountered academic failure in the past and may not be willing to face it again.

P3: This is a big step in their lives and they have failed so many times ... that failure is looming above them.

Thus, the most common perception was that in order to be successful on the GED science test students need to have good reading skills. In addition to good reading skills many teachers emphasized a basic familiarity with the content area of science.
Perceptions About the Preparation Needed by Students to be Successful on the GED Science Test

Reading strategies and test-taking skills

Findings indicate an emphasis on reading and answering questions. This could be an effect of the format of the GED preparation materials and the GED test itself that is made up of passages of information followed by questions pertaining to the passages. The claim made in most of the preparatory materials is that all the information required to answer the questions can be found in the passage itself. The teacher at the site that utilized computers for a considerable portion of the GED preparation expressed the desire to take students off the computers and make them work in text-book type situations, citing the reason that the GED test is a written test and that the students need practice in test-taking skills. Most of the teachers and the students interviewed stressed the importance of reading and answering questions in order to be successful on the test.

Some students placed more emphasis on the reading aspect of the preparation while others placed equal emphasis on practicing test-taking skills by answering questions and solving the tests in the GED preparation material.

S3: Really the preparation that is needed is the reading over the science material. Reading to know it and learn it.

S5: The only thing I can say is to read, go over the material and basically you have the material.

S4: What is needed is going through the whole book and taking all the little pre-tests and everything that is in the book and possibly going to another book.

S7: Pre-test, and see how well you do on the pre-test, and a lot of reading.
Most students emphasized reading from the GED preparation materials, but a few suggested reading other materials, not related to the GED, to prepare for the science test.

S8: Reading helps you to understand the words that you don't understand while taking the test. And reading helps you get to know the words better.

S6: You need a lot of reading about science, just science things, how you do them, or maybe just read books on science.

Other strategies

While most of the students were of the opinion that the only preparation that is really required to be successful on the science test is reading and answering questions or taking tests, a couple of students were of the opinion that other strategies such as hands-on science and group-work are also essential.

S14: Reading these books and answering questions or reading outside materials, like newspapers and other books or doing experiments or working in groups.

The opinion of the majority of the students, however, was that although it would be nice to have other strategies and these strategies would help them learn science better, they were not essential in preparing them to be successful on the science GED test.

S2: Hands-on would be nice ... but I don't think it would help .. because there is not going to be any hands-on in the GED.
Pace

An important factor is the pace at which the students proceed. The majority of the students in the GED programs selected have been out of school for many years and felt the need to ease into it at their own pace. Most of the teachers appreciated this need and supported the students in preparing for the GED at their own pace.

S8: I think it is important to go at your own study pace, at your own speed.

S12: I'm comfortable here, I'm at my own pace, nobody's pressurizing me ... that's where I have problems, I get nervous when I'm pushed too much. Here, nobody's telling you to hurry.

In response to what a student would need to prepare for the GED science test, one student responded “I think I’d need a little bit more than what they are giving us ... at a slower rate too”.

The idea of pace becomes especially important in the case of students with learning disabilities. Most of the teachers interviewed have had experience in dealing with GED students with learning disabilities and a majority of them currently have students with learning disabilities in their classes. They appreciated the importance of allowing students, especially those with learning disabilities, to proceed at their own pace.

T1: I have a student now that has a reading disability .... I have been working with him taking him very slowly through reading, because that’s his main problem, and since he’s been here he has improved, maybe not as fast as other people would like him to improve, but according to his standards, he is improving just fine. And a lot of people must realize that people can’t move at the pace that you want them to move on, you have got to let them move at the pace that they are capable of moving on. This way, they won’t feel like they have not accomplished anything. A lot of people fail to realize that all people are not
made up the same way, they're not going to learn just as fast as anyone else, but they will learn it in their own time, and when they do, they will master it, just like everybody else.

Direct instruction

Some students believed that there should be more direct instruction in science like there is in math or English. They were of the opinion that if they had direct instruction where the teacher explained the concepts on a chalkboard, they may be able to understand science better. This opinion was expressed both by younger students who have recently been in a formal learning environment as well as older students who have been out of school for an extended period of time.

S2: It would be more interesting if we had examples, you know, like what the teacher does in math.

S8: I prefer to have instruction first. But if I didn't have a choice, if I had to read by myself and come back to the instructor, I could do that too.

S6: I just can’t sit down here and read, because that’s boring. Unless she (the instructor) lets us do something or does it on the board, that’s when I can learn.

Thus the dominant perceptions about what preparation is required to be successful on the science test is reading and answering questions based on the reading and solving practice tests in the given area. Students also placed emphasis on the relevance of the material they were reading to their individual lives and to society as a whole, the importance of proceeding at a pace that they are comfortable with, and the importance of incorporating learning strategies other than reading and answering questions based on the readings. However, the dominant strategy across all the GED programs sampled was individual reading from published GED materials and answering questions based on that reading coupled with solving the tests present in those materials.

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In a majority of the sites, all the preparation the students got in science was reading from published GED support materials. This included solving the pre-tests, reading the passages and answering the questions that follow, and then solving the post-tests and practice GED tests from the published GED books. After working through the reading material and questions on their own, students generally asked the teacher for help in specific areas that they did not understand. In general, there was no reluctance to ask for help and the teachers were perceived as being very helpful and easily approachable. Approximately half of the sites selected had some type of computer program available to help students prepare for the GED, but with the exception of one site, the science section of these programs was not generally used by students in their GED preparation. There existed a reliance on publishers' GED materials especially those from Steck-Vaughn and Contemporary.

The following section presents glimpses of different programs that highlight the major similarities and salient differences in approaches to preparation for the science part of the GED in the different programs sampled. Although most of the programs sampled operated under similar constraints of time and funding, there existed a wide range of strategies and innovative techniques, some aimed at capturing the students' interest and providing the students with learnings that are applicable to their everyday life.

Glimpses of Different Programs

Glimpse 1: Site 1

The room is arranged like a traditional school room. The teacher's table is at one end and desks are arranged in rows, facing the teachers table. There are students sitting at desks
with GED books in front of them, reading the passages and answering the questions at the end of
the passages. There is no interaction between the students and they are working individually.
Every once in a while, a student lifts his/her hand up and gets the teachers attention. The teacher
walks over to the student and explains the part that he/she did not understand. After this, the
student continues working on his/her own. Some students are taking practice tests and are
recording their responses on answer sheets. When they finish with the test they bring the sheet
up to the teacher who goes over it and marks wrong responses and notes the areas in which the
wrong responses occur. The teacher then uses this information to decide which material from the
books would be most suitable for that student. Once a week the students and teacher go to a
computer room and work on a GED program on the computer. However, none of the students
are using the science component of the computer program.

Glimpse 2: Site 2

There are computer terminals set up at one side of the room. There are a number of
students working at the terminals in silence using the Plato program. Every once in a while a
student will attract the instructors attention and the instructor will go over and help him/her out
either with a technical question about how to use the program for new users or a question about
the content. At the other side of the room are desks set up in rows. There are some students
sitting at these desks working from the GED books. There is no interaction among students and
they work primarily in silence. Every now and then a student working from a book will ask the
teacher for help with material they do not understand and the teacher will go over to them and
explain the passage to them and help them work through the questions. At times the teacher
calls all the students away from the terminals to the desks and does group instruction, mainly in
English or math. There is no group instruction in science.
Glimpse 3: Site 3

There are computer terminals at one side of the room and desks set up at the other side. The instructors table is near the desks. The instructor is sitting at the table and some students are working on the computers while some students are working at the desks. The computers have GED software, but not for the science section. Students mainly work from books or tests and they have to record their responses on computerized scan sheets which are scanned and the progress of the student recorded. The emphasis here is on testing. Students are tested regularly and their responses are graded to record progress in different areas. At times the instructor moves around the class to see how the students are progressing. Sometimes students take their work up to the instructors desk for help if they are having a problem with a particular passage that they are reading. At times the instructor gets all the students together and discusses their work but this is primarily in language usage. Students are encouraged to work on their own and prepare for the test by continuously taking practice tests, the stated objective being to make the students comfortable with the format of the GED tests and to improve their test-taking skills.

Glimpse 4: Site 4

There is a large table in the center of the room with all the students and the teacher sitting around the table. Charts showing the periodic table of elements, anatomy of the body, and mathematical formulae are up on the walls. There is a chalkboard at one end of the room and an overhead projector. Sometimes students work independently on materials out of the GED books asking the instructor or tutor for help when required. At other times, the teacher discusses passages with the whole group and the group works together on the material. Sometimes the teacher brings in supplementary materials like newspapers and magazines and uses them as a starting point for group discussions on current events and issues. Students enthusiastically participate in the discussions and relate it to their own lives and share these insights with the
others. The teacher tries to relate topics studied in the GED materials to what the students experience in their everyday life. For example, when talking about measurement, the connection is made to measuring and mixing cleaning solutions which the students, some of whom are custodial staff, use in their jobs.

**Glimpse 5: Site 5**

There are 2-4 students at any given time with one instructor. Sometimes a tutor comes in too. The attention here is mostly individualized. The students are tested to determine what materials would be suitable for their level. The student is then given the appropriate materials to read either in the classroom or at home. The students work individually either at home or in the class by reading passages and answering questions about those passages. They check their answers themselves and if they do not understand a particular passage or if they have a lot of wrong answers in one particular area, the teacher helps them individually in that area. When there are more students present on a particular day, the teacher selects topics that are amenable to group discussions and instruction.

**Glimpse 6: Site 6**

The desks are arranged in a U-shape with the chalk-board forming one side of the U. Students have a folder of materials, most of which are math work sheets and some English work sheets. Sometimes students work on their own from the GED books. Sometimes there is direct instruction where the teacher goes to the chalkboard and introduces a topic. After introducing the topic the teacher gives the students relevant materials to work on and the work is individual after that. Students work on their own and if they have any problems they ask the teacher for help. Students are allowed to take the materials home so that they can work on it at home. The teacher helps them out with any difficulties they have with comprehending the material. Once
every 2 weeks a science tutor comes to work with the group. On these days students work in groups on experiments or observe demonstrations. The experiments are simple and require readily available materials. Sometimes the students have worksheets to go with the experiments. At times the teacher tries to connect the science experiments to math and calculations. Some students seem interested in the experiments, some seem bored and have to be constantly cajoled to be part of it. Some students demonstrate interest in using the materials that the tutor brings in and experimenting with them on their own and doing 'neat stuff' with the materials.

Glimpse 7: Site 7

The room has tables arranged randomly and a chalkboard in the room. The chalkboard has a math trivia question on it which is addressed sometime during the day. At times the students work on their own from the GED books and at other times on the GED computer program. However, the students do not normally use the computer for the science section. Very often there are group discussions. The teacher brings in additional resources such as newspaper articles, magazines, and books about the topics covered in the GED books and uses these to start discussions. The teacher facilitates discussions in such a manner that the students are lead to realize the relevance of the topics in their own lives and in matters of importance in society. The additional materials used are designed to stimulate the students interest and make them more aware of what is happening in the world around them. The teacher brings in relevant newspaper and magazine articles about current events, weather, and other important issues in society and tries to connect them to what the students are reading in the published GED materials.

The following is a glimpse of a field trip, including preparation for it, at this site:

The instructor organized a field trip to a forestry lab and introduced the students to it by talking about gypsy moths and why they are a problem and what is being done to address this problem. The teacher then led the discussion toward common household pests, how to get more
information on them, and how to eliminate them using an example from her own life. She then asked people in the group to share similar experiences. The teachers philosophy is that the students should be led to discover the connections to their own lives, they should not be explicitly told these connections. This can only be accomplished by facilitating a group discussion on the topic. The discussion then moved to other pests that are not native to the U.S. and have been brought here from other countries, for example certain bacteria in Lake Erie, and what harm this does to local ecosystems. She then made the students aware of what large scale efforts are being conducted to save local ecosystems. Students actively participate in the discussions and some who do not are gently drawn into the conversations. Students appear involved in the discussion and excited about sharing their experiences and views on the topics discussed.

On the day of the field trip the general mood was one of excitement. Some students expressed wonder at seeing a slice of a leaf under an electron microscope. They listened passively to a scientist talking about geographical information systems but did not appear to be very interested in this. They were however very interested in seeing samples of leaves with different growths on them and being informed about which were diseased and which were just organisms which would not harm the plant. They were also interested in the sections of tree trunks and how the researchers could tell the years in which the trees withstood forest fires. The students also evinced interest in the concept of controlled forest fires, why they are becoming necessary, and how they are accomplished. Some students questioned the researchers further about this. The part of the field-trip that the students found most interesting was a presentation by a researcher who showed the students slides and explained his project with gypsy moths. The researcher was a very enthusiastic speaker and the students responded with equal enthusiasm by asking questions and probing him about his project.
Glimpse 8: Site 8

There is a single table in the room and the teacher and students sit around it. There is a board on one of the walls which displays the students' work. The students mostly work in groups. The teacher uses materials from the published GED books, but the students work on them as a group, reading through the material and then answering the questions together. The major focus here is group work and learning from each other. When answering the questions the students express their own ideas and their rationales and discuss them. Sometimes it is one of the students in the group itself that leads the group toward the right answer and sometimes it is the teacher. There is a lot of social interaction among the students and between the teacher and the students.

The next section discusses various aspects of the different programs sampled including assessment, instructional strategies, and instructional materials.

Aspects of GED Programs

Assessment and material selection

The majority of the sites sampled administered the TABE (Test of Adult Basic Education) to students as they enter the program. This test gives the teachers an indication of the reading level of the students. However it does not test the students in the individual content areas. For testing the students on this, teachers relied on the pre-tests in published GED materials. Teachers used these tests to identify the students' areas of difficulty. Based on the grade-level comprehension capability of the student assessed by the TABE test and the areas of deficiency
identified by the practice science tests, teachers selected material for the students in those areas and at that grade level. The material generally came from published pre-GED or GED materials.

T7: When they enter the program I give them the TABE reading comprehension. Based on that, if they score 10th grade or higher than that, then I will start them on the practice test before remediation. I will give them the social studies test first because I would say, not a hundred percent but real close to a hundred percent always do better on the social studies practice test than on the science practice test. If they do fairly well, I would say 48 or higher on the social studies then I go ahead and give them the science. If they don't do the same on the science, 48 or higher, then I go through the science questions, figure out what areas they are lacking in and give them science background. If they are lacking in chemistry, that's what I'll work them on. If they are lacking in a reading skill then I'll try to give them science background in that reading skill.

At site 3 where the emphasis was on testing the students to measure their progress, students were repeatedly tested on the materials they read and based on their scores on these tests they were given additional materials and thus progressed through the program.

T4: When they come in we usually TABE test them and that is just a test to see what grade level they fall under. And then we put them on that particular course, we start them on their individual curriculum, so if they fall on the 7th grade level, we then have them working on materials that are on that grade level. We post-test them and if they get an 80 or above on the certain post-test at that grade level, then they move up. And that's how they progress through the class.

The teacher at site 7 used her own assessment test to determine the reading, writing, and math skills of the student. This was the only site sampled that used an informal assessment in addition to the published assessment tools generally used by all the other sites.

T3: I give them a little assessment test that tells them where they are in math and in their reading and writing skills. So I can tell their reading level pretty well with that assessment test. It's not a very structured thing.
Apart from the basic assessment of reading skills, most teachers also gave the students an assessment in the different content areas. The tools used for these assessments were generally pre-tests in published GED materials. These assessments were then used to determine which specific areas the student was having difficulty with and the student was then supplied with material in that specific area. The materials were taken from pre-GED or GED published materials, the materials used most commonly in the programs being those published by Steck-Vaughn and Contemporary. In many programs there was a clear emphasis on providing the students only with materials in areas where there is a perceived deficiency. Thus the selection of the materials was geared primarily towards being successful on the GED test.

P3: I do a skills inventory from the contemporary GED book, they start with that. Then we will use Contemporary for a teaching load and when I think they understand it then ... it depends on whether they are on the GED level, because I have several levels like pre-GED ... then I will switch to Steck-Vaughn and see if they really understand it and again we will do a skills inventory and we will do only the areas that they need to study, so in science there's an emphasis on only the areas that they need to know.

T6: I use pre-post tests and the GED test and look for areas of difficulty. I go through questions individually irrespective of scores and then pull out materials. Even if they get a 50-54 on the test, in diagnosis you can notice deficiencies in particular areas, then I pull out materials on those areas. I give the practice GED test and use it as a benchmark. The important thing is to get to know the student. First start with a basic reading assessment. If the student is having a lot of difficulty I back up to ABLE material which is supplemental so that the student is familiar with terminology. I mostly teach from GED books, but also use pre-GED materials as supplemental.

T8: I usually test them, I use the little Contemporary pre-tests and post-tests, the print is much larger in that book. I use that to get an overall understanding of where they're at, and then I break it down to those 5-6 areas, and then they go back and review each one. That's how I set mine up, I don't just give them a book and say read this. I like to start them out, give them a pre-test and find out what areas they may have done really well in.
and focus on the rest. Usually they need to work on about 2 areas out of 5. When they work on the materials, then I re-test them to see where they’re at.

If students fell below a certain grade level with respect to reading on the TABE, the teachers generally focused on developing the reading strategies of the students and not on particular content areas. Students were given reading materials at a lower level in different subject areas and the focus was on improving their reading skills.

T7: They take the practice tests, if they fall below the 10th grade level, that tells me that their reading skills are not good. No, I should not say not good, that they’re weak. So that’s when I just concentrate on reading skills strictly, it might be in the social studies context or it might be in science context, because that’s what they’re going to have to know anyway, but the focus at that point is reading skills.

The teacher at site 2 talked about her plans to revamp the system she used to assess students and select materials. Here the emphasis appeared to be on selecting materials to address perceived deficiencies with the aim of progressing the students quickly through the program and helping them successfully complete the GED test as soon as possible.

T2: I’m in the process of reevaluating that (the preparation I give the students) myself now. I plan on giving the students at least the pre-GED test to see where their weaknesses are in each of the science areas. If I notice that my lower level students have any weaknesses in the pre-GED I will make them work in pre-GED materials because they cannot handle the GED book. If my upper range students successfully complete the science area in the pre-GED book then I will immediately administer the entry test in the GED book (Steck-Vaughn) to see what areas they seem to be weaker in. Even though I would like them to work through the whole science area in the GED book, some students hope to finish quickly and I think by administering the entry test they can concentrate only on their weak areas where the other students can work through the entire area, but at least that will give them some indication of where their weaknesses are.
One teacher, operated from the philosophy that most of the students do not come with any prior science knowledge and therefore do not really need to be tested in science. For the science preparation, all students started at the same level and used the same materials intended to cover all the areas of science that are included in the GED test.

T1: 95% of my students have no knowledge of science when they come in through the door. They're not tested on science and the reason I know this is because every time I introduce science they do not know it. I just start form the beginning with it using the pre-GED science (Steck-Vaughn) and I just pull information out of here and we go through some of the terminology, but first of all I introduce them to the terminology of science.

One teacher talked about the importance of administering the students a locator test when they first came into the program rather than a practice test, so as not to overwhelm the students. The TABE locator test gives a general indication of the students reading, language, and math skills.

T8: I used the new TABE locators this year, the students feel comfortable with the survey, but the core battery is similar the practice test and I think it’s overwhelming when they first start out class to give them a test that they cannot understand. So the locator is great, but I still don’t think they actually correlate to the actual tests, I think that the information is completely different. They don’t test for science and the social studies, so I have a separate test from Contemporary for the literature and the social studies and the science and I give them the locator and the survey for their reading and their math and their language.

Thus most of the sites sampled had a similar approach to assessment and material selection, first using the TABE to test at which grade level the student is working and then administering pre-tests from published GED books to identify areas of deficiency.
Instructional strategies used in GED programs

Individual Reading

The most common instructional strategy employed in the programs was students working individually from publishers GED books. This strategy was apparent in the majority of the programs with a few exceptions. While reading there was not much interaction among the students. Many of the sites relied only on this strategy, while in a few other sites, while students spent the majority of the class time in reading individually, the teachers did incorporate other strategies as well. For the individual reading strategy, the onus was clearly on the students. The students had to be motivated enough to individually work on the material and work by themselves at home. In the sites where this was the only strategy employed there was no teacher influence on the motivation of the students and nothing was being done in the program to promote the students' interest in science. The students' goal of achieving the GED certificate was the only motivation for them to progress through the program and there was nothing being done to cultivate their interest in different subject areas.

S1: I just did the science part that's in the GED book. I just went over some of that.
R: Is there any other help you get here for preparing you for the science test?
S1: No, just the book to study for the GED.

S16: We did several sheets on science, it was like work sheets, but that's all I can think about in science. We did a few work sheets.
R: Did you have any discussions on the sheets?
S16: Sometimes we did it together, it was just like multiple choice, you just read the paragraph and answer the questions.

S4: I learned quite a bit by going through the whole science book. And usually I would do that on my own time and then if I had any questions I would come back and talk to the teacher about it and read about it and whatever I could not understand she would help me understand better. When I went through the science book, I did it all, the questions and
answers and everything. I did pretty good and I tested myself at the end, they have a post-
test at the end and I did pretty good, so that's why I didn't think that science was a
problem.

S12: Well, we studied a little science, we went over it. We don't get a lot of science, we
have a big book that we do.

S8: Well, I do the tests first and when I'm through with the test, I go back and see what
I've missed, and that's how I learn from it.

S5: They give you different levels of science to read over and they see which level you're
at, maybe 10th grade or 11th grade, and you take it from there and read that material, and
once you read that material you can pass the test, you just have to have a good memory.

A majority of the students sampled were of the opinion that they would like to see other
strategies incorporated into the teaching and learning of science in the GED program (See
discussion on Student perceptions on what would help them prepare better for the GED science
test). However, some students liked this strategy and preferred working alone. This strategy of
individually reading and answering questions appears to be suitable for these students.

S16: I like to read and to answer questions, that's what I like to do, I prefer just doing it
alone.

Students had different perceptions about how this individual reading was helping them
learn. Some students believed that they were learning something when they read.

S16: Any part of reading I think helps you in your everyday life. Anything that I could read
and remember and would like to ... I think that's important.

However, the majority of the students felt that reading alone was not enough for them to
learn the material being presented to them.
R: Do you think that anything you are reading in these books, the examples you do and the practice tests, make you think about or know more about science?
S2: No, because at the time what you are thinking about is just answering the question and hoping that it is right.

Some teachers believed that this problem could be addressed by more one-on-one time with the students. This is possible in programs with a few students, but in programs with a large number of students and a single teacher on any given day, this approach of one-on-one tutoring is not logistically feasible.

T2: I try to sit down with them one-on-one as much as I can and if the classes are small, which they normally dwindle down at certain times, I normally give them more attention. I try and pinpoint what types of problems I see.

Even though the dominant strategy in all the programs sampled was individual reading and answering questions based on the passages read, there appears to be a common feeling among both teachers and students that this is not the most appropriate strategy for these students. This strategy does not do much in terms of igniting and sustaining students interest in science and is geared primarily towards helping them successfully complete the science portion of the GED test by giving them experience with reading passages and answering questions similar to the ones they will encounter on the science GED test. Teachers who rely totally on this strategy were of the opinion that the characteristics of GED programs and the population of students that attend these programs preclude the feasibility of other strategies. The main problems cited include lack of time, resources, and the fact that they do not have the same students every day in class. These problems are explored more in detail in the section on Problems and Issues in GED Programs. However, other teachers, working under similar constraints had incorporated other strategies like science experiments, field trips, and classroom discussions into their science programs.
Testing

In Site 3 the emphasis was clearly on testing. The students were tested regularly and the tests graded to measure the progress of the student. The students worked individually, reading passages and answering questions based on the passages, the only difference here being that their responses were in a test format and were graded. This allowed the teacher and student to keep track of the student's progress and directly address areas of perceived deficiency.

S3: Whatever areas we're weak in, they give us those books and little cards, our test cards, and we test day to day on that .... then run it through the machine and see what we are still weak in and what we progressed in.

The teacher at this site admitted to not having materials that focused on science, but stressed the importance of giving the students practice in experiences similar to the actual GED test. She also believed in relieving students' anxiety about the test by helping them realize that all they need to know to be successful on the GED test is how to read and interpret the passages and answer the questions based on that.

T4: I think some of the students feel uncomfortable about the preparation they receive for the science test because we don't have materials that focus heavily on science. We have materials that give practice for the science test, but nothing like lessons. There's just questions that are set up just like the test, so sometimes they are a little wary about taking the test. Sometimes they are quite comfortable with it because I usually try to get them to look at it in a different way. They really don't have to know the actual factual information, but they have to know how to answer the questions, how to interpret the questions.

T4: Tests intimidate them period. When they first come here, after they're here for a while, I'd have to say that they kind of get used to it. It's like a challenge to them and they appreciate it, they actually appreciate that challenge because it shows that they're progressing. So I think that they will probably just take it like a normal day in the program because it's a day full of post tests and pretests and pretests and posttests and so I think they will be all right with it as far as the science is concerned. Like I said, they are not
exposed to science so they will probably be a little wary, but I think they will be all right eventually.

This teacher also believed in the benefit of individualized strategies for adult students in terms of not intimidating the students and avoiding competition among students and possible embarrassment.

T4: I think that individualized instruction is the best because it does not intimidate the students. They’re not competing, they feel comfortable, no question is a stupid question because it’s the level they are learning at and they accept it.

The teacher was of the opinion that students eventually get used to this strategy and enjoy it.

T4: It takes a little time to get used to getting all of it, just coming in and grabbing a book and sitting down and working all day. But after they get into it, they enjoy it and appreciate it.

The students too appreciated the preparation they were getting for the test and it’s role in making them comfortable with taking the actual GED test. However, they also indicated that they would like to learn science in other ways too, by doing hands-on experiments and going on field-trips.

S3: They could be more technical about what they give us. It’s a lot of reading, but when you are going into science there should be more inventive things, like hands-on things.

In this site too, we see the students’ interest in being exposed to different methods of learning science other than an individualized approach. Even though the teacher and students believed that this strategy of continuous testing helped students overcome their anxiety about
taking the actual GED test, both agreed that other strategies such as hands-on experiments or field trips could be a more suitable approach to learning science.

Group Discussion

Most of the students and teachers interviewed did not feel satisfied with the heavy emphasis on reading published GED materials and answering questions. The dominant perception was that group discussion would be a suitable strategy for the science preparation for the GED test.

The most common reason given for this was that group discussion is a method by which students can benefit from each other’s knowledge and experience. One of the important aspects of adult education is the importance given to the knowledge and experience of the learners and the need to build on this and utilize it effectively (Kidd, 1973).

S14: Everybody has different ideas and it's good to use other people's ideas and also, you only know so much, maybe the other person knows a little more than you do, so when you combine them together, it's good.

S12: It would help because other people have their own opinions and what they know about things, and different people have different opinions.

S8: Because there's different opinions, where one gives one opinion and one fact and another one can come along and give another fact and their opinion.

Students in sites that employed other strategies in addition to group discussion such as hands-on science experiments and field work felt that group work was the appropriate approach to those strategies too and cited the same reason, the opportunity to learn from each other and draw on each others' knowledge and experience.
S4: As far as doing experiments and stuff like that it's good to have a whole group, just to be in it, I guess you would understand it more. I could be wrong and another one could be right, someone else would be right, we can learn from each other.

Teachers who used this strategy were of the opinion that group discussions are important in keeping the students involved and interested in the subject. In addition, it helped students relate the topic of discussion to their lives and enabled them to see its importance. The teacher at Site 7 believed in involving all students in the discussion, and drawing out from them experiences that help them see the relevance of the topic of discussion to their own lives. Another major reason cited for having group discussions was to keep the students interested in the material they have to learn.

T8: They (the students) think the material on its own is too dry, if they do it together, they seem to be excited about it. I'd say more large groups than small groups when it comes to science. And field trips, it has to be visual. As many visuals as you can possibly have, the more the better.

Group-work also facilitates transferring some of the responsibility of teaching new students from the teacher to the students themselves thus helping students learn by teaching other students.

T6: The students also have the responsibility to teach new students. As a result of this, after awhile all students learn.

However, as with any other group of students in any other program, there are various preferred modes of learning. Not all students believed that group discussion is important or that it helps them learn. Some students preferred working on their own and were quite satisfied with the strategy that encompassed individual reading and answering questions based on that reading with minimal interaction with other students.
S16: We did several sheets on science, it was like work sheets, but that's all I can think about in science. We did a few work sheets.

R: Did you have any discussions on the sheets?

S16: Sometimes we did it together, it was just like multiple choice, you just read the paragraph and answer the questions

R: And you did it as a group sometimes?

S16: Yes

R: Do you prefer doing it by yourself or doing it as a group?

S16: I like to read and to answer questions, that's what I like to do. I prefer just doing it alone.

One student expressed the opinion that though they could learn the material by individual reading, an advantage of group discussion was that the teacher would be aware of the progress of the students and what they do not understand and would be able to address those problems directly.

SN2: To me I think it does not really matter, because as long as I understand the terms and all that, I'll go ahead and do it on my own and if I don't, I'll ask somebody. But I like group discussion because if you don't understand it she (the instructor) will see and will follow up on it and explain it to you, and that is good.

A similar sentiment was expressed by a teacher who felt that having group work enabled her to keep track of the student's progress and proceed at a pace that alleviated anxiety and did not intimidate the students. This is especially important with this population of students who have experienced failure in traditional academic settings before and may be frightened away by the prospect of being overwhelmed. This teacher also addressed the issue of avoiding competition among students by working one-on-one with certain students who were not at the same level as the rest of the group. However, like all other teachers who used group strategies, this teacher's perception was that group work made the class more enjoyable. Students expressed a similar opinion regarding group work making the learning experience more enjoyable.
T6: I don't want to frighten them away. These students are easily scared, if you scare them they won't come back. For some of them, this is the third time of trying to get it but they've always fallen back and went back home and did not do it, you know, always had a reason. So I try to introduce it very slowly and that's not just for science, that's for anything, to get their feet wet first. I introduce it to them and when I see that they are laughing and understanding then I go a little bit further. We work good as a team, as a group. I don't want to leave anyone behind because that involves hurt feelings. Adults are set in their ways and they don't want to think 'hey you are better than me', like in high school, but they like working together as a group. So depending on their level of understanding, I might have one-on-one with them, but basically I deal in a group setting, it's more fun that way too.

Two different approaches to group discussion itself were apparent in the programs sampled. Some teachers used group discussion with the published GED materials in order to facilitate learning and understanding of these materials.

T1: All I do really is assign them a part of the science to read and then we try to have a general discussion about what they read to make sure they are understanding what they are reading. The whole book is made up of little pretests and posttests, so they take that to make sure that they are understanding.

Most of the teachers however, used group discussion as a medium for initiating student interest in science and awareness of science-related current issues in society and increasing their awareness of the world around them in general. This corresponds to the concept of scientific literacy in terms of increasing students awareness of science issues in society with the goal of promoting effective citizenship.

T6: They are aware of issues generally through the TV. They think of it more as newsworthy current events, rather than science, like the comet and cloning. Students do talk about it, it gets discussed in the classroom if it makes the news. If we had more time, there is tremendous interest and we could use it, not towards the GED but towards their interest in science, to initiate it. The more students there are the more participation there is and students speak out.
T8: We do not have a whole lot of discussion on science. We have more discussions on current events, that's why I always feel that they should change the test. We may talk about something related to science, but it is usually through a current event through a newspaper clipping.

Some teachers also used group discussion in order to stimulate interest in the students in reading materials other than the published GED books.

R: Are the students interested in reading additional materials apart from the book?
T3: Some of them are, mostly if I allow time in class and I structure it, they're willing to do it if we have a discussion about it. They like to talk about things.

One of the major problems cited by teachers who incorporated group strategies was the forever changing nature of the class. With most students attending these classes on a voluntary basis the subset of students in a class on any given day is very rarely constant. Students who are absent on any given day miss out on the group work and it would be difficult to repeat it again for those students without losing the interest of the other students. In addition, the enrollment in the program is constantly changing with students dropping out and new students enrolling at all times during the year.

T3: Time constraints, and the problem of not having the same class everyday. That is one of the biggest drawbacks in this program. When I was teaching elementary school, I had the same class every day. Because if there's some students missing, the class changes and there's always new students coming in, so it's hard to integrate the new students without having the other ones go over the same material. I can't do a lot of group teaching. That's the advantage of the science program though, I can do group teaching, I can bring the whole group into that whenever they come in, it seems.

Even though some teachers indicated having students at different levels as the reason for not incorporating group teaching strategies, this teacher was of the opinion that science is easily
amenable to group work because all the students are more or less on the same level in science in that they have not been exposed to it too much. Therefore by introducing different topics in the group discussion she was able to involve all the students in the discussion regardless of how long they have been in the program.

Another teacher felt that though the changing nature of the class was a drawback to group strategies, both she and the students shared the perception that it was a valuable strategy. In addition, it is also amenable to eliciting students' experiences and helping them relate the topic to their lives. This is acknowledged as one of the very important aspects of adult education. In order to hold adults interest, it is important that they see the use of that subject in their everyday lives (Meriam & Cafarella, 1991).

T8: I have some small groups, usually 2 or 3. Large groups work well in math. I'd say the reason it does not work well in science is because you never know, on a typical day in adult education, you never know, it's not like they are all going to be there one day, so you cannot continuously go on with something, because you will lose them along the way. But we like to do things together. They feel like they are getting something done when we sit down as a group. So I try to incorporate that. And then I like to have them work together in small groups where they can help each other out. When we watched the childbirth movie it brings out your experiences on what actually happened to you. Some days we have good discussions. Sometimes you can run into problems though, you have to be really careful with adults what you are talking about.

Thus in the sites where group discussions or group work was one of the strategies used, we see a very favorable attitude towards it and a belief in its advantages in everybody. Compared to all other strategies employed in the programs sampled, group discussion was one that drew the most favorable responses from the students involved. The students felt that they benefited from this approach and the teachers felt that it increased their understanding of science as well as their awareness of the role of science in society and the relevance of science in their own lives. Since the majority of the students stressed the need for the material they are being
exposed to be relevant to their everyday life, this emerges as an extremely important strategy in the science portion of GED programs. In addition, document analysis of the published GED materials revealed that they do not directly address the issues of science in society and its relevance to everyday life but they do contain topics that could be used in discussion along with supplementary materials such as newspaper articles, magazines, or videos to increase students' awareness.

**Hands-on Science**

Two of the sites sampled included science experiments on a regular basis. These sites had a tutor come in a couple of times a month to do science demonstrations and experiments. One other site did hands-on science occasionally. One of the more innovative sites (Site 7) had incorporated demonstrations and experiments as well as field trips into the program. Here the emphasis was clearly not limited to reading. The teacher at this site highlighted the importance of making science relevant to the lives of the adult learners. Data indicate that the students responded more positively to strategies such as this.

S14: I like probably the demonstrations, I like probably the field trips. I think you learn more by seeing. Lectures are good, I think you need the lectures and then we need to go into the experiments on them. I mean they lecture about how something works and then it's good to see how it works so that we can retain it. They need to follow up on that.

Some students also stated that the science they learned was mostly by doing experiments or watching demonstrations because either they could not remember doing anything from the published GED materials or they found it uninteresting.

S14: The tutor was here and she talked about atoms and what they did, the electrons and neutrons and molecules and nucleus and how this all comes together and they make a particle. I can't remember doing anything from the GED books, it's mostly through the tutor, she comes in and she teaches it.
S6: The tutor brings out stuff and shows us things. That's how I learn it. I just can't sit down here and read because that's boring. Unless she lets us do something or does it on the board, that's when I can, that's when I learn it.

R: Do you do any of the readings from the book?
S6: Yeah.. we do. But I really don't.

The teachers' perceptions were that students responded positively to hands-on science and demonstrations. In their opinion it held students' interest and attention and the students could learn more and understand more if they were actually doing something hands-on.

T1: I have a person that comes in twice a month and she does all science. She does chemistry and just everything and she brings in manipulatives and everything that they can work with. I mean she has stuff floating and all that. She just does everything with it and that right there holds their attention, when they have the hands-on where they can deal with matter and stuff.

T5: I did have a lady tell me that what we have done here helped her with the science part of the GED. I had some good feedback.

One aspect of doing experiments that the students seemed to enjoy was working in groups.

T3: I think they enjoy working in groups. When the science tutor comes, some of them enjoy that, they are a little bit overwhelmed by that, but that's okay, she gives them a lot of information that they have had little contact with in the past, so it's like getting data overload.

An observation of a hands-on science session at one of the programs revealed that not all the students were interested in the experiments. Some students sat on the sidelines and did not participate while others went through the motions not really understanding the reasons for what they were doing. Interviews with the students revealed that the experiment in itself was perceived as enjoyable and a diversion from the routine of reading and answering questions, however, the
students were not sure of what they had learned from those experiments. The tutor, while explaining the principles behind the experiments, generally made no attempt to relate it to anything in the students lives.

S10: What would help .. reading, lecture, and some experiments, not a lot. I'm just not interested in ... measuring air and stuff like that, I'm not into that.

This student was referring to an experiment where the students lit a candle standing in a shallow layer of water in a beaker and placed a cylinder over the candle and measured the height to which the water rose in the cylinder and the volume of air it corresponded to, to determine the percentage of oxygen in the air. Interview questions with some of the students revealed that they had no idea about what they were trying to accomplish by those experiments or what they were supposed to learn from that. This idea is explored more thoroughly in the section on Doing Vs Learning.

The teacher stating that the students were comfortable with doing science experiments, however, expressed doubt as to how much the students are learning from the experiments and their attitudes toward this.

T5: I think they feel comfortable with it (doing experiments) as far as I can tell, with what I've done with them. Because I usually tell them enough about it, or I may do it first and then let them do it. Sometimes I've done it myself and let them watch, but I like to have them do it. I set up stations or a couple or 3 groups doing the same thing. But I don't know if they have a good attitude about it, if they learned from it (emphasis intentional).

Many of the students who have not been exposed to hands-on science in their GED program were of the opinion that experiments would be a way to make science fun and interesting and that compared with just reading something, actually doing something creates ownership of the learning associated with it and would help them retain it more.
S1: I guess, have experiments.... I think that would be one way to make it fun .... have different experiments.... I think to me once you do a thing, it is yours, but reading a book, if you just read about it ... I think one should do something, then you know more about what you are doing.

The tutor also indicated problems associated with doing science experiments in GED programs, especially obtaining the funding for doing these experiments and demonstrations. She suggested incorporating more hands-on science into the workshops that the teachers attend so that they could do similar activities at their respective sites.

T5: If there was funding for some chemicals, that I could use do to demonstrations, that would be helpful. And I suppose there could be a grant written up, I have not tried to push that or pursue it. Some of the workshops (at the conferences) could be more on science and could demonstrate to the teachers so that they could go back to their sites and follow through.

Another issue was the comfort level of the teachers themselves in doing science experiments. Many of the teachers in the sites sampled had degrees in elementary education or adult education and were not themselves comfortable in the domain of science experiments. Moreover they expressed concern about the procurement of the materials to do hands-on science in their program. The time factor associated with accumulating materials for hands-on science was another important reason cited among those hampering the teachers' ability to do hands-on science in their programs.

T7: Hands-on stuff... oh absolutely. But that's another thing, I myself am not real comfortable with experimentation much less getting the materials that you would need to do something like that. Not that they would be expensive, but where do you get litmus paper, where do you buy it, you know you have to have eye-droppers and you have to get dyes etc. I do have a microscope that I have pulled out from time to time and put slides under it from the little microscope that my kids had at home. I had students who have
never seen an onion cell, an onion skin cell or pond water, all those things crawling around in pond water. I have students who have never looked through a microscope, so anything like that, anything would help. But then again, it's preparation time. When I'm teaching everything I don't have a whole lot of time to go out and garner those materials, but it's on my agenda.

The teacher at site 7 did a lot of science in class compared to the other sites. She highlighted the importance of making the science relevant to the adult learners involved and using examples from their everyday life. Another important factor mentioned was the importance of making it fun for the students and having them work in groups. Here again we see an emphasis on group-work for enhancing the learning experience.

T3: I do the science moment things. The other day we talked about the Earth about the percentage of the Earth that is water by using an apple and cutting the outside. I try to use science in small ways, the distribution of water, the water cycle. We did some experiments on that last fall. I did this activity on mystery powders where we take certain powders that are in your kitchen like baking soda, sugar, starch, plaster, and then you have them react with certain solutions and observe the reactions, what properties they have. Hands on things that are kind of fun for them to do and they can work in groups.

Thus, the data indicate many facets of the hands-on science occurring in GED programs. It also supports a finding from traditional academic settings that hands-on science does not necessarily mean that students are learning science better and are involved in the process. It highlights the importance of the hands-on science done being relevant to the lives of the adult learners. Another important consideration is the preparation the teachers have to do hands-on science. Even though all the teachers sampled indicated that they would like to do hands-on science in their classroom, they cited various problems associated with it, one of them being no exposure to hands-on science themselves and no time to plan and garner materials for this. This is one aspect that can be addressed in teachers' conferences. Suggestions by the teachers included incorporation of actual demonstrations and activities in the teacher workshops that would
give the teachers ideas that they could directly implement at their sites and making kits available
to the teachers that contained all the information and materials necessary to do science activities.

Field-Trips

At site 7, students responded very positively and enthusiastically to the science field trip. Some acknowledged that they found parts of the trip boring and removed from their lives, however the overall response was that it was a learning experience and that it made them aware of things going on in the world around them and they got something out of it that related to their own lives.

S14: It was interesting to find out how they can blow things up to find out what causes the diseases. It was interesting to see how they find out different things about gypsy moths and different kinds of insects. One important thing that I learned is where you can call for help if you have a tree dying. I know what to do if I have a sick tree in my yard. I know what different types of growth on plants mean. I went on a walk the other day and I could see things and know a little more about them, that the insects are sealed off in the little bumps, it made me feel good that I knew that (emphasis intended). I also know now that some of the stuff growing on trees is not harmful. Before, I did not notice these things, but now I’m more aware of nature, and insects, and preservation, and all the different efforts going on to preserve nature.

This response indicates that the learning takes on a new meaning for the students if they can relate it to their own lives and specifically if they can use the knowledge in everyday life. Another important aspect is the feeling associated with knowing something useful that they would not have known otherwise. The fact that many students in GED programs cite feeling better about themselves as one of the main reasons for trying to earn a GED increases the significance of the remark “it made me feel good that I knew that”. Using field-trips to equip students with knowledge that they can use in everyday life is a powerful way to empower GED students who otherwise appear isolated from what is going on in the world. It is also a powerful tool for increasing their awareness of science issues in society such as environmental conservation.
Students and teachers comments about the actual components of the field trip highlight their ideas on what makes field-trips interesting and captures their attention. The teacher and the students in this field trip stressed the importance of the enthusiasm of the people involved in the field trip and the need for using different strategies such as more visuals in order to hold the attention of the students.

S14: The one guy who showed slides and the larvae was the most interesting, it was explicit. The slides made it interesting and by seeing it, it stays with one more, seeing more of it helps you to understand it.

T3: I think it's not very interesting to stand watching a computer screen for a long time, I would shorten that part. The last person who spoke was very enthusiastic, he talked for a long time, but he talked enthusiastically and he had visual aids, that was good, the students enjoyed that.

Field-trips also provide a good method for introducing students to different kinds of science-related careers and increasing their awareness of the different ways in which people are involved in science. This is especially important in GED programs since most of the students are in the process of obtaining their GED in order to qualify for more jobs.

T3: I have some students who are not interested in science and some who are very interested. I knew this. During the trip they were interested in some things and bored with some things. One student who cannot usually sit still did very well. He is very interested in science, but he said that this was not the science he wanted to do, looking at bugs through microscopes. He was not interested in this kind of science.

These trips can also be used to give students an appreciation for the work of scientists and an understanding of the technological progress that has made amazing things possible.
T3: After we have gone out to the laboratory, they have a great respect for scientists and regard for them because they talk about realms that we never dream about, electron microscopes being able to slice a little piece of log into a zillionth of a fragment. So there is a sense of awe about it. And great regard and respect for people who have the minds to accomplish these experiments and doing what they are doing. And at this lab, they especially work with the gypsy moth and reforestation, and those are both topics that are covered in the scenic book, so that's what worked out well.

T3: I think the students got an insight into how hard people work, what the government pays for and how dedicated people are about their work.

This also stresses the importance of connecting the field trips to topics being studied in the program. This teacher also had other ideas for field trips that could be connected to the science that the students were experiencing in the program. Another important aspect of these field trips is that they increase the students’ awareness of science issues in society such as conservation of resources and preservation of local ecosystems.

T3: I take them out on field trips, we have gone to the department of agriculture science labs and I'd like to take them to the university sometime to visit some of the science labs there and see what they are doing. Right now we've just done a unit on water resources, so I'd like to visit the soil and water conservation department here.

One important finding that emerged from the data is the importance of the preparation given to students before the field trip. This was expressed both by the students and teacher differently. One student expressed the need to know what the trip is going to be about and what to expect from it in order to enhance the learnings from the trip.

S14: Many times, when you are not expecting anything, you just go and look, you don't really connect. It's like with the science and the math and the hygiene and the bacteria. You don't think about bacteria growing on your teeth. But that's science. But when you're into dental hygiene and you're taking this, then you're very much aware of all the enzymes in your mouth and it makes a difference. So the same way with field trips, when you know
you need to look for certain things, it makes you more aware of what's going on around you and you do that.

A similar sentiment was expressed by a teacher at a different site who learned the importance of preparation for field trips the hard way by taking the students on a field trip and realizing later that the students were not aware of what they were supposed to be looking out for or learning. An important consideration here is that these students were not in high-school long enough to experience science field trips like these and for many this was their first such encounter. In such situations, contrary to most adult education literature, these GED students expressed the need for clearer directions from the teacher.

T6: I once took the class to a science museum and just let them explore on their own. Most of them did not really explore, they thought it was too advanced for them. They were overwhelmed and did not seek out stuff. I realized that I need to prepare them better, with lessons and specific directions. In science you need to provide more information than in other areas.

At site 7, while talking about what she learned herself from the field trip, the teacher expressed disappointment about not being able to use the field trip to its maximum potential in instilling in students an appreciation of the technological advances of today’s society and their relevance to human life. She also talked about the importance of students connecting the field trip to the materials they were learning in the program from the GED materials. This stresses the importance of combining the published GED materials with other strategies in order to help students see the connection between what they are learning in the science preparation they are getting for the GED and science issues in society and the relevance of science in their own lives.

T3: What I did not see was the wonder of seeing protoplasm, cells and all. I was disappointed about that. I wanted them to get an understanding of what we can do these days with all the advances we have made and that the same procedures can be used to see what's wrong with humans, human diseases. The life science section in the GED
covers this, diseases, bacteria etc. I would have liked to see them make the connection between the two. If we went earlier in the year, we could discuss this and its relevance to their lives and its relevance to what they have to read in the GED book. I would question them and draw it out of them.

Thus field trips appear to be useful in cultivating students' interest in science and making them aware of science in the world around them. The field trips can also be easily connected with the science in the published GED materials. However, preparation for the field trip emerged as one of the most important factors in accomplishing its goals. The students expressed the need to know what to expect and the teachers involved realized the importance of preparing the students and having time to process the information received which could be used to discuss the relevance of that information to their lives and to the materials they were reading. Two teachers from different sites, arrived at this realization separately after being involved in a field trip that did not completely meet their expectations and achieve the desired outcomes. Increased interaction among GED teachers would facilitate sharing of such information so that teachers could draw on and learn from the experiences of others.

Direct Instruction

Most adult education literature focuses on self-directed learning and advocates the concept of a facilitator rather than an instructor (Merriam & Cafarella, 1991). However, an important point to consider here is that students in GED programs have not had much science in high school. Moreover, a majority of the students have been out of school for an extended period of time. As a result, many find themselves overwhelmed by the science presented to them in the GED program. In such a situation, some students expressed a preference for the traditional method of teaching or direct instruction.

S4: I like that our teacher gives us more hands-on teaching and on the board, not just giving us the book and have us go through the book. If we have any questions, she goes
to the board and questions us about it, so that way she knows where everyone is standing.

Some teachers were of the opinion that direct instruction would help with certain students. This direct instruction could be conducted as a group so as to incorporate aspects of group work that students appreciate.

T7: Direct science instruction would help the students in science because when you're teaching, it's my belief that when you are teaching a skill, a general process skill like reading, you can do it in any context, it does not have to be out of a so-called basal reader. It can be out of the newspaper, which is not great grammar or paragraphing skills, but then you learn what you don't do, what's not correct. But there are others, like my current class, we were learning reading skills in the context of the declaration of independence and the Constitution. Now that is something useful to every American. And I noticed that with direct instruction in that group, within just several months, their reading skills shot up, they could look and find information, they learned how to skim through, and how to write complete sentences and organize their thoughts.

Thus even though direct instruction is not advocated in the adult education literature, in some contexts it may prove valuable. One such context is the learning of science in GED programs. Direct instruction along with group work can be used to introduce basic ideas in science and enable teachers to use questioning strategies effectively to determine what the students know and don't know.

Miscellaneous Strategies

Teachers in different programs also used other strategies on a less frequent basis (e.g. activities, both indoor and outdoor; watching videos followed by group discussions).
One teacher had the students go out during class time to watch the eclipse and used it in a discussion on eclipses.

P3: The students were excited about going out and watching the eclipse, that was a fun thing to do. We don't have any kind of lab to do any sort of scientific experiments, we don't have the capability, I can't do them ...

One activity involved students filling in the parts of the human body on a picture of the body during a health lesson. Students responded positively to this exercise and reported that it helped them learn.

S16: I learned a lot of stuff that I did not know about. Like when we filled out the parts of the body and we read a lot about health, that was very interesting.

The teacher at site 7 believed in incorporating science into the class on a more regular basis than just doing science lessons every now and then. She had a collection of ideas that could be used without much pre-planning for the class and she introduced them at opportune moments in the class.

T3: I have these folders where I keep science ideas, science materials, like this one on spoons and mirrors and pendulums. This is like a one-room school house. So it's hard for me to plan. I come in the morning, see who is here and what is the most important need of the day. So I have to say that science really is, right at this point with the class I have, probably not a top priority. So I try to keep some little things available so if there is a moment we do a little bit of science here and there.

The teacher at site 8 also incorporated different strategies including having the students watch relevant videos followed by a discussion on the videos and having a nutritionist come to the class and do activities concerning diet and health.
T8: The last video we watched was on the flower all the different parts of the flower and one was on childbirth. That was more of the human body, and they always love to watch stuff like that. Because I think that most women can relate because they have had children, and most of the people in my class are women.

T8: We had a nutritionist come in. It was a 7-week program and each week she had something different and the students ate everything she made and they talked about what they were eating and they kept a log of what they were eating. That was fun. The students loved it. They love talking about food but at the same time most of them knew what they should be eating. So it was a really successful lesson and experience that they could look forward to.

These strategies used topics relevant to the students and appear to be successful in involving the students and holding their interest. Another approach used by this teacher was one that is often associated with elementary school, i.e. displaying of the students' work and recognition of their work in the form of stars. This is not common practice in adult education situations. However, the teacher's perception was that this approach was helpful to the students and was appreciated by them.

T8: We like to display their work, they are real proud of their work. Anytime they do something special they get stars. It has to be something we can do together as a group. And I put everything that they do up there (board), it makes them feel good about themselves. When we did the nutrition unit, we all made these picnic baskets with a well balanced lunch and we put them up. It was like an art project, we put them up in the room. It makes for a better environment, and if the environment is good, they are more productive.

In all these miscellaneous strategies we see the emphasis on making it relevant to the lives of the students. The students involved responded favorably to strategies such as this. In addition to providing a diversion from the regular routine, it helped make the students aware of important topics that have direct application in their lives. Moreover it was conducive to increasing their feeling of self-worth with respect to owning this information that they could use in their lives.
Increased interaction among GED teachers would facilitate sharing such low-cost high-impact ideas that other teachers could incorporate in their programs.

**Materials used for science preparation in GED programs**

**Steck-Vaughn Vs. Contemporary**

The books most commonly used in the GED programs sampled were the GED books published by Steck-Vaughn and Contemporary publishers. Other books used to a lesser extent included books published by Baron's and USA Basics. However, between Steck-Vaughn and Contemporary, teachers expressed different reasons for relying on one more than the other and cited different strengths and weaknesses of the books to support their choices. Teachers' reasons for choosing one of these ranged from familiarity with the materials from a particular publisher to perceived advantages of one over the other or the use of materials from different publishers for different purposes. The more common perception appears to be in favor of using Contemporary as a starting point and once students have finished these materials, starting them on Steck-Vaughn. This in part could be a result of the perception that Contemporary is easier to understand than Steck-Vaughn or it could be the result of the perception that Steck-Vaughn is more valuable for strengthening students' skills in the different content areas while Contemporary is good for addressing reading skills.

The teacher at Site 1 used Contemporary to start the students out and after the students progressed through these materials, she introduced them to Steck-Vaughn. Her belief was that Steck-Vaughn requires a higher level of understanding than Contemporary.

P3: I do a skills inventory from the Contemporary GED book, they start with that. Then we will use Contemporary for a teaching load and when I think they understand it then ... it depends on whether they are on the GED level, because I have several levels like Pre-GED ... then I will switch to Steck-Vaughn and see if they really understand it and again
we will do a skills inventory and we will do only the areas that they need to study. So in science there's an emphasis on only the areas that they need to know.

The teacher at site 5 had a similar opinion about the materials from the two publishers but added that in her opinion the materials from Contemporary emphasize reading skills while the materials from Steck-Vaughn emphasize the content areas.

T7: Most often for that level I use Steck-Vaughn and Contemporary again depending on whether they need science strengthening or reading strengthening. For the content I generally use Steck-Vaughn, for the reading strengthening I would use Contemporary. Because it's just the format one stresses more than the other, it's just the way it's formatted, that's the way it works out....

The teacher at Site 8 was of the opinion that the students were more comfortable with the Contemporary materials because of it's format that made the learning process easier for them.

T8: I would have to say I like Contemporary better (compared with Steck-Vaughn) just because they are written in a way that they are easier to understand, with pictures, and the print is larger and the students feel like they are successful because they outline each test and if they have problems with the questions they have practice pages they can go back and work on. So, as adults they feel that they are part of the learning process, because they can go back and work on things, whereas the Steck-Vaughn is more of an exercise form, it's a drill kind of focus. Now it depends on the learners, some people like drill work and some people like to find out where they are at, work on those areas and then review. So I'd say that most people are comfortable with Contemporary just because it's easier to understand.

The teacher at site 2 primarily used materials from Steck-Vaughn because of her familiarity with those materials.

T2: I've primarily worked with Steck-Vaughn especially in the science area. I believe that those are the only materials that I've used because I'm so familiar with that book, I feel
comfortable with it. In some of the other areas I do pull out some materials from Cambridge and Contemporary, but I have not done that in science.

R: Do you have other materials for the students to read?

T2: Yes, but primarily it would be in pre-GED materials for students who I feel cannot handle material in the GED book.

Like all the other teachers sampled, this teacher too used pre-GED materials for students who they believed were not ready for the GED-level materials. One teacher started out all students with the pre-GED materials in order to build up their confidence before introducing them to GED-level materials.

T6: The way the materials are written is confusing, especially in the more advanced books, the information is not easily understood. Therefore I use pre-GED materials instead, because if the students understand, it gives them confidence. Then they can move to advanced terminology.

The teacher at site 8 had similar views about the value of using pre-GED materials with the students in GED programs. She too, thought that the published pre-GED materials did more for stimulating students' interest and increasing their confidence than the published GED materials.

T8: The Contemporary regular science is a little bit more difficult. Whereas the pre-GED level breaks it down in a real nice way, it's almost as if you're reading a novel and they like that. They like to be able to get something out of it, something that they're learning, that they're actually reading and finding interesting. The graphs and pictures are really nice, it helps them understand too.

The teacher at site 7 relied heavily on the pre-GED materials published by Steck-Vaughn. Her rationale for using these materials was that the content was presented in a manner that complemented group discussions and promoted the use of other materials such as books,
magazines, and newspaper articles in the classroom. These materials often served as spring-boards for a discussion of contemporary issues in society.

T3: I start with the GED book (Steck-Vaughn pre-GED) and try to cover the basic areas that are covered in the book. I have looked at the practice test occasionally to see what's on it, so that's how I decide. I have not given them a pre-test. I've just used this book to be truthful, it provides areas for discussion and I use newspapers or magazines for additional information, and the library.

T3: And actually I like the way these lessons are structured, because they start out with asking them what they already know about the subject and then ask them to survey the article and then ask some questions as a motivational thing to see what they think they are going to learn. So I like the structure of these lessons.

Nearly all the sites sampled used pre-GED materials with students who were not at a reading level that corresponded to the reading level in the GED materials. The pre-GED materials most commonly used were from the same two publishers: Steck-Vaughn and Contemporary.

Supplementary Materials

Different sites used different materials to supplement the standard GED books that they used to prepare students for the science test. These supplemental materials included computer programs such as Plato and Steck-Vaughn GED 2000, newspaper articles, and books by other publishers used at the middle school or high school level.

P3: It depends on what they are having trouble with. If graphs or charts or diagrams are giving them problems, then I will set up specific graphs or diagrams for that area. I have a small computer for geography. Now geography kind of overlaps with science to a certain degree so we work on that, particularly the meridians and latitudes. I do have different modes. I have a recorder and listening texts that they can listen to. But I'd say my main modes are textbooks and the computer, it just depends on what the student
needs. You make that assessment and when you see what difficulties they are having, then you try and address that need.

T2: I generally use Steck-Vaughn. If they are with me long enough and they are able to bring up their skills in writing and math sufficiently, and I feel that their reading is progressing, then I sometimes put them in some of the areas on the computer (Plato program) where they walk through the science areas. I think it's more difficult on the computer. It's more difficult than even the book. But it is something they can supplement with.

T3: (The book) provides areas for discussion and I use newspapers or magazines for additional information, and the library
R: Do you have access to a library here?
T3: Yes, they have a bookmobile that comes to our parking lot every other week, and I can call the library and say we are studying such and such, could you bring some books. And partly I need to find areas where I can get reading materials from the lowest level to the high school level. And we have a library close by, we could almost walk to it.

Teachers that used classroom discussions as a strategy in their programs also used materials that are not GED-specific such as newspapers and magazines.

T7: We use other materials too, magazines that I subscribe to, newspaper articles of interest or other materials made for teachers. I have on the door a periodic table of elements, I have a chart of the Solar System, a chart of the human body, and the different systems of the human body.

The teacher at site 7 emphasized the role classroom discussions played in motivating students to read materials that are not GED-specific. The materials that she generally selected were aimed at increasing the students' awareness of the world around them.

R: Are the students interested in reading additional materials apart from the book?
T3: Some of them are, mostly if I allow time in class and I structure it, they're willing to do it..... If we have a discussion about it. They like to talk about things.
Responses from students in this program supported this and indicate that these students believed that they could learn about science by reading materials that are not GED-specific.

S5: In magazines, you can come across different science materials to read, like Time magazine and different newspapers and different stuff like that. So you can learn from different magazines and also reading the science materials in different books.

However in all the programs that emphasized individual reading, the only materials that the students were exposed to were GED-specific published books.

T4: We order most of our materials from Steck-Vaughn and USA Basics. And those are the two that we get most of our materials from because we have a CCP curriculum. That's an individualized curriculum where each student works on their particular learning level.

These materials, in general focus on strengthening students reading skills in preparation for the GED test and not on the content areas involved.

T4: I think some of the students feel uncomfortable about the preparation they receive for the science test because we don't have materials that focus heavily on science. We have materials that give practice for the science test, but nothing like lessons.

T2: There are not many materials that actually focus on the science portion. They have more materials to prepare for math and writing and language, but no materials that actually prepare you for science, actual science and actual factual information.

Thus, even though books published by Steck-Vaughn and Contemporary were the most commonly used books in the GED programs, the programs that used instructional strategies like group discussions in addition to reading individually and answering questions, used other materials to enhance these strategies. The types and range of materials used depended
generally on the teacher's initiative in locating these resources and on the teacher's previous teaching experience and collection of materials garnered during those experiences.

GED Computer Software

Even though the majority of the programs sampled were equipped with computers and software to prepare students for the GED, these did not appear to get used much by the students. This was especially true for the science portion. Not many students in the programs sampled had worked on the science portion of the GED software. This could be attributed to the fact that in many programs, the GED software was relatively new. Most of the teachers interviewed had not been able to formulate an opinion about the science part of the software because either none or very few students in their programs had worked with this software.

T7: We purchased Steck-Vaughn's GED 2000 and pre-GED software. And so far I have only had a couple of students go through the science portion on the computer. I don't do a good job of pushing it.

The reason given for this was that the presence of many students and a single teacher at any given time did not permit the teacher to spend time individually with students to teach them how to use the program.

However, one teacher who had a few students work with the science portion of the Plato GED software was not very satisfied with it.

T2: I generally use Steck-Vaughn. If they are with me long enough and they are able to bring up their skills in writing and math sufficiently, and I feel that their reading is progressing, then I sometimes put them in some of the areas on the computer (Plato Program) where they walk through the science areas. I think it's more difficult on the computer. It's more difficult than even the book. But it is something they can supplement with. I don't feel that they adequately present the material. I think they are assuming that
the students have a lot of prior knowledge on some of the sciences, and I don't feel that the students do.

In addition, this teacher felt that working on the computer was repetitious for the students. Moreover, since the GED is a written test, she saw more value in having the students work in similar environments.

T2: And eventually I will be taking the students off the computer more because I feel that it's getting very repetitious for them, and having them work more in text-book type situations, especially since the GED is a written test. I feel they need more experience in testing skills.

Document analysis of this software program revealed that this software is structured in such a manner that it does require students to have some previous knowledge of science. Moreover, unlike print materials where the passage and the questions associated with it are on the same page, the computer program presents the passage and the questions associated with it on different screens. Even though there is a provision for the students to go back to the passage that the question relates to, this format appears to emphasize knowledge of some basic facts and concepts of science rather than just reading skills in the content area of science.

One of the students from Site 1 who had worked with the Steck Vaughn GED software had an extremely favorable opinion of it.

P2: On the computer, they give you more knowledge, because they give you the vocabulary, the words that are being used in the passages as you are reading. So you understand what exactly they are talking about. And it gives you a chance, you can write it down and go back and look over it so you can get an understanding of it. And it also gives you an outline, and they break it down for you, to give you the main objective of the whole passage, and then they give you tips, highlighted areas, what are the most important things that you've read about.
P2: I think the way the computer program is set up is pretty good because they have a couple of pre-tests and at the end of the chapter they have the challenge test which is the overall chapter, all the practice tests that you did, and that's kind of like a repetitious way so you remember, that's the key to remembering.

Materials for Hands-On Science

Most of the teachers sampled were of the opinion that hands-on science would help their students understand science better and would stimulate students' interest in science. However, one of the main reasons cited for not being able to incorporate hands-on science into the program was the difficulty in accruing materials for such an endeavor. Many GED teachers are paid on an hourly basis, so there is not much of an incentive for them to collect these materials on their own time. Moreover, since many have never taught science in an elementary or secondary setting, they have no idea how they would go about locating such materials.

T3: Hands-on would help them. I wish .... that takes time for a teacher to go and seek out those things and to prepare for that, so it would be nice if we just had little packets that would be prepared, kits on different topics, a recipe that says these are the ingredients you need to do this. I found a lot of books in the library that do that, that's why I go to those books. But I wish they'd say, with this unit, here are some kits and some maps. You know, none of these things, no visuals come with the GED materials. A teacher has to gather all that and most teachers are paid by the hour, so I'm thinking they are not as much inclined to spend hours and hours doing research and all.

The idea of having kits on different topics that could be used for doing hands-on science seemed to be popular among the teachers sampled. However, there are no such kits that are presently available to GED teachers. The availability of such kits could promote the use of hands-on strategies in the science portion of GED programs.

P3: If they had to design the program, the science part such that they had kits that we could use to teach with, there's a lot of science out there, microscopes, even if we could
show them acids and bases on litmus paper, some of that we’d even go and buy. If I had to try to bring that in the classroom. So I think there’s a lot we can do to try to connect science to everyday life.

Teachers who have had experience teaching science in secondary settings did have additional resources collected during that experience that they now used in their GED programs.

T5: The materials I use are just things I made up myself from having taught chemistry. There’s Janice Wanfree who has a little series of paperbacks out, touching on the various areas of science. And she has one for projects for science fairs that they have in high schools and suggestions for preps and things to do. I have litmus paper so we can talk about acids, bases, and salts a bit. But I don’t really have a source for chemicals. I just have some litmus paper and of course baking powder and vinegar, the household things.

T3: Some materials I’ve gathered as I’ve gone to workshops along the years as a teacher. The library has some very good books, experiments that you can do. I have some books that I have picked up on the way. I have these folders where I keep science ideas, science materials, like this one on spoons and mirrors and pendulums.

One of the most important reasons that supplementary materials are essential in GED programs is the ever-changing nature of the class. On any given day a class is generally composed of students who have been in the program for varying periods of time from a few years to a few days. This makes it important to have a range of materials in order to hold the interest of students who have been in the program for an extended period of time.

T2: I have to keep reinventing the wheel so to speak, so that students who have been here a while are not getting the same materials over and over. So, I’m constantly getting supplementary materials for these students.
All the teachers interviewed believed that the published GED materials are not effective in making students aware of science issues in society. The teachers believed that the materials need to be changed to reflect current issues important to society today.

T8: I don’t think the students are very aware of since issues. I would say they have minimum knowledge from what they see on TV and read in newspapers.
R: Do you think the Steck-Vaughn and Contemporary materials are doing a good job of making them aware of issues?
T8: They definitely don’t. I think it’s a problem that everyone knows exists but no one wants to fix it.

R: Do the GED materials you use contribute to making students aware of science or environmental issues?
T6: No. I’m sure there are some exceptions. I think they are coming around to it, and I have not been able to secure those materials, so based on the materials that I have in my room, which are 1992 or 1993 probably, in those, the answer is no. Given the same format, they (students) would be more happy with passages that would be more applicable to adults and life.

R: Do you think the books are making students aware of issues?
T2: Issues? No. I think methods, yes, laws and things like that have been standard. But not issues, because they change and they’re not changing the textbooks. I think they need to expose them to the fact that things change just like history changes. More things are being discovered, we have so many new breakthroughs that people don’t know anything about, it’s like they’re caught in time.

R: Do you think the publishers materials are making them aware of science issues?
T7: No, not the ones I have. Like I say the more recant ones, I know Steck-Vaughn and Contemporary have done a better job in their newer issues of the GED materials. I know that they changed them to be more user-friendly, but I don’t know content-wise what they have in there. The materials are too text, to school-bookish.
Format of Materials

Teachers also emphasized that the materials need to be modified to present science in a more interesting format.

T7: The pictures are not interesting. I mean with science you have got to have figures and diagrams and photographs to explain processes and what they look like, and everything is black and white in the books that I have. I'm thinking South-Western is a newer publisher in GED, they were not in adult education until recently. They've put out some things and they have used color. I'm not saying that they are any better in science because I don't know. But science needs to be more exciting than black-and-white text, it's not something they're just going to read through and get done.

Other teachers too believed that the published GED materials need to be modified more frequently and that they should have ready access to these new materials in their programs. Document analysis in several programs revealed that many programs did not have the latest editions of the published GED materials.

T8: I would say a lot of the materials are very good, even back to the basic human biology, everybody needs to know that. I just think it's old fashioned. In a way it's good, because a lot of people will look at it and remember it from high school or junior high and I think it's easier to pick up where they left off. But I just think it's time to change. We have changed our history books, history changes and so we change along with it, what we teach in history. But science books seem to stay the same. They have not changed much in the last 15 years. I think in high schools now, they do incorporate more, but these tests are still based on books that were 8-10 years ago. I think they haven't changed much. They always change history and I don't know why not science. I guess it's because they think it's basic, you know you look at your elements, everything in science has a core of where you start and I'm not saying that that's wrong. I like that, but I still think that they need to incorporate more experiments, more hands-on things, make science more interesting to people and I think they would have a better response and they would have a better memory of it if they did more. It's not a subject that should be taught
with paper and pencil, you need lots of overheads and lots of getting your students involved, it's hard to get your students involved when they are bored.

Thus, data indicate that the most commonly used science materials in GED programs were materials published by Steck-Vaughn and Contemporary. However, teachers expressed dissatisfaction with these materials and emphasized the need to change these materials to make them more interesting and make them more current with society. Programs that used strategies other than individual reading had a way to get around the limitations of these materials by using supplementary materials that are not GED-related. There was very limited use of the science portion of GED software in the programs sampled. Another important finding is that even though teachers indicated an appreciation of the benefits of hands-on science, the major impediment cited is the lack of ready availability of the necessary materials. Teachers also believed that the published GED materials did not have much value in making students aware of current issues in society or in making them aware of the relevance of science to their lives and to society. This highlights the importance of using strategies such as classroom discussions and field trips to fill this gap in the science education of students in GED programs.

Program issues and problems

Time

The teachers interviewed discussed a wide range of issues that constrained them in one way or another. The most often cited issue was the limited time that students spend in the class. The time students spent in the GED programs sampled ranged from 2-20 hours a week. Teachers in sites that had students for 2-4 hours a week cited the limited time as the biggest barrier in accomplishing anything with their students.
T6: Knowing about the world, for example the weather patterns. Students are generally on top of that, and we have had discussions on weather, reasons for snowfall, etc. We do not have the opportunity to do that often because it is a 3 hour program.

T2: I really don't know how aware students are of science issues, we have not discussed it. In other programs where I taught, I did more classroom teaching, and these would become topics that we might even write essays on. Or at least just discuss in class. Current events, that sort of thing. I don't get to do that with this class, because our time is so limited and because it is more computer based.

T2: Even 4 hours per week is not enough. It is frustrating when students do not do work at home. But I can understand the reasons, because of job and family, they have busy lives.

T6: That is the frustration of being a GED teacher, we have to work on what has to be done, other than that we have to forget about everything else because of the limited time.

T7: There are some teachers across the state that do this kind of stuff with science (hands-on) and last year when I went to a conference there was a lady that did kitchen chemistry or something like that. She was dealing with potatoes, the starch thing and stuff and I did get the names of some resources that you could use but I never got the resources because I said, well I don't have time to read, I don't have time to use them again. So again, I'm trying to get the biggest bang for my buck. When my students are here only 4 times a week I'm going to do whatever I'm going to get the best out of them and it hasn't been science at this point.

T2: Hands-on activities would certainly make science more meaningful to them, but I don't see that happening here. For one thing, they would have to be here for more than 4 hours per week.

Even though the amount of time that students are in class is of major concern, the new welfare laws coming into effect will reduce that time even further. Students on welfare will be required only to spend 10 hours per week instead of 20 in class, so sites which have a lot of students on welfare and depend on government dollars for funding, will be reducing the hours for which classes are offered by 50%.
T3: The cut down to 10 hours is sad for the students because they go through the program much faster when it is 20 hours and they had a broader range of knowledge and awareness and they were more prepared for the GED. We will not be able to do as much in 10 hours.

This teacher currently employs a wide range of strategies in her program and was extremely concerned about the impact that these reduced hours would have on her program and her students.

Science Teaching Experience

A major obstacle faced by many GED teachers is the fact that most programs have a single teacher teaching the entire range of subjects. Many of the teachers have never taught science in an elementary or secondary setting and are not very comfortable teaching it in their programs.

P3: I would love to do hands-on activities ... that would be a lot of fun. They (the students) would be really excited about it. But then you would need a hands-on teacher. I'm unusual in that I went through 3 years of science in college. Most of the teachers are either reading teachers or social studies, and you cannot cover all of it. If you are going to do a science program, then you will need certified science teachers.

P3: Within the GED set up as it is now, you have one teacher teaching. Some places in the state have teachers who are just teaching science or teaching social studies, that requires a revamping of the entire program and I don’t know if we can go that way.

T5: It seems to me that many of our teachers are elementary education teachers and some have a math and science background, but most don’t. And so the program could be strengthened perhaps by having a person with a better background in the math and science area. I don’t know whether this really answers your question or not, but ABLE teachers are expected to teach everything and it seems to me that that’s a handicap to the program. Why not go ahead and specialize, especially where it's the main center.
Why not go ahead and let the person with a math background just teach math and not have to be concerned about subject areas or areas that they do not have training for. There's been a push for ABLE teachers to teach everything. That's needed in some sites maybe in rural sites.

T7: I myself am not real comfortable with experimentation much less getting the materials that you would need to do something like that. Not that they would be expensive, but where do you get litmus paper, where do you buy it, you know you have to have eye-droppers and you have to get dyes etc.... But then again, it's preparation time. When I'm teaching everything I don't have a whole lot of time to go out and garner those materials, but it's on my agenda.

T7: In my opinion the minority of the ABLE teachers are proficient in science and/or math. They don't feel comfortable themselves much less are they going to teach it well.

Class Composition

Many teachers perceived the ever-changing nature of the class as a constant challenge. Since most programs have open enrollment and students can basically walk into the class at any time, this poses problems in terms of students missing out on certain topics or activities that were introduced or conducted when they were not present in the class. In many cases it is not possible to bring these students up to speed with the rest of the class without inconveniencing the other students. It also causes problems in terms of continuing on a certain topic in consecutive classes.

T7: I don't know logistically how field trips would work in ABLE programs, I don't know what is the cost involved. In my particular program, it would be a time issue, since they are here only an hour and 45 minutes each time they come so we would be limited in having access. I could get access to some of the science labs on a campus and have some of the teachers willing to give us 30 minutes of their time, or have someone come in and talk, I don't know. I mean there are a lot of possibilities. But with our students you never know who is going to show up and then you have somebody come in and there's only 3 students here.
T3: Time constraints, and the problem of not having the same class everyday. That is one of the biggest drawbacks in this program. When I was teaching elementary school, I had the same class every day. Because if there's some students missing, the class changes and there's always new students coming in, so it's hard to integrate the new students without having the other ones go over the same material. I can't do a lot of group teaching.

Another factor in the class composition is the presence of students at very different reading levels in the same class. Since most programs had a single teacher, this teacher had to cater to students at widely different levels of reading skills at the same time.

T2: Yes, the LD students and I did have 2 students who had English as a second language and it's hard to accommodate everybody. Especially when we have open enrollment. Even though we encourage students who are below the sixth grade reading level to upgrade their skills before they come here, many of them opt to come anyway and we do not refuse them. So sometimes we are accepting students that have as low as a 2nd or a 3rd grade reading level and it's hard to gear lessons that will accommodate students who are between 2nd and 12th grade, you're constantly trying to find that middle range. It would be helpful if for the students accepted into the class, we would accommodate everybody but group them according to abilities. Maybe say between grade 9 and 11 together, students in this range. However, that's kind of difficult to do. Because a lot of our students work and a lot of them are single parents, so they have baby-sitting problems, so we don't have that luxury, I'm afraid, but it certainly would be helpful, but I don't see it changing.

Resources

A major challenge that GED teachers face is the lack of resources and funding to obtain required resources to enhance their programs. One teacher estimated that while the government spends a couple of thousand dollars per secondary school student per year, the average amount spent on each GED student is between 100-200 dollars. This lack of resources was one of the
major impediments cited for not having the ability to incorporate hands-on science in GED programs.

T4: I think some of the students feel very uncomfortable to be very honest, because we don't have the materials that focuses heavily on science. We have materials to practice for the science test, but nothing like lessons. There's just questions that are set up just like the test.

T2: I think hands-on is the best for science to be appreciated, but we can't really do it here.

P3: The students were excited about going out and watching the eclipse, that was a fun thing to do. We don't have any kind of lab to do any sort of scientific experiments, we don't have the capability, I can't do them.

T6: I love hands-on and think it is one of the best ways to learn, the learning is much greater than when trying to draw pictures or talk about it. The problem would be the equipment, and a room to store it in. If I had an ideal setting, it would be great.

T8: I would like to do science experiments and have microscopes and stuff, but we just don't have the funding for it.

T8: If I didn't have any constraints, I'd buy a huge chalkboard, because I love to draw pictures and talk about it. Buy all kinds of microscopes and hands-on stuff. I'm a big hands-on person.... If you didn't have restrictions with money you could just buy the worms or things you are working with for every class. Because with adults you always have different ones in class. So I'd always have to do the same experiment again maybe 2-3 times because somebody may have missed it. So if I didn't have constraints I'd like to have access to resources, to a science lab like they have for computers and they have for reading, and maybe could have one for science. Where we could go as group and do all kind of things. I'd love to have our own resource lab, of course I know we can't afford it.

T1: I find my students do not like to take the book home and work with the book because they don't like to copy stuff down, they usually will write it down wrong, they like to have their own study materials, and that has always been a problem with adult education.
there's never enough materials. So if I was going to teach some things, I would buy more of workbooks for them to work with. We don't have the funding to do it.

T2: I feel that it's frustrating because I need to explain to the students in a way that they can see it and we don't have the materials, we don't have the labs or the manipulatives that we need to really make science fun. And they want it. Their interest level is always down because it's a textbook, that's a paper and pencil kind of thing, and science needs to be more hands-on I think.

With respect to resources, most teachers admitted to having difficulty in collecting resources to use in their programs either because of time constraints or because of not knowing where to look for them.

T3: Hands-on would help them. I wish .... that takes time for a teacher to go and seek out those things and to prepare for that.... .... no visuals come with the GED materials. A teacher has to gather all that and most teachers are paid by the hour, so I'm thinking they are not as much inclined to spend hours and hours doing research and all.

A reason cited for the difficulty in acquiring appropriate materials is the fact that GED teachers were not on K-12 mailing lists and therefore did not receive any information on instructional materials.

T6: GED teachers are not on the K-12 lists, so they generally do not get to know about the resources available. Truthfully, though I will not use it because of the time limitations.

One way to overcome this limitation is increased interaction among GED teachers which would facilitate sharing of ideas and resources. However, the teachers sampled were of the opinion that there was not much interaction among GED teachers even in the same program.

R: Do you have any interaction with other GED teachers?
T3: Not as much as would be good for us. We don't spend a lot of time interacting. As I said, it's very different than when you are on a salary and so people are very aware that
they are being paid by the hour. I would like to see new ideas, like "what have you done in science, I did this. Oh okay, I can use your material" and then exchange it, materials and resources. But the director of the program finds it very hard to get us all together. Because we all have lives apart from this. We need to initiate it more on our own.

Focus on English and Math

An explanation given for the fact that science is not emphasized in most of the programs sampled, was that there was a focus on English and math in most of the programs because these were perceived as areas of deficiency for GED students.

S17: We are generally doing English and math, it takes a lot of time.

T1: Because their downfall is math, so they really want to concentrate on math, or their downfall is literature, so they really want to apply that.

T2: The students that I see that take the GED have the most difficulty with math and the writing skills and for many of them it takes a long time for them to overcome their math phobia as well as to learn grammar and to write a good essay. So that's why the most emphasis is placed on those two areas.

Policies

Some teachers felt constrained by the policies of the institutions where they taught.

T2: The way the institution wants it, it is now to be mostly computer based even though I am going to try to get in more classroom instruction, but primarily they will have to spend most of the day on the computer.
Teaching Staff

Many teachers felt that if there was at least one more teacher in the program, they would be able to better serve the students. Having just one teacher in a setting where learners often require individual attention, made it difficult for the teachers to incorporate strategies other than individualized reading.

T2: In an ideal situation I would hire another teacher. I would give more direct instruction in basic reading skills, basic math concepts, and then on into science and social studies. I would hire another person to also teach and buy the necessary tools to teach all those things.

T7: We purchased Steck-Vaughn’s GED 2000 and pre-GED software. And so far I have only had a couple of students go through the science portion on the computer. I don’t do a good job of pushing it. Because when I put a person on the computer especially if they have never even turned one on before, they need someone to sit there with them practically and step them through it. And since I’m the only one in the classroom that can work through that with them, then that takes me away from the other 5 or 6 people that are sitting there.

T2: In this class, when they come in they are so focused on the work at hand there isn’t as much just general discussion. When I worked with other students, because I had them everyday for 4 hours a day I got to know their personalities and I got closer to the students and I only worked with 15 at a time. Now because I teach 4 classes, 4 individual classes instead of just the one, I see more students and really don’t get to know them on a personal basis the way I did. So there is very little discussion of outside events.

Goals

Another challenge mentioned by some teachers was the teacher’s and student’s competing goals and not enough time to address both.
T3: Well, I'm not exactly proud. I mean it's not as much as I would like to do, and I always think there's more that could be done and I wish I was doing it. I guess I get pulled into what the students want, and I try to have them set their own goals. And I try to look at those goals and say to them there's also some things you need to do beyond those particular things, but their goals should take priority to them.

Thus the teachers sampled cited a range of program issues and problems that they consider as barriers that they face in their programs. Some barriers such as lack of time to garner resources and lack of knowledge about resources can be overcome by increased interaction among teachers and sharing of resources. Others such as the constantly changing composition of the class, lack of training, and lack of funding are more difficult to address and need to be addressed at a higher level by policy-makers.

The next section discusses student and teacher perceptions on how the science part of the GED program can be enhanced.

Perceptions on Enhancing the Preparation Students Get for the GED Science Test

Student perceptions about what would help them prepare better for the GED science test

Individual Reading

Students expressed a wide range of opinions about what would help them learn science and prepare for the GED science test. The most common strategy in the programs sampled was individual reading and answering questions based on these readings. Students had different opinions regarding this strategy. Some students responded positively and were of the opinion that this strategy is valuable in helping them prepare for the test.
SN2: You need a lot of reading about science, just science things, how you do them and all that stuff, or maybe just read books on science.

However, the majority of the students voiced discontent with this strategy and some expressed an open dislike for reading.

S8: Well, I don't really like the reading and that's why I don't know ... what I should know.

**Hands-On Science and Field Trips**

The dominant perception among students at all the sites sampled was that a more hands-on approach with demonstrations and experiments would help them learn science better. Most students felt that by doing the experiments they would learn more science than by just reading about it. In addition, they believed that it would make the learning experience more enjoyable.

S11: Oh, I'd like to do experiments and stuff where I could be hands-involved instead of just reading, I think I would learn more.

S8: Projects are good because they make you think, but I have not done any in a long time. I don't know about myself now. I would imagine I would learn more if I would do it with my hands instead of reading.

S16: I think I would probably like to learn science by .. probably more doing than reading.

S1: I guess have experiments, I think that would be one way to make it fun, have different experiments. I think that once you do a thing, it's yours. But reading a book, if you just read about it ..... I think one should do something, then you know more about what you are doing.

SN1: To make it more interesting, the best way is participation, experiments, and visual aids.
SN6: Probably more experiments.... because it shows me the ways that you can do it better with experiments, and shows you hands-on experience with it.

S5: You don't have science fairs and different stuff like that that you have in high school. But doing different projects, that could help in a way. I enjoy hands on more than reading, so I would say more of doing projects would help.

S4: I'd probably do a lot more experiments, some hands-on, and on the board. Doing some things on the board with it, asking them questions and answering questions.

S6: I would not let them sit there and read a book, that's for sure. I'd have hands-on kind of stuff, that's fun. Games maybe.

S18: They should make science more interesting. Instead of talking and just doing the packet. Like doing experiments and stuff.

Another common perception was that along with hands-on science experiments, another strategy that they would enjoy and learn from was field-trips and learning about science in the environment.

S5: To make science fun, I would have to say more hands-on, like doing different projects, maybe even going outside somewhere, doing different things like that. I believe science is outside too, doing different things.

SN4: More field-trips, parks or someplace where people learn about rocks and fish and stuff like that.

However, students had differing opinions on the value of hands-on science in helping them to prepare for the GED test. Some believed that since the GED test was a paper-and-pencil test, hands-on science would not really help them prepare better for it although it may prove helpful to them in learning some science.
R: Do you think doing any hands-on experiments or demonstrations would help?
S3: For some.. in some cases.. very minor. Because when you go to take your GED there won't be any hands-on.

R: What would help you prepare for the test?
S11: Reading books like what we do here, and also reading newspapers and keeping up with things, listening to the news.
R: Do you think actually doing experiments or watching demonstrations would help?
S11: I think so.
R: Would it help you specifically on the test or would it just help you learn more science?
S11: I think it would just help you learn more science, but not for the test. The test is all reading.

S10: What would help .. reading, lecture, and some experiments, not a lot. I'm just not interested in ... measuring air and stuff like that, I'm not into that.

One student voiced the same reason for doubting the value of hands-on science in GED programs as some of the teachers, which was the problem of addressing students at different levels in the same class. This student seemed quite satisfied with the approach of individual reading and was of the opinion that more reading is what would help students prepare for the science GED test.

SN2: You need a lot of reading about science, just science things, how you do them and all that stuff, or maybe just read books on science.
R: Do you think anything else would help?
SN2: uh ....
R: Do you think actually doing experiments would help?
SN2: Experiments? I doubt it. Because you've got to have teachers who will do the experiments first of all.
R: But if you had teachers to do the experiments?
SN2: If they did, it might or might not help. Because in the GED you don't know what's the level (the students are at), so you don't know if the experiments can go for anybody or not, it depends on the level of the students.
S12: Well, I didn't like experiments in class, I always fell asleep, they're not really my kind of thing to get into. If you don't read what's in the book, you won't understand, so I think reading is more fundamental than the experiments are.

Direct Instruction

Even though most students thought that hands-on science and field-trips would help them learn better, they still appreciated the need for some direct instruction. This is contrary to most adult education writings which advocate self-directed learning and consider direct instruction a strategy applicable to pedagogy and not andragogy. Andrology is based on the premise that the adult learner is capable of self-directed learning and therefore would benefit from a facilitative strategy as compared to a direct instruction strategy (Knowles, 1980). However, many of the students sampled recommended the use of direct instruction in the science part of GED programs. Among the reasons they used to support this were that the teacher would be able to see the level they're at more clearly and would also have the opportunity to address any gaps in their understanding.

S14: I like probably the demonstrations, I like probably the field trips. I think you learn more by seeing. Lectures are good, I think you need the lectures and then we need to go into the experiments on them. I mean they lecture about how something works and then it's good to see how it works so that we can retain it. They need to follow up on that.

S13: Sometimes I prefer to have instruction first. But if I didn't have a choice, if I had to read by myself and come back to you, I could do that too.

Some students expressed the need to have a separate teacher for science. Most GED programs have a single teacher for all the 5 subject areas and many of the teachers themselves consider this a problem. This is explored more in detail in the next section, Problems and Issues in GED Programs.
S5: I believe direct instruction would help. Like the science teacher, having a science teacher for science, math teacher for math, a reading teacher. I believe that would help. Because I don’t believe that any of the teachers are really into science. Like in high school, they have a science teacher and they broke it down like that. I believe that would be a type of improvement.

While recommending the use of direct instruction, students highlighted the importance of the teacher answering their questions and helping them understand the concepts involved.

S8: Well, I would try to answer the questions, try to explain to the students what I know about the subject to give them a better understanding, explain to them so they can catch on.

Group Work

Another strategy that a majority of the students believed would help them was group instruction. The most common reasoning given for this was that this strategy helped students to draw on each others’ knowledge and learn from each other. This is a very important tenet of adult education which stresses the importance of building on the learners’ experience and knowledge and facilitating the sharing of the wealth of information that adults posses by virtue of their experience (Kidd, 1973).

S4: Probably a day or two of science would have helped, maybe not on the board, just like a class discussion or something.

SN2: To me I think it does not really matter, because as long as I understand the terms and all that, I’ll go ahead and do it on my own and if I don’t, I’ll ask somebody. But I like group discussion because if you don’t understand it she (the instructor) will see and will follow up on it and explain it to you, and that is good.
This concept of group work appeared to be important in the context of hands-on science too.

S4: As far as doing experiments and stuff like that, it's good to have a whole group, just to be in it, I guess you would understand it more. Maybe I would be wrong and someone else would be right, so we can learn from each other.

Application to Life

One aspect that a few students considered important and that ties into direct instruction and group work is the use of examples in any strategy incorporated. Many students thought that for them to understand better it is important to have examples that they can recognize. These examples could be in the context of direct instruction or group work or it could be through other hands-on science experiences. Another aspect highlighted by a number of students was the use of visual aids. Most students were of the opinion that a visual approach would aid them in understanding the concepts involved.

S7: It all goes back to reading and discussing. Or maybe there could be examples. Like in biology ... growing different plants and watching them grow. ... I'm the type of learner who likes to see.

S2: It would be more interesting if we had examples, like what the teacher does in math.

SN2: I think it could be made simpler with things that we recognize from life, what we have in our life, not things that we never knew about.

S2: I would give more examples, of course this is not an ordinary classroom so it's kind of hard, but sometimes I feel they should give examples of the science part, like they do on the English part, for putting in commas and stuff like that, they show you examples on the board, and you are participating in where the commas should go and all that. I think science should be done the same way .... if they have the time. But I guess it's hard to do in such a short time. That would probably be a better example than just reading
something on a piece of paper. I think we would be able to catch on. Like in English they
give us examples, in history they give us examples, in math the teacher tells you and lets
you figure out how to do it, and I think that if the science part would be done in the same
way we would be a lot better off.

One student, while mentioning at the beginning of the interview that he could not stand
science went on later to talk about many aspects of science that he was avidly interested in such
as inventions. His reasoning for this was that science becomes interesting when perceived in the
context of our everyday life.

R: You mentioned that you cannot stand science . . .
S3: I can't stand it as far as the ... how exactly should I put it ... it's interesting in everyday
life but when it's coming in books, I can't stand it. I'd rather have it naturally.

Individualized Attention

A factor that many students considered important was the one-on-one attention given by
the teachers to individual students. In some of the programs observed, this individualized
approach is the norm rather than the exception, however, as programs get larger it becomes
more difficult. However, in most of the programs sampled, irrespective of the size, the teachers
were involved in a one-on-one basis with the students depending on the students need for this
attention.

S3: I'd do a lot of fun things individually for those who want to pursue it. Show a lot of
experiments and share my knowledge.

SN4: I would work with them one-on-one, actually show them how it is done and make
sure they are not confused about what's going on in science.

S7: I do the test first and then when I'm through with the test, I go back and see what I
missed and that's how I learn from it.
R: Do you always have someone to go over what you missed with you?
S7: Well, that's why I need a tutor, that's where a tutor comes in.

In programs in which the student to teacher ratio was high compared to other GED programs, some students expressed the need for more individual attention from the teachers.

S3: If they had a one-on-one basis with you instead of an all out.. like you give a test and you see where everybody's at. I think one-on-one counseling would help because you got a lot of students and you got one teacher.. I think one-on-one would help.

Pace

Another important requirement according to the students was that the students be allowed to proceed at their own pace.

S2: I think I'd need a bit more than what they are giving us... at a slower rate too.

Some students attributed feeling comfortable in a program due to the fact that they were allowed to proceed at their own pace.

P2: Go at your own study pace and let them know that they are doing a good job and if they had any questions concerning the science they were doing, sit with them and explain it and make sure that they understood. Let them know that you know that everybody has different levels of comprehension, so whatever speed they have is fine. That's the best thing, not to push anybody. The best thing in any situation is to let them go at their own speed.

Thus we see a range of student perceptions about what would help them prepare better for the GED test. The most common of these included hands-on science, field trips, group work, direct instruction, independent reading, additional reading, and the ability to proceed at their own
pace. It is important for teachers teaching these students to be aware of the students need and structure their programs accordingly. Every student has their individual learning preferences and in order to enhance the quality of this GED experience for them, it is necessary that these individual preferences be accommodated by incorporating a range of different strategies that span these preferences.

Teachers' perceptions of the changes they would like to make in the GED science preparation in their programs

Hands-On Science

Most teachers sampled expressed a desire to incorporate more hands-on science in their programs. Like the students, the teachers too believed that science is better learned by doing rather than by reading. They also were of the opinion that hands-on science would increase students' interest in the field of science.

T4: I think hands-on experiments are the best for science to be appreciated. For myself, I did not appreciate it until I was able to have hands-on. I'm not saying that I liked it any more. But I kind of understood it a little better. And it helped me open my mind up to it a little bit better. So I think hands-on instruction would be effective.

T4: I think they will shy away from science because they have not been exposed to it too much, but I think that if we indirectly approach them with hands-on experiences, group instruction, and stuff like that, they will respond to it more positively than just putting them to the paper or the book. So I think they will be more open to it that way.

T8: I think we need to incorporate more experiments, more hands-on things, make science more interesting to people. And I think they would have a better response and have a better memory of it, if they did more. It's not a subject that should be taught with paper and pencil, you need lots of overheads and lots of getting your students involved. It's hard to get your students involved if they are bored. And they are bored in science,
they are bored in social studies. So we as teachers need to make it more interesting, I
think then we will get somewhere.

T8: If I didn’t have any constraints, I’d buy a huge chalkboard, because I love to draw
pictures and talk about it. Buy all kinds of microscopes and hands-on stuff. I’m a big
hands-on person. That’s why in elementary grades children love science because they
start out at a young age and they do all those neat things, but as the kids become a bit
older the experiments become more expensive and every class that you do it in costs
money.

However, most teachers were of the opinion that despite it’s various advantages, it would
be very difficult to incorporate hands-on science in their GED programs. The most common
reason cited for this was lack of available funds.

T8: I would like to do science experiments and have microscopes and stuff, but we just
don’t have the funding for it.

T6: I love hands-on and think it’s one of the best ways to learn, learning is much greater
than when trying to draw pictures or talk about it. The problems would be the equipment
and room to store it. If I had an ideal setting, it would be great.

T5: If there was funding for some chemicals, that I could use do to demonstrations, that
would be helpful.

Many GED teachers do not have the necessary knowledge and skills to facilitate science
experiments or demonstrations. Having workshops in which GED teachers could learn to do
demonstrations and experiments in science would be one way of addressing this problem which
acts as a barrier for teachers incorporating hands-on science into their programs. Many of the
teachers sampled had degrees in elementary education and many others had degrees in adult
education. Only 2 of the teachers sampled had strong enough backgrounds in science to be able
to incorporate hands-on science in their classrooms.
P3: I would love to do hands-on activities ... that would be a lot of fun. They (the students) would be really excited about it. But then you would need a hands-on teacher.

Connections to Everyday Life

Another aspect of science that the teachers considered extremely important is the connection to everyday life. Most of the teachers sampled intended to place emphasis on helping the students to make the connections between science and their everyday life.

P3: There's a lot of science out there... ... I think there's a lot we can do to try to connect science to everyday life.

T7: I do have some books that I purchased from the Little Professor Bookstore on Teaching Yourself Biology, something that would not be a technical type of book that a normal person would not be able to understand. It's written in lay terms and a lot of it is spelled out. So I would like to start using that at some point, and a biology coloring book that shows you the different parts of the body and the systems in plants, things like that. I don't think I found one for chemistry yet. I love chemistry, it's just you are what you eat, because there is so much chemistry in our everyday lives that it is so applicable.

T6: Many students don't read much for pleasure or to acquire knowledge. The curiosity factor is small. They are so involved in living, work, and family. They don't give a second thought to things they believe they have no control over. They do science like cooking, yardwork, etc., but would never think of it as science. As a teacher I could do that, to lead them to this, what do you do scientifically at home, to think of these things as being science. They don't make the connection.

T5: They should do more with writing experiments, suggestions for what teachers could do and then try to relate them to their everyday lives. And yet put in there something about the atomic structure, and about the differences between elements and compounds, between mixtures and compounds, and just the basic ideas in science. So that people have a better idea of what science really is, what chemistry really is, what the different areas of science are and then how they might relate to their everyday lives. The difference
between general and organic chemistry, the idea of fuels and oil refining, that would fit with everyday life.

However, many of the GED programs sampled in their current state do not reflect this emphasis on the connections between science and everyday life. Some programs, however, focused a lot of effort in this direction. The strategy most commonly used in these programs to guide the students towards making the connection between science and their lives is group discussion. A lot of the group discussion in these programs was centered around science topics that are also current issues in society as well as the connection between the science they are learning about and their everyday life. More interaction among GED teachers would possibly enable the sharing of ideas among teachers who practice these strategies in their classes and the others who see the importance of connecting science to everyday life, but have not been able to accomplish it in their programs. Increased interaction between GED teachers can facilitate the sharing of experiences and insights gained during the incorporation of new strategies. In GED programs with the obvious constraints of time and money, this approach could prove highly beneficial and help teachers in taking maximum advantage of minimum resources.

**Interdisciplinary Approach**

Another aspect that a few teachers touched on was an interdisciplinary approach to teaching and learning. Since most GED programs have a single teacher teaching all the areas of the GED, they have an excellent opportunity to integrate the disciplines and help students see the connections between these disciplines and their connections to everyday life and to society.

T6: One area stressed would be graphing and mapping, charts etc. Because it touches on science, math, and social studies. It should touch as many areas as possible. Use science materials and science information to do graphing and charting.
T3: I would try to integrate the subject areas, and this is what I basically do myself, so that when I’m doing a subject area on Earth science, we write about it, we do math related to it. I’ve also pulled in maps this month for geography and so with maps we’ve been able to, we were doing scale, how to make your own map with a scale.

One teacher intended to focus on math and science in the program stating that these are the subjects essential to the well-being of society as a whole.

T1: I think I’d focus a little more on the math of the GED as well as the science of the GED because that’s what our society lacks today. Look at the students in our school system, most of them cannot even pass the 9th grade proficiency test.

Direct Instruction

Some of the teachers sampled expressed an interest in doing more direct instruction in their programs. One teacher had had a very positive experience with doing direct instruction in the context of social studies and was of the opinion that direct instruction in science would benefit the students.

T7: In an ideal situation I would hire another teacher. I would give more direct instruction in basic reading skills, basic math concepts, and then on into science and social studies. I would hire another person to also teach and buy the necessary tools to teach all those things.

T7: I have been concentrating on the math curriculum and the reading curriculum for lower level readers, but science is one thing that I would like to start giving direct instruction soon.
Science Issues in Society

Many teachers highlighted the need for their students to be aware of science issues in society. The concept of scientific literacy highlights the importance of the individuals' awareness of science issues in society and participation of citizens in effective citizenship based on this awareness. Most teachers acknowledged this importance of increasing their students' awareness of the world around them in general and of science issues in particular.

T6: If we had more time, there is tremendous interest (in current science issues) and we could use it, not towards the GED but towards their interest in science, to initiate it.

Some of the programs used particular strategies to stimulate this awareness and interest. The most commonly used strategy involved group discussion centered around a newspaper or magazine clipping of a current event or issue in the news. Some teachers were of the opinion that though they would like to increase students' awareness of these issues, time would be a major barrier. However, 2 of the teachers sampled, incorporated these strategies into their program on a regular basis. Interaction among GED teachers could facilitate sharing of ideas on what topics to discuss and how to facilitate the discussion to get maximum impact in a minimum amount of time.

Miscellaneous Changes

Other strategies that teachers believed they would like to incorporate in their programs were giving students opportunities to work in the field of science and cultivating an environment where students help each other learn and take responsibility for this learning.

T8: I would like them to have opportunities to work in the field of science, see what people do, what scientist do, explore it more.
T6: When the responsibility of learning is on the student, the students also have the responsibility to teach new students. When they teach it to someone else, that's when learning occurs.

One teacher while acknowledging very little familiarity with the practice GED tests expressed the desire to become more acquainted with them.

T3: I'd say it's hard for me to comment much on the practice tests. I sometimes administer it but I don't do it, and I think you learn it by doing it. There are parts of it that once they've taken the practice tests, I've gone over specifically with them, but I have not done that so much with the science test. I have not sat down and gone over the parts with them as much. I don't have all the knowledge (about the practice tests) that I probably should. You probably will spur me to go and look at the test more closely. I'm caught up in my day to day needs here, teaching, reading ...

Thus the teachers in the sites sampled had a wide range of ideas on the changes they would like to make in their own programs. At the same time some of the sites sampled were already incorporating some of these ideas in their current programs. More interaction among GED teachers would facilitate sharing of ideas and techniques and would help the teachers in incorporating some of these changes. At the same time it could also serve to motivate the teachers and would assist them in getting maximum returns on the resources invested in the program.

The next section discusses themes that cut across all these different sites. Themes indicate the commonalties and the differences between the sites with respect to various aspects of the science part of their program.
Important Themes

Relevance

The most dominant theme that emerged in the interviews with students and teachers in the GED programs sampled was the issue of relevance. Students insisted that the science that they learn has to be relevant to their life in order for them to internalize it. The importance of relevance has been widely discussed in the educational literature. It becomes all the more important in GED programs where the typical student is an adult who has been out of school for a very long time and who has a plethora of life experiences by the time they enter these programs. Moreover, for many of these students day to day survival is what they focus on the most. Therefore, in order to hold their interest and to enable them to use their learnings in their everyday life, it is essential that the science they learn in these programs be relevant to them and to their lives. This relevance includes relevance to society too, since each individual is also a member of and is affected by the world around them.

Many students acknowledged that they could learn only those things that are important to them in their life. Everything that they could not see the importance of in their lives was irrelevant to them.

P2: I remember selectively .... things that are really what my interest is in. That’s what’s hard about it because you have to remember things that are not so important to yourself.

One student was of the opinion that science could be fun when it is presented as part of everyday life, but when presented in a book, removed from daily life, he did not have any interest or liking for it.
S3: I'd do a lot of fun things individually for those who want to pursue it. Show a lot of experiments and share my knowledge.
R: You mentioned that you cannot stand science ...
S3: I can't stand it as far as the ... how exactly should I put it ... it's interesting in everyday life but when it's coming in books, I can't stand it. I'd rather have it naturally.

Many students admitted having trouble learning science that they did not see any application for in their lives, but at the same time being very comfortable with those topics that were seen as part of everyday life.

S2: When they talked about the molecules ... I had trouble with that, because I cannot remember going into that part of science, and it kind of threw me. But as far as for life, everyday life chemistry and biology, I don't have any trouble with that.

Many students expressed a preference to learn things that are more applicable to their everyday lives and more interesting to them as people.

S10: (I would prefer to learn) science about the Earth and not about matter and weight and all that, just things that are more realistic to everyday life.

P1: When you approach somebody with something, you can give it to them so that they find it interesting, they can resolve it in their minds somewhat better. So it's got to be more interesting to them.

S14: I think they should teach about other things than the nucleus and the elements. The reason I'm saying that is that I don't think it is useful. Unless you are going into that field and you need to know. I guess it's because it does not intertwine with my life, I would teach on different things. Things that relate to us as people in our life. Of course we know, we've got to conserve the Earth, conserve water, different things, probably more of making us aware of that kind of stuff, things that we're actually involved in.

This student went on to talk about the importance of learning science that she could use in her life.
S14: I think if we’re not going to use it, it does not benefit us. And I think you learn more when you think “Oh God, it will affect me”, like the sun rays causing cancer, too much of it, we need to be aware of what the elements and things that we got can do for us. Where if you are talking about molecules, electrons, neutrons, protons, there’s no value to me, because where do I use it? I know that they add, they make a molecule, and that’s what holds things together, and that’s important, but not to me.

This student who was taking a separate course that would help her pursue a career as a dental hygienist after she received her GED diploma, was of the opinion that she had to learn some part of the science that was not really relevant to her life because of the career she wanted to pursue. But because it was important to her future career plans, she considered learning that important.

S14: About the elements, I was not too interested in it. But the other part .. I’m into dentistry now. I have to know all about the atoms and the electrons and the neutrons. Because I have to learn about it, it’s all right. How does it affect my life? Really it does not.

One student brought out an important difference between learning science in school and learning it in the GED program. While in school students generally find many topics interesting even though they may not have any direct application in their lives. Even topics they do not find interesting, they feel the need to study them just because it’s part of the course. However, adult students have seen a lot of life and know which part of their previous education they had a chance to actually use in their lives and which part they consider unimportant to their lives. At this stage of life, they do not see the value in learning things that they will have no use for in their lives. The things important to learn now are things that they can see a direct application for in their lives or that enhance the quality of their lives.
S10: I guess because science came easy to me then (in school), I probably liked it better than anything else. You don’t mind doing ... it’s like you don’t even have to open a book because you already know. It’s related to health ... health and sciences together.
R: Do you feel the same way about it now?
S10: No
R: Do you have any thoughts on why?
S10: I guess back then it was probably more important than it is now, now that I’m in a grown up state it does not seem to be (important). I don’t care about molecules, I don’t care about the nucleus and the atoms and how they spread apart. I guess through the years it has ... I know it has a part in my life, but I don’t know what that part is anymore. So it does not interest me anymore, it’s like “who cares?”. But back then I found it interesting, different things, like how many rings around Saturn. I don’t feel now it has as much relevance in my life. It’s like making a living and buying your food and groceries.

With regard to hands-on science, students were of the opinion that even though they may have found the experiments interesting, if they did not see the relevance of it to their lives, or if they could not use that knowledge directly in their lives, it was of no real value to them and they would not remember it. Some of the students at sites that had hands-on science admitted to not remembering what the experiments were about or what was done during the experiments. Some admitted to not really getting anything useful out of those experiments and not having learned anything from them.

R: Do you think experiments are useful for learning science?
S14: I think they are good for teaming things, but then again we go back to “I don’t use it in life” see. That’s the bad thing, who is going to sit there and take stock or whatever that stuff was and it goes into a balloon and it expands. And that’s good and it’s neat, but I don’t go home and do it, so it’s of no value to me. That’s probably why I don’t retain some of the stuff, because you never use it. It’s interesting, but you don’t use it.

One student, contrary to responses from all other students, was of the opinion that any reading that she does would be useful to her in her life.
S16: Any part of reading I think helps you in your everyday life. Anything that I could read and remember and would like to ... I think that's important.

While talking about a recent field trip to the department of forestry laboratories, one student expressed the opinion that the most memorable part of the field trip was one that provided her with knowledge that she could directly use in her life.

S14: One important thing that I learned is where you can call for help if you have a tree dying. ... I know what to do if I have a sick tree in my yard. I know what different types of growth on plants mean.

Most of the teachers interviewed appreciated the need for science to be relevant to the lives of the students.

T1: I'd probably try to do something more with writing the experiments, suggestions for what teachers could do and then try to relate them to their everyday lives... ...the idea of fuels and oil refining, that would fit with everyday life.

T7: Preparation for the science test has no more impact on students' lives than preparing for the social studies or the literature. Because again they don't see it as relative unless I make it relative which does not happen very often. I mean it just does not come up.

T3: I think the test should rightfully expect that there be some knowledge of science. But I think that it should be the kind of science that would be applicable to their lives and even if it is, for example water resources and the cycle of rain and renewing resources and things and how we use our environment, those are things that they can touch and have some knowledge about that they can see and use. And even though I tell them that a lot of study is thinking skills that will apply in a broader way, they have got to see some use for it or they are just going to reject it because they are adults.

One teacher was of the opinion that most of the students do not see any relevance of science in their lives.
T1: I think most of the students can do without science. They know it's a requirement of the GED so therefore they have to deal with it, but in general they do not see where it serves any purpose in today's society. You must realize that 90% of the students are here for getting jobs and they cannot see how science is going to affect those jobs.

Some of the teachers in the sites sampled focused their efforts on making science relevant to the lives of the students. However, most of these efforts were in the context of strategies such as group discussion or hands-on science or more innovative strategies such as field trips or having a nutritionist come into the class and do activities and group work.

T5: I've noticed that the teacher has resource people come in, like a guy from nutrition, balanced meals, what foods are good and how to prepare an economic meal. That would have direct impact on the students.

T5: I try to relate it a little bit with everyday life and what's practical and what's harmful and safe and why. Also the idea of oxygen combining with other fuels to produce heat, that the reactions are exothermic producing heat, some producing light, why we have body warmth and that the same kind of things are happening inside our body along with many other chemical reactions. We talked a little about nutrition and health.

T7: They are not aware (of issues in society), they just never have been and they just generally are not. I bring things in and just by some of the comments of some of the students they tell me that it makes them more interested in learning about what's going on in the world around them, because I try to bring in articles to read. They're not aware of the world around them. Political issue or their tax dollars or school levys because they've never been strong readers so they have never been motivated to read or become more mentally involved in current events and the environment. So I try to bring things in, if it's the growing season, plants or stuff in the newspaper that they would be interested in. ... I have several students that take blood pressure medication and they don't know how to read what's on an ingredient label. Because they're not readers. But I try to motivate them by finding something that they might be interested in and taking that and running with it for a while. It often opens doors and they say "Hey the world is full of very interesting neat stuff, all you have to do is pick it up and read it".
T7: They don’t realize it, but they mix chemicals every time when they are cleaning floors, now we have touched on that. There was an article in the paper on the uses of vinegar. And I brought it in and one of the ladies brought it up and we talked about ratios, and it still did not hit home. And I said “I know some of you use cleaning supplies that will say so many parts of this cleaning solution and so many parts of water”, and they all jump up and say “Oh yeah, what does that mean”. So see, there’s chemistry and math, but they didn’t relate it until I said don’t you do this in your work.

In all these responses we see how interaction between teachers and students in the form of group discussion is extremely important in helping students make the connection between science and their everyday life. Another teacher highlighted the importance of class discussions in facilitating the transfer of the science learnings acquired in the program to the students’ everyday life.

T8: I don’t really see them apply it in their daily lives, from taking what they learned here and actually bringing it into their lives. It’s not something they think about or just because it’s not something we talk about on a regular basis.

One teacher talked about what she would do differently the next time she took the class on a field trip. Even though students who had been on the field trip found most parts of it interesting and relevant to their lives, the teacher was disappointed that it was not as relevant as it could have been and shared her ideas on how she could have made it even more relevant.

T3: I wanted them to get an understanding of what we can do these days with all the advances we have made and that the same procedures can be used to see what’s wrong with humans, human diseases... If we went earlier in the year, we could discuss this and it’s relevance to their lives and it’s relevance to what they have to read in the GED book. I would question them and draw it out of them.

Teachers in sites that used reading and answering questions as the primary strategy expressed the need for the published science materials to present science in a manner that’s
relevant to the students' lives. Interaction between the teacher and the students through group work or hands-on science provides opportunities for the teachers to use standard published materials and to make them relevant to the students' lives by facilitating discussions aimed at this. However, in sites that rely primarily on individual reading, the teachers depend entirely on the published materials to make science relevant to the students.

T8: That's one of the problems with science, the way it's set up. I don't think they can see the relevance to their lives. They need to do something to make it (books) more current with what we're doing, what issues we're focusing on. And it's not like history, it's the same things and concepts that they've already been exposed to those, now as an adult, to go back and go over the things they learned in school. I think the whole thing needs to be changed at the high school level too.

Some of the teachers shared their ideas on how they would like to make science more relevant to the students. These included using science books that were not GED specific and using discussions to lead students toward discovering connections between science and activities that they perform everyday like cooking and yardwork. The common reasons cited for not currently incorporating these ideas were lack of time and resources. More interaction among the teachers would facilitate sharing of ideas and resources and help these teachers in incorporating these ideas into their programs.

One teacher who did hands-on science had suggestions on how the materials that teachers used could be improved so as to help teachers enable students to see the relevance of the science they are learning.

T5: They should do more with writing experiments, suggestions for what teachers could do and then try to relate them to their everyday lives. And yet put in there something about the atomic structure, and about the differences between elements and compounds, between mixtures and compounds, and just the basic ideas in science. So that people have a better idea of what science really is, what chemistry really is, what the different
areas of science are and then how they might relate to their everyday lives. The difference between general and organic chemistry, the idea of fuels and oil refining, that would fit with everyday life.

Thus the common perception among students and teachers in GED programs was that the science learned should be relevant to the lives of the students. When using individual reading as a strategy, teachers relied entirely on the published GED materials in helping students make these connections. However most teachers and students agreed that these materials did not accomplish this effectively. This highlights the importance of using group strategies in different forms such as group discussions, field trips, or science experiments to help students see the relevance of the science they are learning to their lives and thus facilitate internalization of this knowledge and information acquired in the program. The ownership of this knowledge and information and the understanding of its relevance to their lives could also empower the students and contribute toward a better feeling about themselves which is one of the major goals cited by GED students.

**Connections to work**

Some of the students in the programs sampled had some previous experiences in a science-related field or were currently involved in a science related field. These experiences ranged from being a medical assistant to a phlebotomist to a dental hygienist. Most of the students who had such science-related career experiences related to the science they were learning in the GED program more than some of the other students. Moreover, because of their involvement in the field they had a better understanding of how science relates to everyday life and how the science they were encountering in the GED program was relevant to their lives and their work.
S2: Since I work in the medical field, some of the questions I got ... was no problem to me. When they talk about blood that was no problem, when they talk about plants, I think that was no problem for me.

S14: ...with the science and the math and the hygiene and the bacteria. You don't think about bacteria growing on your teeth. But that's science. But when you're into dental hygiene and you're taking this, then you're very much aware of all the enzymes in your mouth and it makes a difference.

One student admitted that some of the science she was learning about was important because of her career as a dental hygienist, but still could not see its relevance in her life.

S14: About the elements, I was not too interested in it. But the other part .. I'm into dentistry now. I have to know all about the atoms and the electrons and the neutrons. Because I have to learn about it, it's all right. How does it affect my life? Really it does not.

One teacher who had a few students with backgrounds in the medical field in her program, felt that this background helped the students with the science section.

T2: I think that the advantage is that some of my students have a health background, they have worked in some sort of health field. And therefore, because it is at least 50% on biology, that is something they are familiar with. I think that the chemistry and physics are difficult because a lot of the students have no experience with it.

The teacher at site 4 who had many students who worked in a hospital setting felt that this exposure to science helped the students in areas of science related to their work.

T6: If they come from the nurses floor, they find it easy. If they are from facilities or some area which they feel is not science, then they are frightened about it. It all depends on their experience in the hospital.
Thus, some of the students in the programs have had experiences in science related fields and these students appear to be able to make the connection between science and their lives or work more easily. One of the important tenets of adult education is to build on the experiences of the learner (Kidd, 1973). In GED programs, group discussions could be used effectively to draw out the students' previous experiences and these could be shared with the group to enhance the awareness of the relevance of science in students' lives.

**Current issues in society**

Recent reform efforts in science education place an emphasis on the importance of increasing students' awareness of current issues in society. This awareness is acknowledged to be the basis for participation in effective citizenship involving science and technology issues in society today. Most of the teachers interviewed shared this recognition of the importance of awareness of science and technological issues in society. Many believed that developing such an awareness not only empowered the learners to participate more fully in society but also helped them realize the relevance of science to their lives and to society.

One teacher expressed the opinion that the published GED materials should be changed to emphasize the role of science in current issues in society. She believed that instead of learning about facts and concepts, the students need to be exposed to current issues in society to increase the relevance of their learnings to their lives.

T8: That's one of the problems with science, the way it's set up. I don't think they can see the relevance to their lives. They need to do something to make it more current with what we're doing, what issues we're focusing on.

T7: We do not have a whole lot of discussion on science. We have more discussions on current events, that's why I always feel that they should change the test. We may talk about something related to science, but it is usually through a current event through a newspaper clipping.
Many students shared this opinion about the relevance of science. They believed that science should be made relevant to their lives, to the issues they deal with daily on an individual basis and as members of society.

S14: I think they should teach about other things than the nucleus and the elements. The reason I’m saying that is that I don’t think it is useful. Unless you are going into that field and you need to know. I guess it’s because it does not intertwine with my life, I would teach on different things. Things that relate to us as people in our life. Of course we know, we’ve got to conserve the Earth, conserve water, different things, probably more of making us aware of that kind of stuff, things that we’re actually involved in.

Students in many programs appear to have a general understanding of many environmental issues. Some of these understandings appear to have been acquired by reading the published GED materials.

S3: I was reading from a booklet that they have on the shelf about recycling ... plastics, things like that that can be reused, oil refinery places, just a lot of chemicals that’s what I’m really interested in ... how bad they are, how they hurt the world.

Many other students in the same programs, however, were of the opinion that they do not read about any of these issues in the readings they do from the published GED materials.

R: Can you think of specific examples of how science can help you be a better citizen?
S7: Well, you will be able to beautify the country, plant and ... make it clean. Be an environmentalist
R: Do you learn about any of these environmental issues in the readings you do here for the GED?
S7: No.

R: Do you learn about any of these issues in the books that you read here?
S12: I don’t know.
R: Do you read about issues like global warming or acid rain here in the preparation you get?
S5: About what?
R: Global warming or acid rain or the ozone layer?
S5: The ozone layer I'm familiar with, but the other two things you said, I'm not familiar with.
R: Do you have any contact with those issues in the readings you do here?
S5: Not in the readings. You know, they don't really teach science. I have come across the ozone layer, but not the other two.

The teacher at Site 3 believed that the materials they had in the classroom were suitable for increasing students' awareness of science issues in society. However, since the strategy employed there was individual reading, many students focused on just reading the passages and answering the questions and not on internalizing the knowledge or information provided in those passages.

T4: The materials that we have increases their awareness (of issues) if they are really going to take it in. You know, because you have some students, and most students when it comes to science, they just read it over real quickly before they answer it and that's all. But some students actually open their minds and absorb it. Then it increases their awareness.

Some student responses reflect this assumption. These students vaguely remembered reading about some of these issues but could not recall what they read or even the topic they read about.

R: Did you read about any environmental issues in the preparation you have had for the test?
S4: Yea, I think there was some in the book. I cannot remember, but there was something in the book.
This highlights the importance of using strategies other than just individual reading in the GED programs. One teacher who had used direct instruction and classroom discussions in a previous program where she taught, throws light on the use of classroom discussions in making students aware of current issues. In her current program, Site 2, the emphasis on working individually on the computer, precluded the possibility of such discussions and hence limited her role in enhancing students' awareness of science issues in society.

T2: I really don't know how aware students are of science issues, we have not discussed it. In other programs where I taught, I did more classroom teaching, and these would become topics that we might even write essays on. Or at least just discuss in class. Current events, that sort of thing. I don't get to do that with this class, because our time is so limited and because it is more computer based.

Other teachers who used classroom discussions as a strategy in their programs, acknowledged the use of these discussions in increasing students' awareness of issues in society.

T7: Well if you get into the environment, the conservation, pollution, recycling, you know to throw that piece of Styrofoam in a landfill, it's going to be there for tons and tons of years, and I don't think they are even aware of that. We can talk about these things in class.

These teachers also appreciated the role of these discussions in increasing students interest in science. Classroom observations at site 7 illuminated the enthusiasm of the students in discussing and learning more about current science issues in society such as conservation and cloning.

T6: They are aware of issues generally through the TV. They think of it more as newsworthy current events, rather than science like the comet and cloning. Students do talk about it, it gets discussed in the classroom if it makes the news. If we had more time, there is tremendous interest and we could use it, not towards the GED but towards their
interest in science, to initiate it. The more students there are the more participation there is and students speak out.

One of the teachers expressed the opinion that students' lack of efficient reading skills has kept them alienated from issues currently considered important in society. She highlighted the importance of using classroom discussions in enhancing students' awareness of such issues. Her observation too was that students participate enthusiastically in such discussions and that once students are made aware of these issues through classroom discussions, it stimulates their interest in learning more about what is going on in the world around them.

T7: I bring things in and just by some of the comments of some of the students they tell me that it makes them more interested in learning about what's going on in the world around them, because I try to bring in articles to read.

In addition classroom discussions have the advantage of giving the teacher an opportunity to use a more interdisciplinary approach. Reform efforts in science education emphasize the importance of an interdisciplinary approach to increase the relevance to students' lives.

T3: Recently we were doing a section on Earth Science. And I've combined science with geography. We used this natural resources map. We talked about water resources, oil resources and how it relates to human use and how you transport those resources, things like that. Just try to tie geography and science together.

Data indicate that students in programs that use strategies other than reading were more aware of current issues in society. A major reason for this appears to be that the teachers in these programs used materials other than the published GED materials to enhance students' awareness of such issues.
R: Do you think any of the science you learn here for the GED can help you be a better citizen?
S14: Yeah, probably, bacteria-wise and stuff like that. We've learned how you have to wipe off the can before opening it .. And replanting the trees when you pull one out. Saving plastic .. and things like that.

T3: We had a discussion once about DNA and what it is and they did not know about that, particularly after the O.J. Simpson trial. So that's one that I can think about that they did not have any prior knowledge about. We had a discussion about cloning. I brought the cover of time magazine, we talked about that and what did that mean in terms of both ethical issues and in terms of what did it mean and what effect does nature have over nurture. That was a good discussion, but that's on TV, so they have been listening to TV. We try to talk about current events from time to time.

Another important finding is that the students on the whole were more aware of environmental issues than other science issues.

R: We have talked about issues like pollution and other environmental issues and cloning and other issues like that. Do you learn anything about these issues in the preparation you get here for the GED?
S8: No, well some of it. The cloning, I don't know about the cloning. But the Earth and the atmosphere and the vegetation of the Earth, yes.

Document analysis revealed that most of the issues addressed by the published GED materials were environmental issues which have not changed over the past few decades. However, other science issues which were more contemporary did not get addressed. A major reason for this could be because the basic content of the books does not get revised often.

Increasing the general public's awareness of science issues in society has been acknowledged as important in the effective participation of citizens in society. This has been highlighted as one of the goals of recent reform efforts in science education. Data indicate that an efficient strategy for increasing GED students' awareness of current science issues is classroom
discussions. Moreover, students respond enthusiastically to such discussions and are able to see it's relevance to their lives and to society.

Science education at the elementary and secondary level has always had increasing students' interest in science as one of it's goals. Discussions of current science issues in society could be used in GED programs to increase adult students' interest in science. Since many GED students use the GED to launch themselves into a new career, this could be important in stimulating their interest in a science-related career.

**Preferred modes of learning**

Most of the sites sampled adhered to one particular strategy when it came to the science part of the preparation for the GED test. In a selected few sites the teachers used a combination of strategies. Only one site, site 7 exhibited a wide range of strategies. However, student responses indicated that they would prefer a range of strategies to help them learn better.

S14: They should have different methods like lecture, watching videos, slides etc. Then it becomes more memorable because you have a picture that stays with you.

S4: I like that our teacher gives us more hands-on teaching and on the board, not just giving us the book and have us go through the book. If we have any questions, she goes to the board and questions us about it, so that way she knows where everyone is standing.

S1: I guess, have experiments.... I think that would be one way to make it fun .... have different experiments.... I think to me once you do a thing, it is yours, but reading a book, if you just read about it ... I think one should do something, then you know more about what you are doing.

S14: I like probably the demonstrations, I like probably the field trips. I think you learn more by seeing. Lectures are good, I think you need the lectures and then we need to go
into the experiments on them. I mean they lecture about how something works and then it's good to see how it works so that we can retain it. They need to follow up on that.

SN2: To me I think it does not really matter, because as long as I understand the terms and all that, I'll go ahead and do it on my own and if I don't, I'll ask somebody. But I like group discussion because if you don't understand it she (the instructor) will see and will follow up on it and explain it to you, and that is good.

S16: I like to read and to answer questions, that's what I like to do. I prefer just doing it alone.

S10: What would help .. reading, lecture, and some experiments, not a lot. I'm just not interested in ... measuring air and stuff like that, I'm not into that.

Thus student responses indicated preferences for a wide variety of strategies from direct instruction to individual reading, hands-on science, demonstrations, and field trips. But most of the students expressed the need to have science presented to them in a more visual format.

The teachers too appreciated the need for using a more visual approach to teaching science.

T3: The last person who spoke was very enthusiastic. He talked for a long time, but he talked enthusiastically and he had visual aids, that was good. The students enjoyed that.

T8: They (the students) think the material on it's own is too dry, if they do it together, they seem to be excited about it. I'd say more large groups than small groups when it comes to science. And field trips, it has to be visual. As many visuals as you can possibly have, the more the better.

It is a well documented fact that students have different preferences when it comes to modes for learning. In traditional academic settings, efforts are made to address all these different learning preferences (Claxton & Ralston, 1978). However, a corresponding effort
appears to be lacking in GED programs. It appears that in most of these programs students are exposed to only one strategy which may not correspond to their learning preference.

While some students preferred individual reading and answering questions which was the dominant strategy in most of the programs sampled, others preferred either more group discussions or more kinesthetic approaches like hands-on science or field trips. Students in GED programs whose high school experience was many years ago were not exposed to the range of strategies that students in today's academic settings are exposed to and are not aware of the different possibilities. There is a general feeling among the students that even though they prefer other strategies, if they did not really have a choice they could be comfortable with just reading and answering questions.

S13: Sometimes I prefer to have instruction first. But if I didn’t have a choice, if I had to read by myself and come back to you, I could do that too.

Only one teacher from the sites sampled used a learning styles inventory to determine the learning preferences of the students with the aim of using these preferences in deciding the strategy to be used with that individual. These inventories can also help make students more aware of their own learning preferences.

T7: I do a little learning styles inventory on occasions for auditory, visual, and kinesthetic. And then if I have not already determined what they are, just for the fun of it, just because they need to know what kind of learner they are. So sometimes we will do that and determine their kind of style and then I will teach them accordingly. If they are auditory then they need to hear, they need to discuss whatever it is they are working on rather than sit at a table and look at it, because that obviously is not their learning style.

The programs sampled represent the range of strategies employed, the most dominant being individual reading and answering questions. Student responses predominantly indicated
that they preferred other more visual and kinesthetic approaches to learning as well as working in
groups. In traditional academic settings there is a growing appreciation of the differences in
learning preferences of the students (Neill, 1990). Students in GED settings too, have the same
individual differences in learning preferences. Due to the limited time spent in a class in the GED
program, it may not be feasible to address the learning preferences of each individual student.
However, employing a wide range of strategies would make it possible to capture the attention
and interest of individual students at different times.

Technology in the classroom

Most of the GED sites sampled were equipped with some type of computer program to
help students in their preparation for the GED. With the exception of one site, however, the
science part of these programs were not used much by the students.

The teacher at a site that did not have computers expressed the importance of
introducing them in the program.

T1: We're ready to introduce computers here, because this is a computer world and
you're going to need to know computers for anything, your home, your job, everything is
all computerized.

One teacher was of the opinion that the computers helped the students not only in
learning the content but also in motivating the students.

T6: The reason the retention is high is the computers. When students master it, it
courages them and other learners.

Students had various opinions when it came to the importance of the computers in the
course. In most of the programs sampled, even those in which students work regularly on the
computers for preparing for the GED, students did not regularly use the computers for the science portion. Most relied primarily on the published GED books.

One student reported a positive attitude towards working on the computer because of the ease of going back and looking up the information in the passage provided.

P2: On the computer, they give you more knowledge, because they give you the vocabulary, the words that are being used in the passages as you are reading. So you understand what exactly they are talking about. And it gives you a chance, you can write it down and go back and look over it so you can get an understanding of it. And it also gives you an outline, and they break it down for you, to give you the main objective of the whole passage, and then they give you tips, highlighted areas, what are the most important things that you've read about.

However, another student found it limiting and not as useful as the GED book in preparing for the science portion.

S3: Computers don't really help me... it's also limiting. The book has more information. So I don't really work on it, if I do, I work on language.

Teachers reported various problems with getting the students to work on the computer programs for preparing for the GED. Some problems included technical ones such as the system being down, while others included logistical problems such as the problem of teaching students how to use the programs and guiding them through the programs when there was only one instructor for many students in the class.

T7: We purchased Steck-Vaughn's GED 2000 and pre-GED software. And so far I have only had a couple of students go through the science portion on the computer. I don't do a good job of pushing it because when I put a person on the computer, especially if they have never even turned one on before, they need someone to sit there with them practically and step them through it. And since I'm the only one in the classroom that can
work through that with them, then that takes me away from the other 5 or 6 people that are sitting there.

Although most teachers felt it was important to get the students working on the computers, the main reason for doing this was to get them acquainted with computer technology that would help them in a future job and not necessarily to prepare them for the GED. One teacher questioned the use of using computer programs to prepare students for the GED which is a paper and pencil test.

T2: Eventually I will be taking the students off the computer more because I feel that it's getting very repetitious for them and having them work more in text-book type situations, especially since the GED is a written test. I feel they need more experience in testing skills.

Thus, with respect to educational technology in GED classes, we see the whole spectrum of positive attitudes about the importance and advantages of having students use the computers in their GED preparation to questions about the value of these programs in preparing students for the GED. However, students who did work on the computers, appeared to enjoy doing so. Moreover, there appears to be a common perception that working on the computers is important for equipping the students with a skill that they would most likely need in a job. Since one of the main goals of students in GED programs is to qualify for better jobs, this aspect of the technology which students are exposed to in the programs may be important.

Reading vs. learning

The most widely used strategy in the GED programs sampled was individual reading. A few students expressed a preference for this strategy while most of the students sampled believed that science could be made more interesting by using other strategies.
An important factor that emerged from the data was that while considering reading strategies, the focus was generally on reading skills and being able to interpret the passage and answer the questions following the passage rather than what was actually in the passage. Many students acknowledge this focus and stated that they did not really pay much attention to the content of the passages since their focus was on answering the questions correctly.

R: Do you think that anything you are reading in these books, the examples you do and the practice tests, make you think about or know more about science?
S2: No, because at the time what you are thinking about is just answering the question and hoping that it is right.

S5: I already had looked at the science pretest, the practice pre-test and I passed. So really, I was not good in science, I did not care for it too much. So I came here and I started reading a little bit and I started, you know, reading and not keeping the knowledge in my head. It was easy for me ... I really don't care about science.... The readings don't really teach you science.

Teachers too were of the opinion that most students just read the passages and answer the questions following those passages without really thinking about or understanding what the passage was about.

T2: The materials that we have increases their awareness (of issues) if they are really going to take it in. You know, because you have some students, and most students when it comes to science, they just read it over real quickly before they answer it and that's all. But some students actually open their minds and absorb it. Then it increases their awareness.

Some teachers tried to calm their students’ apprehensions about the science test by assuring them that they did not really need to know any of the science in the passages, they just had to be able to know how to interpret the passages correctly and answer the questions following the passages.
T4: Sometimes they are quite comfortable with it because I usually try to get them to look at it in a different way. They really don't have to know the actual factual information, but they have to know how to answer the questions, how to interpret the questions.

Other students could remember vaguely the topics they read about, but not what they actually read in those topics.

R: Did you read about any environmental issues in the preparation you have had here for the test?
S4: Yea, I think there was some in the book. I cannot remember, but there was something in the book.

Another student was of the opinion that because what they did in class were worksheets where they basically read the passages and answered the questions, she could not remember what it was that she had read.

S16: We did several sheets on science, it was like work sheets. But that's all I can think about in science, we did a few work sheets.
R: What were the things you learned in those worksheets?
S16: I'm trying to remember. It was the first thing that we did, so that's why I don't remember. It was just sheets, so that's why I don't remember what the topics were.

One student talked about her experience in a different program, when she was preparing for the GED for the first time. She was of the opinion that she found science difficult to understand because the strategy used in the program was individual reading.

SN1: Science was a bit complicated, because you did not have anybody to tell you how it goes, you cannot get it out of a book, out of wording. Because in classes we just study on our own and we have to read the passage and either we understand it or we don't understand it, it goes either way, because in science you either understand it or you don't understand it.
One student however, was of the opinion that she learned quite a bit of science by reading the published GED book on her own. If she did not understand something that she read she would approach the teacher with it and the teacher would help her understand it. This student was an older adult (58 years old) and was very motivated to learn new things and very enthusiastic about the things she was learning by reading the science GED materials.

S8: I don't remember anything that I learned in school, but I learned quite a bit by going through the whole science book. And usually I would do that on my own time, and if I had any questions, I would come back and talk to the teacher about it, and read about it and whatever I could not understand she would help me understand better.

One student attributed the fact that she could not remember what science she had in high school to it being all reading and not enough hands-on science.

S17: I think science is more doing. I think that when I was in high school, if I did the actual act I think I would have remembered it more. That's why I think it must have been a lot of reading, that's why I can't remember it.

An important finding here is that the majority of the students sampled were of the opinion that they were not really getting much out of the strategy of individual reading except strengthening their reading skills. Most of the students admitted to not remembering anything from the readings they had done in preparing for the science part of the GED. The focus was principally on the ability to interpret the passages and answer the questions rather than on understanding the content or internalizing the information presented in the passage. Thus even if the published GED materials present science that is relevant to students' lives and that could increase their awareness of science issues in society, if the students are not focusing on the content and issues presented in these materials, they cannot impact the students in any way.
Since individual reading is the most dominant strategy employed in the programs sampled this represents an area of concern.

**Doing vs. learning**

Most students who did not have hands-on science in their programs were of the opinion that hands-on science would help them learn science better and would make it more interesting. Students at sites that had hands-on science acknowledged that it made science more interesting. However, some of these students were of the opinion that they were not learning any science by doing these experiments or watching demonstrations. This sentiment was captured by one student who was of the opinion that if the hands-on science was not relevant to her life or applicable to daily life, even though it may be interesting, she would not really learn anything from it.

S14: We've done experiments here in the classroom where we've taken ... See I don't even remember what I took, something and you light a match and we had balloons and whatever would go up in the balloon would cause the balloon to expand. So we've done a little bit like that, dealing with balloons and a candle, setting down in something and sometimes if it's lit, if you do one thing it will go out and if you don't, it stays on, but I don't remember what we did.

R: Do you remember what you learned from that exercise?
S14: Probably combustion ... No (laughs)

R: Do you think experiments are useful for learning science?
S14: I think they are good for learning things, but then again we go back to "I don't use it in life" see. That's the bad thing, who is going to sit there and take Stock or whatever that stuff was and it goes into a balloon and it expands. And that's good and it's neat, but I don't go home and do it, so it's of no value to me. That's probably why I don't retain some of the stuff, because you never use it. It's interesting, but you don't use it.

Classroom observations during the hands-on science sessions in this program revealed that the focus was on doing the experiments and understanding basic scientific concepts rather
than it being useful to the students. Most of the students at the site appeared to be caught up in the excitement of doing the experiments but appeared to be uninterested in the scientific concepts explained by the teacher after the experiment. While explaining the basic concepts underlying the experiments such as 'oxygen makes up nearly 20% of air', the teacher did not really connect the discussion to anything beyond these basic concepts. In one instance when the instructor poured some hydrogen peroxide into ground beef and placed a match that was nearly extinguished into one of the large bubbles generated, causing it to burn brightly, the students thought it was a 'neat' thing to do, but their responses indicated that they did not really understand why they were doing this or what they learned from it.

S10: What would help .. reading, lecture, and some experiments, not a lot. I'm just not interested in ... measuring air and stuff like that, I'm not into that.

Research in elementary and secondary settings have shown that it is not enough to get the students physically involved in hands-on science, it is equally important to get them mentally involved. This is especially important in the case of GED students, who emphasize the importance of what they learn being relevant to their lives and having direct application in their lives or in society. One way of getting the students mentally involved in the hands-on science experiments would be to guide them towards seeing the relevance of those learnings to their lives through group discussions that complement the hands-on science experiments.

Interest in science and exposure to science

Some teachers and students attributed the lack of students' interest in science to their lack of exposure to it. One teacher believed that exposing the students to science by hands-on experiments and group work could stimulate the students' interest in science more than just having them read from a book.
T4: I think they shy away from science because they have not been exposed to it too much, but I think that if we indirectly approach them with hands-on experiences, group instruction, and stuff like that, they will respond to it more positively than just putting them to the paper or the book. So I think they will be more open to it that way.

However, one student was of the opinion that even the reading stimulated her interest in science.

S8: If I'm learning this now, in the future I'm going to need this, so it's going to come back. And I'm going to remember. I'm going to save these little pamphlets and I can look back and this is a start for me. This science is a start, because I just was not interested in science, I don't know why. But I was looking at this (material) and I said "Oh my goodness, I like it."

The teacher at Site 6 too voiced a similar opinion.

T1: Some of them believe that it's not fascinating or interesting, they come in with a negative attitude toward it. But when they start reading about it and picking up things that they didn't know before, they become comfortable with it.

Another student thought that if science was given as much attention as English and math in the GED program, she may have had a more positive attitude toward it.

S16: If I worked on it, just as much as we do English and math and the rest of them, I think I would like it the same, but I have not done any science in a while.

Yet another student attributed his changing attitude toward science to his perceived success in it. This student believed that if he had the opportunity to learn more about science he would like it better.

S5: When I was in high school I did not care about science at all, but then I came here and I see now that I am passing science, or I have passed in the pretest, I am learning
more about science and I'm comfortable with it. So, if I was to go on and learn a little more about science, and more and more know it, then I believe that I would like science, but right now I have to say that I'm neutral towards it.

Thus both GED students and their instructors connected interest in science to the students' exposure to science. Most of the GED programs sampled focused primarily on Math and English because these two areas were perceived to be the areas of deficiency for most students. These are the areas that were generally associated with direct instruction and group work. Science was not generally perceived to be an area of deficiency for GED students. But it must be kept in mind that the science test of the GED mainly tests reading strategies in the content area of science. Therefore even if students receive adequate scores on the practice tests for them to pass the actual GED test, this does not imply that the students have a similar exposure to science as students finishing high school. Paying due attention to science in GED programs can be used to provide students with this exposure to and basic understanding of science and to stimulate their interest in science which is considered essential in today's technologically advancing society.

Atmosphere in the program

Many students attributed their positive perceptions about the program they were in to their instructors.

P1: I have a good teacher that supports and encourages us. If we don't understand anything, she makes it very clear. We learned what we were supposed to learn as far as the skills to do those exercises.

S1: They (the teachers) are very nice and they always have time to explain things to you, and I like that part. I think I'm learning, but you know, I'm not really sure of myself. I'm like that in everything in life, I'm not a very confident person.
S14: This part is nice about the instructor, you know you don't have to be afraid of her, and of course I'm an adult so that changes everything. I feel very open and I can ask her anything and I do. That's the way all teachers can be that you can relate to.

Another important factor cited was the atmosphere in the program.

P2: I think they have a good program here ... I think that they work with you .. especially when you show that you really care. And I'm comfortable here .. the atmosphere's real laid back ... I'm at my own pace .. nobody's pressurizing me.

Teachers too realized the importance of the atmosphere on student motivation and morale.

T1: This is a very positive atmosphere over here. It's very relaxed, students are relaxed and we just have fun, because I just believe that you have to have fun in learning or you don't learn. If it's going to be a drag to you then you are not going to get it. So we try to make it a very happy atmosphere over here, a learning atmosphere, and we don't feel intimidated.

Thus, as in most other educational settings, in the GED programs sampled the instructor plays a very important role in maintaining a positive attitude among students. This becomes increasingly important with GED students many of whom have not had positive or successful experiences in educational settings. However, all the students sampled had very positive perceptions about their instructors.

Anxiety

Students in the programs sampled generally had high levels of anxiety associated with taking the GED test. This was generally attributed to the fact that these students have experienced failure in academic settings and also to the fact that the outcomes of this test are
extremely important to their future career. Many students needed the GED diploma to start a new job.

P3: I think a lot of times the students get so nervous that they forget everything they have learned and this is a big step in their lives and they have failed so many times that failure is looming above them. I'm not saying make it easy for them, I'm not addressing that problem, I'm just saying there is a lot of anxiety when it comes to the science portion, almost as much as the math.

T3: They are anxious about the test, how they will remember all that. They hear the length of the whole test, and think that they probably cannot possibly know enough to take a test that's that long.

One teacher felt that helping students see the relevance of science to their everyday life can reduce their feelings of anxiety.

P3: I think they are frightened by it (the science test). But as soon as they see that a teeter-totter becomes an inclined plane ... all of a sudden it becomes user friendly.

One teacher was of the opinion that students' anxiety was caused by the length of the test.

T3: They are anxious about it because they have never probably taken a test more than 45 minutes long. They hear the length of the whole test and think that they probably cannot possibly know enough to take a test that's that long.

However, the GED students sampled did not appear to have any feelings of anxiety about the science GED test in particular. The students were most anxious about math and English.

S10: I'm more scared about the math and the English because that's what they require the most. I was told that for science, you basically read the passage and then you have your answers from there.
S4: My worries were social studies and math ... so that's why I didn't study enough for the science. When I went through the science book, I did all the questions and answers and everything, I did pretty good and I tested myself at the end, they have a post test at the end and I did pretty good, so that's why I did not think that science was a problem.

T6: I've never had anyone scared about science, social studies, or literature. They may score lower on the science test, but they are not frightened.

Some teachers tried to assuage this anxiety by emphasizing test-taking skills to increase their confidence.

T7: It's more a matter of self confidence. It's the fear of testing. And I tell them. "Well you won't have any trouble, you have done fine on the practice tests. I know you have the skills to pass it". And I coach them on test-taking skills, read slowly, read every word, do not skim, read all given possible answers even if you know the first one is it, you read all of them, you eliminate the one's that are not and you determine down to the one or two that's left. So it's more of a test-taking type of skill strategy than self-confidence in taking those standardized tests.

T4: The students think the science test is hard, just because their focusing on "I never knew science, science is hard, I hate science" instead of thinking that this is a passage I have to read it, understand it, analyze it, and be able to answer the questions. And I think that's where they probably mess up.

The teacher at the site that emphasized testing, Site 3, was of the opinion that this emphasis was what reduced students level of anxiety for the actual test.

T4: Tests intimidate them, period, when they first come. After they have been here for a while, I do have to say that they kind of get used to it. It's like a challenge to them and they appreciate it, they actually appreciate that challenge because it shows that they are progressing. So I think that they will probably just take it like a normal day in the program because it's a day full of pretests and posttests.
One teacher assuaged this anxiety by emphasizing to the students that the only thing that they needed to be successful on the science test was reading skills.

T2: I think that my students who have strong reading skills feel pretty confident because I emphasize that the science portion of it is related to their reading ability.

Thus even though GED students had high levels of anxiety with respect to the GED test, this anxiety was no higher for the science section than it was for other sections of the test.

Connections to high school

A common perception among students and teachers sampled was that most GED students did not have much exposure to science while they were in school. This was also one of the reasons cited to explain why some students were experiencing difficulties with the science in the GED program.

S2: Some of the questions they are giving us now are things I probably never went into back when I was in school, because everything's changed.

S13: I did not do much science in school, so it's harder to learn.

T3: The test assumes a working knowledge of some vocabulary and some ideas about science and the scientific method, that in my perception of the students is that they have had very little contact with science in their school years, so they are not aware of these things.

One student who dropped out of the 11th grade just a year before joining the GED program, felt more comfortable with science in high school than he did with the science in the GED program and attributed this to the increased direction given in high school science. He was
also of the opinion that the level of science that he was exposed to in high school was lower than that in the GED program.

S3: High school was a lot easier, because you were walked through step by step better, the books seemed a little bit lower, level-wise. Here it seems more advanced and a lot of things I did not know about in high school are coming up here so it makes you study more and makes you more aware.

Thus, the dominant perception appears to be that students in GED programs have not had much exposure to science in high school. Many of these students were in high school too far back to remember anything about the science they did there. This is an important factor to take into consideration when choosing instructional strategies for GED students. Hands-on science, field trips, and group work could prove effective in stimulating these students' interest in science.

Learning disabilities

All the GED teachers interviewed had experiences with students with learning disabilities of varying severity in their classes. Some of the teachers had students with learning disabilities in their programs at that time. However, very few of these teachers have had much formal training in addressing learning disabilities but they used various strategies to address these disabilities. Many of these strategies were picked up at workshops or were intuitively apparent to the teachers because of their teaching experience.

T7: I do not use screening devices. I do not diagnose because I am not a cognition psychologist or psychometrist or whatever they call them. But I can for the most part watch a student, when I talk to them, the way they answer, the way they write, the way they are processing when they are working with math manipulatives, I can pretty well determine that this person has a processing difficulty. Beyond that I don't use a screening device on them, but I know enough about learning disabilities to know that when someone's having difficulty processing, you can't give them more than 1, maybe 2
instructions at a time, or the glare from the light and their eyes start watering, or they are up and out of their seat a lot or they are paying attention to everything that is going on, all distractions.

T2: I have one young man that I discovered has very little phonics training. Therefore when he comes to a word that he does not know, he just skips over it. He is one who could orally take the test and pass it without much problem. But the main problem I see is retention. When it comes to interpreting a problem, they cannot apply what they have learned. A lot of them have fairly good comprehension skills as long as the material that they are presented asks a specific question and they can find that answer in the passage that they have read. When they have to evaluate or apply what they have read to a question, that's when they fall down.

T1: I have a student now that has a reading disability. I have been working with him taking him very slowly through reading, because that's his main problem, and since he's been here he has improved, maybe not as fast as other people would like him to improve, but according to his standards, he is improving just fine. And a lot of people must realize that people can't move at the pace that you want them to move on, you have got to let them move at the pace that they are capable for moving on. This way, they won't feel like they have not accomplished anything. A lot of people fail to realize that all people are not made up the same way, they're not going to learn just as fast as anyone else, but they will learn it in their own time, and when they do, they will master it, just like everybody else.

T7: I make them look at me. Depending on the severity of it, I make them look at me when I'm talking because if they are not looking at me then they are not hearing what I'm saying. I will only give them one instruction at a time or one idea to process at a time. You use a lot of repetition which is what all learning is anyway, they just need more of it. I make it my business to know how printed material is formatted and presented. Because it needs to be in a simplistic type of mode and there needs to be a lot of white space on a piece of paper, a lot of print crowded in does not work if you have a learning disability. And you don't overwhelm them with more than they can process at a time. I generally use the same materials with them, it might be a little at a lower level. Generally speaking, if they have a learning, generally speaking and this is not stereotyping, if they have a learning disability they are at a lower reading level, because their basic skills are weak, because of learning slow, because it was not diagnosed. Thirty years ago there was no such thing. I think 1968 was the first time Congress actually recognized learning
disabilities, that they existed. They were classified as slow learners and put in special classrooms or just sped on by and they didn't get it. So their skills, their basic skills are generally lower.

T3: I use everything, from phonics to sight-words. We are using a reading system that basically asks students to put a picture in their heads of certain patterns and words rather than just asking them like phonics to remember the symbol or the sound. This system helps them picture it and they have something to associate with it so it is an associative pneumonic system. As far as the grammar and spelling it's been rather useful to me with the students and at least they can pick it up, basic patterns of many English words, so that then they see a word I say so what do you recognize in the word, take the front off, take the back off, what's in the middle.

Some of the teachers sampled did not feel confident in addressing these learning disabilities and felt the need to refer these students to other places where they could get help from people who specialized in learning disabilities.

P3: The number one thing that I think is absolutely mandatory is to have a learning disability teacher. So many adults here have learning disabilities. Some of them are very easy to address in my classroom, I've taken a number of workshops on them, but I come across some whom I cannot help and I send them to a qualified teacher.

T4: We have an assessment person here and she picks those things (learning disabilities) up. Anybody under a 4th grade level we usually try to refer them to another Center that can address their needs. Because our materials are not geared toward a 4th grade level and below.

T2: I do not have any learning disability background other than having worked with students that I have in this particular program. In the other programs that I worked in, we did not accept learning disabled students. So this is my first year with learning disabilities. I have contacted the Literacy Council and I'm recommending my learning disabled students get some help outside the classroom as well as continuing being with me. So that hopefully I can approach this from every angle rather than just the work they do on the computer or the class work that they do here. I would like them to get more one-on-one attention in just what I think they need.
Most of the teachers sampled were not aware of any test format that was suitable for students with various learning disabilities. The only format that they knew about was the regular format. Some others were aware of the provision for extra time to take the test but not of any other format addressing specific learning disabilities. Most of these teachers thought it would be nice to have an oral format for the test and that the regular format of the test that focused on reading strategies would prevent people, who are otherwise qualified to work in the workplace, from obtaining their GED. Since most jobs require a high school diploma or a GED as a minimum qualification, this severely impedes these students' success in finding new jobs.

T3: I have not seen any formats for LD students, I did not even know they were such, I could use some.

T3: I wish there could be an oral part were they could probably take it on tape. I have right now probably, 2/3rds of my class are reading disabled students, seriously learning disabled. I mean the other day I taught from Dr. Suess to Algebra in this class. But I have students, who at this time, I cannot foresee that they will pass the GED because of the amount of reading in it, the difficulty level, so some oral tests would be good. Or a reading level that was more like 4-6 grade level vocabulary. The same ideas, to get at the same ideas, but maybe vocabulary that would be more readable to them. They can't take apart words that are more than 2 syllables. It's very difficult for them to order those syllables to get them.

T2: We do accept learning disabled students and for them critical thinking skills are very difficult. I don't know if any accommodation can be made in the future for these students. They certainly are capable of working in the workplace. However, their not being able to complete their GED or get their high school diploma is going to hold them back. And it's extremely disheartening to me to see that people who could be successful in the workplace are not allowed because of their learning disabilities will not get their GED. And I don't know if anything can be done about that, any accommodation made for them. A lot of them can pass the test if it were oral, because they do have the skills to orally comprehend, but when they have to read and interpret they fall down.
T7: I've had several students that I've spotted as having probably some type of processing difficulty and all have passed it except one and I could not get him to slow down enough to read slowly enough. So it's more of a coping type of skill. I don't know what other format you could use. An open ended essay type format may be better for those kind of people because it would be more output than input. So that might work better for them.

T8: But there are really no provision for that except for a paper work for more time and calculators. I think they should actually have somebody who can actually read the test for them. I've had probably 1 student per year that has special needs. And they usually drop out, because they generally feel that the test will not be suitable for them.

However, one of the teachers sampled was aware of other formats available to learning disabled students but was of the opinion that the cost involved was a major deterrent in utilizing these formats.

T6: If you suspect learning disabilities, then they are tested, but it's very costly. A request has to be made by an educational psychologist to take the GED in an Learning Disability format, but it costs around $1000. Different formats available are larger print, longer time, auditory. But most students do not have that kind of money. Sometimes, their insurance pays for it. Some students, however, are frightened of the answer whether it is a learning disability or not, or a learning style. Many have chosen not to be tested.

Other concerns voiced by the teachers regarding their learning disabled students taking the test were the test taking environment and the length of the test.

T5: I think the problem with the format is all the reading there is. I believe the students are encouraged to take it in one day which is a seven and a half hour stretch and it's a bit too much for some of our students who are coming through with learning disabilities.

T7: I think the reading passages are short enough that a test taker would not lose their concentration. My concern is more in the test taking environment. My GED graduates have come back and told me that it's a noisy atmosphere and there are a lot of distractions. I think that's more of a problem than the actual taking of the test.
One teacher highlighted the importance of addressing the needs of students with learning disabilities in GED programs:

T8: They have always felt so bad their whole life that they are in the special program. They should be able just like anybody else to get their GED.

Thus, teachers in the programs sampled used a wide range of strategies to address learning disabilities in their programs even though most of them did not have formal training in addressing learning disabilities. Some teachers preferred to refer these students to other places where they could get help from people who had more experience with learning disabilities. Most of the teachers sampled were not aware of the different GED formats available to learning disabled students. This highlights a lack of efficient communication to these teachers about such formats.

**Professional development**

All the teachers sampled had regular opportunities for professional development through workshops and conferences. However, very few of these were geared specifically to the GED program and none were geared specifically towards science. Due to this there was not much interaction and sharing of ideas and resources among these teachers with regard to the science portion of their program. Most of the teachers expressed the need to have more opportunities for professional development.

T7: We are required to attend at least 2 staff development things per year. But none of them are on science. Most of them have been on math and reading and writing, but none of them have been content specific for social studies or science.
T2: There are some organizations that you can join but they are not specifically geared to GED instructors. They could be anybody that deals with adult basic education. But certainly anything that could be specific to the GED would be wonderful.

T4: I am exposed to some things through conferences, but I would like to be exposed to more, just to see what they are doing and how it works, on a more regular basis.

T4: I went to a Literacy Network conference that was composed of all the ABLE-funded centers around this area. And then I went to a computer camp last year that was composed of all adult instructors.

T7: First of all I'd try to make sure that the GED teachers had some background in science, either already or provide staff development in science.

One teacher expressed the need and importance for the teachers to have more guidelines and resources in the individual areas of the GED.

T8: There aren't any tools, there aren't any strategies clearly outlined for the teacher to teach the students, so it's more of a self-paced individualized program. We as educators need to have clear guidelines, objectives, and better resources, materials, to teach these subjects. It's just like anything else, as a matter of fact it's even more important because you are giving all this information for the 2-3 years that they would need of high school and cramming it all into one year with not a whole lot of guidelines.

T5: If at the conferences, the workshops could do more with science and demonstrate to the teachers so that they could go back to their sites and follow through.

T7: I think it would be great if we had more workshops in science. I haven't been to a science workshop in a long time. Because the focus has been so much on reading and computers. But we have not had anything on science.

Many of the teachers highlighted the importance of more interaction among GED teachers. This sharing of information, ideas, and resources could help them enhance their
program with not as much additional time and resources as they would need if they were to individually seek out new ideas and resources.

T1: I think if we all can work as a team, more things can be accomplished instead of individually. The more people that you have, the more information you have.

T2: I think it would be helpful to get teachers together, the problem would be teacher's time.

T3: We have some interaction, not as much as would be good for us. We don't spend a lot of time interacting. As I said, it's very different than when you are on a salary and so people are very aware that they are being paid by the hour.

T6: I'd like to see new ideas, like "what have you done in science." Then I could use your materials and exchange materials and resources.

T8: I think it's important for us to work together, you get ideas from each other and we all become better teachers.

Some teachers visited other programs in order to learn about different strategies employed and different resources used.

T2: I have observed other programs and have been to a couple of conferences. I have been to some workshops that have been beneficial at the conferences.

T3: Recently I had some visitors from other centers. That would be good for us to do, to visit some other programs.

Thus, even though the GED teachers sampled had access to professional development opportunities in the form of conferences and workshops they did not have access to many professional development opportunities specific to the GED. Many of these teachers expressed the need to have these opportunities for the specific areas of the GED. Another important factor that emerged was the belief that increased interaction between teachers would help individual
teachers enhance the quality of their programs. However, there did not appear to be much interaction among the GED teachers sampled.

Policy

All the teachers sampled expressed concern regarding the governments' apparent attitude toward adult education. They were of the opinion that adult basic education is a neglected area of education and more attention and resources should be directed to this area.

T3: The whole state of adult education is neglected. I mean in terms of the monetary resources that go into adult education. We just don't value adult education very much, people at that level. We think it's great for graduate school and computer school and all that, but in terms of people who are getting their high school diploma we don't have much value for that.

T1: I think we have taken our interests away from education and put it on jobs, on work. What they fail to realize is that if you can't read, you won't get a job. If you can't add, you won't be able to get a job. So you have to have these programs, you have to have the GED to help our society as a whole.

T7: This is one of the least-funded areas of education, we are the step child. Our legislators don't seem to understand the whole what we are dealing with. I mean the public school system educates their students at 3 to 4 thousand dollars per pupil per year, We educate adults on around 200 dollars a year. And I think that's just absolutely shamefully pathetic. Our legislators just aren't going to get the picture.

Thus the teachers sampled had serious concerns that society and the government do not understand the value of GED programs. This attitude has to be changed in order to have more resources directed towards these programs to enhance the quality of education of adults in these programs.
The GED Science Test

Objectives of the test

The teachers sampled had different perceptions regarding the objectives of the GED test and the science test in particular. Teachers’ perceptions ranged from a demonstration of the ability to comprehend to the demonstration of abilities that correspond to a high school diploma.

T1: I think the test serves its purpose for someone who needs a high school diploma equivalence because it covers everything that a student has to go through in high school.

T4: What I’ve seen of the science portion is just simply passages of certain information that is geared towards a science curriculum. So I think the objective would be comprehension. I don’t see any objectives to it other than that.

T7: I don’t think they are exactly a high school degree. They are not the same as going to school for 4 years. But the purpose of the test was to give World War II veterans the opportunity to have a high school degree. Now it’s being used for other things than that so it probably is the time to change the thinking of the test. Right now it is a reading test, how well can you read what you’re given and interpret the answer to the question.

T6: The objective is just to see if the basic knowledge of the four areas is present. If the student has good comprehension or reading skills they will get through.

T2: I don’t know specifically what the objectives of the science test is, to tell you the truth. You certainly cannot in one test expect the students to retain much of the knowledge that they get in reading the GED science in the book because the time is so limited.

T5: Just that the learner have a basic general idea of science information. I think some of it may relate to environmental issues, and some practical issues like that, some may relate to health or diet, which is good.
One teacher expressed a sentiment voiced by all the students and nearly all the teachers, that it does not really matter what the objectives of the test are, in the current situation in most GED programs the objective is to help the student pass the GED test so that they can get a job.

T3: The objective of my students is to get a job basically, not necessarily an education. And I have to be honest, I teach to the test. I look at certain things on various parts of the test, for example in math, and I know what they have to do to get the most points. This is not the best way to go about it, it's not the way I would prefer to go about. As far as the objectives of the test, I assume it is to test and see if they have enough knowledge to pass the test, not very lofty ideals.

Thus we see a wide range of perceptions about the objectives of the test. In the GED programs sampled there appeared to be some teachers who did not go beyond the objective of helping students pass the test while some others tried to go beyond this and used the program to increase students' knowledge and awareness of things important to them as people and their awareness of the world around them.

The new GED tests

The GED Testing Service is currently developing new GED tests that they anticipate being used by the turn of the century. None of the GED teachers sampled had any inkling of these developments. However, they did have various suggestions about the design of these new tests. The most vocalized suggestion was that the tests should be made more relevant to the students and should deal with topics and issues that have direct application to students' lives.

T7: I think it should be made more applicable to their personal lives.

T3: I think the test should rightfully expect that there be some knowledge of science. But I think that it should be the kind of science that would be applicable to their lives and even if it is, for example water resources and the cycle of rain and renewing resources and
things and how we use our environment, those are things that they can touch and have
some knowledge about that they can see and use. And even though I tell them that a lot
of study is thinking skills that will apply in a broader way, they have got to see some use
for it or they are just going to reject it because they are adults.

P3: I think I'd like to see it become more adaptable to their everyday lives so that they
can see how it applies. I think they could use a lot more of everyday examples so that
they actually make the connection.

T8: I think that they have changed the requirements for the basic level that they need to
be at, but they really have not changed the content in a long time. Now that the schools
are changing, we need to be changing our test too. We need to follow technology more.
The tests are old and I think they need to be updated. They need to be more of what's
going on in the world. I think everybody needs a basic understanding of what science is,
but I think that if you can't apply it to the world, then they don't understand why they are
doing it. It has to be meaningful.

T3: As far as the population of GED students, I think the tests should promote the kind of
skills that relate to life situations and as far as the science goes, I try to talk about how
science applies to their life. Only last week we were talking about oil resources and how
to break up oil on the water and we did experiments with Clorox and detergent and things
like that which has applications in their homes and in their lives. So I think the test should
have things that help them through life, that apply to their lives, the kind of lives they live.

Other suggestions included that the tests should promote increased awareness of current
issues and should serve the purpose of increasing students' awareness of what is going on in the
world around them and that the test should promote life-skills such as critical thinking.

T8: We should probably try to gear them towards what's going on in the world. It should
be more current events, what's actually happening in our country and in the world.

T4: I think they should focus on enhancing life skills an critical thinking, comprehension,
and analytical thought.
However, another teacher was of the opinion that focusing more on critical thinking or problem solving would make the test more difficult for the students. The irony of these comments is that the currently stated goals of the GED test are enhancing critical thinking and problem solving skills (ACE, 1993b).

P3: Because it's a timed test, a lot of people do not think not at the same level that they are thinking throughout the day. Making it involve more critical thinking or problem solving would make it more difficult for them. They may have the thinking skills that they need to solve the problems, but because they are under the constraints of time they may not apply those skills, so you would not get an accurate result of what the student would do say in a work related environment.

Some teachers highlighted features of the test that they hoped would be kept in the new tests. These included the multiple-choice format, the emphasis on the biological and Earth sciences, and the breaking down of the test into different subject areas and the breaking down of the test based on skills needed.

T7: I like the way they break it down to certain percentages so that the people that are studying for it and the teachers will know how much time and emphasis to put on each area, so I would not change that.

T8: I think the multiple choice is good because the person taking the test needs to have multiple choice then they have more of a chance at getting the questions right. But a lot of the time, I think it should not be all set up as multiple choice, because everything in life is not always multiple choice.

P3: I like the multiple choice aspect of the test. I know that there has been some talk in the social sciences for using an essay for going along with that. I don't think I would do that in the sciences. I think the overall perception of it is so frightening that if they knew they had an essay to go with it, that would really freak them out.

T2: I feel that the way it is designed with the heavy emphasis on biology and Earth science is probably the most fair to my students.
T7: I think that the test designers have done a good job of testing critical thinking skills in a multiple choice format. Of course, multiple choice is not the best format to test someone's knowledge, but it does tend to be more objective and less subjective than an essay or something else. I don't think it tests their knowledge of science, it tests how well they read the passage.

Some of the teachers sampled thought that it would be good to have some questions in an open-ended format. In their opinion this would ensure that the students were learning some scientific concepts and not just being tested on their reading skills.

T4: Get more questions that really make the students think and really pick their brain. I would like to see the actual facts that you have to know about science, you know just the basics. I guess more basic, more analytic questions that are down to a high school level. Instead of all multiple choice questions, I might help to have questions where they have to fill in, because you want them to use their mind a little bit more. And if you present information to someone all the time, they can always go back and get that information. But I think if you have some open-ended questions, it might extend it a bit more.

T8: Right now they go in and wing it. So I think they need to make it more interesting as well as let them know that science is worthwhile and you are going to need to know more on the test.

However, after thinking about it a bit more, this teacher came to the conclusion that open-ended questions may not be the best way after all.

T8: Open ended questions are bad because that's what they will have the hardest time with unless it's really well represented. The skills that they have to problem solve are minimal. Because being away from school for sometimes about 20 years, some of them forget how to solve problems in a content area.

Most of the other teachers sampled did not like the idea of having some part of the test in an open-ended format. In their opinion this format was not suitable for the population of GED
students and would make it more difficult for them to be successful on the test. They also believed that this would mean that the teachers in GED programs would have to be proficient in science which was not the case in most of the programs sampled.

T6: If the new tests have open ended questions, students will score lower and be more intimidated. They may learn more but fewer people would be comfortable. This format is as comfortable as a test can be.

T1: Open-ended questions probably will intimidate students. They are intimidated as it is with the information that they have to read and doing the multiple choice but at least with multiple choice you can always eliminate the wrong answer and then when you come down to 2, you can, if you don't really know it, you can give a good guess at it. So they probably will be more intimidated if you have any fill in questions or stuff like that. But it would extend their mind, get them thinking a bit more.

T2: If you start upgrading the science, then you would also have to do it with the social studies and the literature, and it's going to become so lengthy that a lot of people are going to give up before they complete it. So I don't see any way of making the long range benefits more beneficial to them without complicating the process and having more people give up before they get their GEDs.

T7: Our students have not been in school for 20-30 years, that means that teachers like me are going to have to be teaching science and that's going to be a big stumbling block, because in my opinion the minority of the ABLE teachers are proficient in science and/or math. They don't feel comfortable themselves much less are they going to teach it well.

T7: If they go to open-ended questions, then ABLE programs that prepare people for GED need word of it, good advance warning, because we are going to have to start teaching science. If they do that then I think the public schools need to require more science from kindergarten up, so that hopefully our future students will have a better background in science.
Some teachers had various other suggestions. One was to change the format to include other formats such as true or false and introduce breaks between sections to break the monotony of the format.

T8: I think it needs to be organized in a better way, as far as breaking it up in sections, like one section on biology and then a break. And maybe look at the possibility of true and false versus all multiple choice or something a bit different, because I think that after a while they get frustrated and it all tends to blend together after a while. Or maybe even writing a paragraph about what they thought about such and such experiment or something.

Another suggestion was to have only one question pertaining to a paragraph so that if the student misses the concept behind that paragraph they are not at a great disadvantage.

T6: Why not have one paragraph and then one question so that if they missed the concept of the paragraph they only missed one question. Whereas as now if they miss the paragraph they are going to miss 4 or 5 questions and then they feel really bad about themselves and they do not want to go on to the next one.

Another suggestion regarding the test as a whole was to emphasize math and science more in the GED test to emphasize the importance of math and science in today's world.

T1: As far as the test is concerned, writing skills and the literature and art and social studies should not hold that much. I do believe you need to know how to write, of course you do, but I don't think it is necessary to write a 200-word essay, it's just not necessary. I just feel that we need to emphasize math and science. A test that I would design would be balanced out with math and science and they would equal each other out, and the rest would hold a small percentage of the test.

Thus many of the teachers sampled expressed satisfaction with the current format of the test. The major suggestion related to the content and was to make the content more relevant to the lives of the adult students involved.
This chapter, so far, has discussed themes that emerged regarding GED tests and GED programs and teachers and students' perceptions about these. The following section explores GED students' attitudes toward various aspects of science including: the subject science, science teaching and learning, science evaluation, relevance to life, importance in society, science-related issues, scientists and people who use science, science-related careers, and self-efficacy in the domain of science.

GED Students' Attitudes Toward Science

What science is

Life in General

The most dominant perception among the students interviewed was that science encompasses all aspects of life ranging from the human body to the environment to space. Most students believed that science is a part of everyday life.

SN5: The study of life, plants, animals, the universe. It covers all aspects of life.

S5: I would say science is life in a way. It is your surroundings, the things that surround you. Science has everything to do with the Earth really, flowers, soil, different stuff like that. But I don't know a one-word definition for science. Just life and Earth and different stuff like that.

S4: I'd say there are different levels of science, like there's Earth science and the different kinds of sciences, studies of rocks, studies of the air, the weatherman, or something like that. There's different kinds of science. Study the environment, outside, and things like cooking and stuff like that, how things work as far as heat and cold in the
air. I mean science took people to the moon. Science is something that's happening all the time. Technology has to do with science and everyday we're learning something new. I mean as far as math, geometry, anything, you can go through all the math, algebra, geometry, anything and that's it, the limit, but you're learning science from day to day.

S13: Science is the whole world, it is living things, things that are walking around, the Earth itself, the moon, Sun, and all that. Everything, science is everything.... the food you eat, the gas you put in your car.

S4: Someone doing some outside work. Or if someone comes into your home and your furnace is out and he's repairing it or just any kind of work that's being done outside, besides like in the home, cooking and stuff like that, anything that's done outside.

Thus most of the students sampled believed that science covers all aspects of life and has relevance to everyday life.

Knowledge

Many of the students interviewed perceived science as a body of knowledge including knowledge about how the world works.

P1: Science is a body of knowledge about the world ... and how the knowledge is obtained, that's the best way I can describe it.

S4: I think it's really interesting to find out, you know you see things happening, storms, fires, earthquakes, and stuff like that, you can learn how all these things happen and what takes place when it's happening.

S7: Science is probably a field of knowledge.... It's factual.

S12: Science is a lot of things. Science can be the Earth, you can have behavioral science, physical science, Earth science, and two other sciences in the GED book, I don't remember what they are..... Science is dealing with a lot of knowledge that people study.
P2: Just like the ecosystem, how that works, how complex it is, it's interesting how scientifically they put it. Besides that, knowing that somebody has actually studied this, sat there and studied all these things for us to be educated about it, that is just interesting in itself.

Experimentation

Many students equated science with experimentation. They believed that science is experimenting on different things and thus gaining knowledge about how things work.

S10: Science is studying the Earth, the study of everything. You have to do a lot of experiments to find out ways to cure things, invent things, just a lot of studying, a lot of math, things like that.

S11: Science is just experiments, just experiments. I don't really know, I'm not really into science. Different chemicals and stuff that you learn about.

S14: Experiments, they try different things. I think science is the knowledge of what makes the world tick, the sun, the moon, the stars, the atmosphere, and things like that. Just everything, the birds, animals. It's all experiments, science is basically experimenting on things and finding out the end results.

SN2: Anything that is experimental in the world or actually in the world like the weather, all that is science. Just to know what it is and try to calculate what the averages is and all that stuff. I think technology actually is science, doctors, medicine, labs, just a lot of things.

Discoveries and Inventions

Some of the students interviewed saw science primarily as a field dealing with discoveries and inventions. They were of the opinion that science is a creative field and always is associated with new discoveries and inventions that focus on the future.
S3: I'd say science is about facts and opinions and creations. Science talks about the Earth, the inventors, space. Science probably boils down to inventions and discoveries.

S14: Science really has to deal with a lot about the future, future events, things they are going to discover that will make our lives better.

S6: Science is like everything people have discovered over a certain period of time.

The Earth and the Environment

The most prevalent understanding about what science encompasses appears to be science related to the Earth and the environment. This was the aspect of science that was most easily recognized as being science by the students sampled.

SN4: Science is life, different forms of life which is understanding yourself, or other species or anything else out there. Like the Earth or if you want to learn something about frogs... you study animals and small stuff, and cells.... Different things in nature, that's what science really is.

P1: In science you are learning more about your body, about rivers and things, about water. You’re learning about the world and everything around you, the environment, about yourself, about your body.

P2: Science is somewhat important to people's lives because it has something to do with the environment, what happens in different circumstances when something isn't taken care of. It is relevant to people's lives.

S5: Earth, life in general, animals, math also. When I think about science I think about math a little bit, I mean everything, different animal kingdoms, I just have to say the Earth itself.

S17: Water, animals, different things you know. Underwater things, our surroundings and the Earth. It’s going outside and finding stuff, fossils, and stuff like that.
SN6: Probably science is basically a couple of different things, like you have got to know the Earth, parts of the Earth can be science, and the atmosphere, like figuring out how far it is from here to the moon could be science. That's all I know because I don't know much about science. Science has to do with the Earth and the planets, figuring out the soil and stuff on the Earth.

Health and Medicine

Health and medicine was another aspect of science that was easily recognized by the students interviewed. However, the students who talked about this aspect of science were those who were either working in a health-related field or who had serious health concerns in their life at the time.

P1: Science is learning about cells, and membranes, and learning about your body, like health. Health and science runs together. Health always has been one of my favorite subjects.

S1: Sometimes I think science has to do just with everyday living. I know science has something to do with medicine, diseases. It has a lot to do with the cure of different diseases. And the discoveries they made, going to the moon.

An interesting finding in the data is that some of the students did not perceive biology or health as being a part of science. In their opinion these were separate fields in themselves and though they may be related to science, they are not encompassed by it.

S3: Biology helped me more than science did, so science did not really help me out that much, I got more out of biology.
R: So generally you don’t consider biology to be part of science?
S16: No, I never have. I think it was just health.

S2: Science is the study of the elements... and I'm getting mixed up with biology here. Science is the study of the elements and molecules, chemistry-type things. It's the study of everything, the universe.
P2: I think health is important to know about. But I think that when you're in school, health always seems interesting to a lot of students. Health was a separate subject, it wasn't under science...... I don't think of it as part of the sciences, it's kind of different.... I mean it's biology, but it's kind of different.

Astronomy

A couple of students interviewed were of the opinion that astronomy is a big part of science and that is where the focus is today. This opinion appears to have been formed by exposure to this part of science through the media.

S3: I listen to the news a lot as far as science goes, the moon, people putting flags on the moon, that was interesting, how close the moon is to Earth. I don't think science is important ... I don't know how we fit in. As far as the Earth and pollution and things like that, that fits into science. But the way science is today, they're really talking about space, there's a lot more to discover in space.

S14: I would say I think I'm burned out on watching the missiles go and stuff like that. I know they've had a lot of that.

Thus most of the students interviewed were of the opinion that science encompasses every aspect of life. Many students believed that science focuses on experimentation, discoveries, and inventions. The parts of science most easily recognized by the students included the Earth, the environment, and health and medicine. Thus students who had been exposed to science in their GED program and those who had not been exposed to it had similar views on what science is all about.
General attitudes toward science

Student responses indicate a wide range of general attitudes toward science. Some students expressed a liking for it, many said they were neutral toward it, and a few disliked science.

Relevance

The reasons cited for liking science covered a broad spectrum. Some of the students indicated that they like science because they saw it's relevance to their life.

P1: Science is learning about cells, and membranes, and learning about your body, like health. I like health, science and health runs together. Health was always one of my favorite subjects.

S3: I love science. It's kind of difficult but I love it, just because it's interesting and it's always something new to learn....... It's interesting in everyday life, but when it's coming in books, I can't stand it, I'd rather have it naturally.

SN1: I think science is interesting. I guess when I got out of school I thought I'd never use some of the stuff that I use now.

SN4: Because science is everyday life, you have to know some things, even little things that you learn is science and you may not even know it, but it is. So it's very important.

However, some other students were of the opinion that science did not seem to be important anymore because they did not see the relevance of it to their lives.

S7: I guess back then it was probably more important than it is now, now that I'm in a grown up state it doesn't seem to be important. I don't care about molecules, I don't care about the nucleus and the atoms and how they spread apart. It doesn't interest me anymore.
SN6: I did some science. It was pointless, so I didn’t pay much attention to it.

After discussing her understanding of what science is, one student came to the conclusion that science does encompass every aspect of life and she should have a better attitude towards it.

S2: Science is everything in general actually. I should have a better attitude towards it than I do.

The teachers interviewed expressed the opinion that the neutral or negative attitudes of their students toward science were due to the fact that they did not see the connections between science and their lives. Even though most of the teachers shared this opinion, only a few were making efforts to bridge this gap and help students make these connections.

T1: In general, I think most of them can do without it. They know it's a requirement of the GED so therefore they have to deal with it. In general they don’t see where it serves any purpose in today's society, getting a job. You must realize that all the students in here, 90 percent of them are going out for jobs and they can’t see in the field that they're going into how science can affect that field.

T4: I think in general they feel that there's no purpose for it. But you have to understand where they come from. And we don’t promote it, that it does have a purpose. If you see something, someone introduces something to you that doesn’t bring you something, you’re not going to put that much energy into it.

T3: Probably they feel inadequate, they really don’t know what that is, what science is, it’s scope, what particularly involves them, what use it is to them.

These teachers felt that students' interest in science could be stimulated by helping them to see the relevance of science in their everyday life.
T5: I think they feel a little overwhelmed and probably try to keep their distance and would be more open to learning it if there was more hands-on and things that they consider practical, learning more about science in everyday life. I think about operating their vehicles, about stain removal, about cooking, nutrition, and being able to help their children in school.

T8: What they say is that they don't remember much about science or they remember only doing experiments. They remember dissection or something, but they usually don't have a recollection of much and I think it's because it does not apply to their lives. I think if they feel it would apply to their daily life, they would be more excited about it. They don't use much science so they don't feel it is useful or important, but I don't think they are afraid of it.

Connections to Work

Some students were of the opinion that they found science interesting because they saw it connecting to what they do for a living.

P1: I need science in my field because I need to know more about the body, how to help the injured, the sick, the disabled. So it is important in my life and career.

SN1: I work for a painting facility, so formulation's and stuff like that, that's all properties of chemicals and stuff like that. I need to know that.

S1: I learned about the different diets working with the patients in the hospital. I worked all the different floors with different patients so I had to learn all of the different diets. I liked that.

S2: I worked in the lab, studying the blood and learning how to do tests. Learning the parts of the arm where you could draw blood, that was interesting. I liked that pretty well.
New Learnings

For many students their liking for science stemmed from the fact that they found it interesting and they were learning things that they did not know about before.

P2: I was reading science and I found it interesting, some of the things were surprising, things that I didn’t know before. I like the knowledge of what is going on around it and I am interested in sharing the conversation when it is a topic.

S4: I think it’s really interesting to find out. You see things happening, storms, fires, earthquakes, and stuff like that. You can learn how these things happen and what takes place when it’s happening.

S4: I learned a lot in the last five months, more in the last five months than I can remember learning in school and it has helped me to know... just a lot of things. It’s helped me to learn a lot of things like where rain comes from. I knew it used to come and you know it’s coming from the sky, but I didn’t know how it’s built up, like the Sun and just everyday things, you learn a little bit more about the Earth and insects and stuff like that. I mean you learn a little bit more, there are things that I didn’t even know.

SN2: Science is understanding it, it’s not just knowing it and letting it go after a few days. If you understand it, it stays in your mind and it’s hard to forget about it and even if we do, if we go back and look at it, we can remember it. That’s why I like it, it’s the knowledge of understanding it.

This aspect of their interest in science, of knowing what’s going on in the world, ties in to the needs, expressed by some of the students, of becoming more aware of what’s happening around them and being able to participate in conversations on different topics.

S2: I felt kind of dumb when they were talking about acid rain because I didn’t know anything about it. I’d like to know more about these things.

S14: I think finding a job for me. Being smarter, knowing what’s going on around you.
P2: For me it's important just to have an education about it, to have the chance to try to know some things. That way if I'm in a room full of people and they get on to some scientific topic, I'll know what they are talking about.

One student perceived science as interesting because it dealt with what's going on in the world, but still expressed a dislike for it.

S2: It's interesting. It's not my favorite thing to do. You need to know what's going on in the world. So it's interesting, I just don't like it. I'm the type of person that has to have things easy, so I'm kind of lazy as far as school, learning different things. But once I get into it, I find it interesting.

**Hands-On Science**

Some students attributed their liking for science to the hands-on aspect of science.

S4: I'm really interested in the chemistry part of science, as far as doing experiments, about mixing things and how things are made into solids.

SN3: Science is a fun subject, you do fun things.

**Gender**

Data do not indicate any gender differences in the students' attitudes toward science. Most of the teachers interviewed agree that they had not noticed any gender differences.

T1: I don't think there are any gender differences. I mean they all come in here with the same feeling toward science.

T7: I'd have to say there are no gender differences. Because right off when you asked that question I'm thinking that I never thought of that. So obviously I don't think there has been any. They equally, men just as much as women, have those hesitations.
T3: I really haven't seen any differences. I have a young man who is very interested in science, but I have a woman that's been very interested too. So maybe I don't have enough of a population to draw conclusions about that. It hasn't seemed very different to me.

However, two teachers were of the opinion that their male students had more interest in science than their female students.

P3: I'd say the men enjoy it and would like to get into it more and the women don't care about it. And I think that's part of our culture, it's taken science away from women. We don't give them the opportunities to see how much fun science can be. Now this would seem like a sexist remark, but I prefer to think of it more as a reality, that men tend to do certain things and women tend to do certain things. And men work more with tools and measurement and things like fixing vacuum cleaners, more than a woman does. I'm not saying women don't do such things, I'm just saying overall that I see more men come in with a mechanical ability that women can have if they develop it, but they don't develop it. What I'm trying to get at in a roundabout way is that I've had many men come and tell me "I didn't know that that was the principle behind that". So it's kind of fun taking them one step further into things that they are doing in their everyday life and making them realize a lot of principles that they never gave thought to. Women couldn't care less, at least that's my experience. I can't say that I've had any women excited about the sciences.

T5: I think the men seem to have a little more attraction to doing the chemistry and the science than the women do, I don't know how much difference, they're more mechanically minded.

Another teacher expressed the opinion that her female students approached biology with a more favorable attitude because of their career choices that needed this aspect of science.

T2: In the last program I worked primarily with women. There I saw a general attitude that they were a little more receptive to the sciences, particularly the biology, because a lot of them were going into nursing or health care.
Exposure to Science

One of the major contributing factors related to students' attitudes toward science appears to be their exposure to science, especially their lack of exposure to science in high school. Most of the students sampled had no contact with science in high school and others had minimal contact. Even those students who had some science in high school, did not remember ever going into physics or chemistry.

S9: I have no idea what science is. When I was in school, they never really talked about science, it's like I'm just learning it now.

S18: I don't like science, I never really learned nothing about it.

P2: I think if I had gone all the way to chemistry, I would have remembered something, but I was just into general science, there was nothing that really stood out for me to recall.

S2: I can't remember science back when I was in school, so it's like Greek to me. I don't really find it very easy but that's because of where I quit school at.

S9: When I was in school, they never really talked about science, it's like I'm just learning it now.

S13: We probably had science, I've probably just forgotten. Most I remember is English and history and math and writing.

The teachers sampled for interviews voiced very strong opinions about this. Most teachers felt that the lack of focus on science in high school that contributes to the students' lack of exposure to science is the major factor contributing to their students' attitudes toward science.

T2: I think they find it intimidating primarily because so few of them have taken science in school, Earth science is as far as most of them go, few get to biology. But when you
mention chemistry or physics, that is just completely intimidating to them. Primarily because they have never been exposed to it and they see no relevance to what they are going to be doing. I'm not sure how much science is required to graduate from high school, it may be only 1 credit hour. And if it is, I think they just take a general science or an Earth science course and that's about it. I doubt whether many of them really even consider any more.

T4: Well, in general, it's just like math. Math and science are hand in hand. I just think they're not exposed enough to it in school. I think they will shy away from it because they haven't been exposed to it too much. But I think that if you approach them with hands-on experiences and group instruction and stuff like that, they will respond to it more positively than just putting them to the paper or the book.

T7: They don't like science. Probably because they feel ill-prepared, which goes back to their background. They haven't had it in the schooling that they have had. They did not have enough science to say that science is fun. We are exposed to English and history, but we're not exposed to science enough. That's why, I think, they don't like science, because they feel ill-prepared, they don't know enough about it, they don't feel confident. I think it's just because they don't have the knowledge, they don't know enough about it.

T2: Partially because they've never been exposed to it and they see no relevance to what they are going to be doing.

Some students attributed their attitudes not only to the quantity of their exposure to science in high school but also to the quality of their science experience in high school.

S5: In junior high school I liked science a little bit, we did different things, different projects. But in high school, I really didn't care much about it because I really didn't understand, I didn't try to understand science. But you know, the more you read about it, the more you learn.

SN5: I liked it in school, but it seemed that they didn't really take out the time that I really needed to really touch me.

P1: I found it hard because I didn't comprehend the material as well as I would have liked to.
P2: I don't remember since it's been such a long time ago, I absolutely had no interest in what I was doing at that time.

P2: The teacher was very inaccessible. I don't think he wanted to be, it was just hard for him to be accessible to all the kids in the classroom.

Many students interviewed believed that the more they learned about science the more positive their attitude toward it.

S16: If you get to know what science is, I think it will teach you a lot and it would be interesting too.

S5: So if I was to go on and learn a little more about science, and more and more know it, then I would believe I would like science.

One aspect of the exposure students had to science in high school appears to be connected to their experience with dissection. For a few students, the experience that stood out in their memory about science in school was dissection, and none of them believed that this was a pleasant experience.

S4: I don't know what grade I as in. It was dissection. I do remember, it was kind of ..... I was kind of grossed and worried. We did other experiments too, that was one that's stuck in my mind.

S7: I remember the dissection. I hated that, and I still do. The teacher was not considerate and I did not like it .... He forced me to cut open something .... and I guess you have to do it. But I didn't like it, that's the way I feel.

One teacher voiced a similar view that their experience with dissection could be a contributing factor to students' attitudes toward science.
T6: Schools break students' motivation because of useless things. Some people may have been repulsed by certain things in science like dissection.

However, many of the other students remembered doing dissection as an interesting experience.

S14: I liked science and biology and dissecting the frogs. I liked that, I found it interesting.

Achievement

Another factor that appears to have some connection to students' attitudes toward science is their feelings of achievement in the field.

P2: It gives you kind of a bad feeling, you know, when at one time you just couldn't get it. You tried really hard and you just kept messing up and you're like "What do I do to remember?". Now that I'm older I see that it can be interesting if I give it a chance. But it's still kind of hard for me to try to remember it all, but just parts that I have remembered makes me feel that I've achieved something.

T5: They were defeated or they failed so they didn't finish high school and the science and the math seemed to be the problem. For some of them it's just the reading problems that they have, not being able to read the materials fast enough or keep up with the group, and they become discouraged.

Two of the students interviewed connected their feelings toward science to their perceived success in science.

P2: I'm kind of neutral. I'm not crazy about it but it's important, I can see why, it's challenging, and some of it is interesting, so that's what keeps me neutral. I never really liked it and I never really was good at it.
S5: I would have to say neutral, because when I was in high school I didn't care about science at all, but then I came here and I see now that I'm passing science or I have passed in the pre-test, you know, learning more about science and I'm comfortable with it.

One student attributed her success in science in school to the fact that she enjoyed the subject.

S1: I probably got good grades because I enjoyed it. It was a likable subject when I was in school.

Home Environment

The importance given to science in their home environment varied widely across the students sampled. Most of the students stated that science was never a topic that was discussed in their homes. Many did not remember ever doing any science related activities or projects at home. Most of the students did not remember ever visiting any science museums as a child.

S2: My parents might not have known too much about science. I can't say but I'm assuming they might not have known too much about it. There was 7 of us running around. I don't remember them taking us on museum trips or anything. It was a different generation.

S4: We never talked about science at home, it always revolved around math.

S1: I was raised in the south in a poor family, so the different experiments that we would do in school, I thought it was really amazing.

S14: I had no one to help me with projects, my mom worked and my dad worked.

S6: We never talk about science.
However, there were some exceptions to this. Two of the students talked about learning science at home, one through a grandparent's hobby and one through a gift given to him by his dad.

S3: My dad bought me a chemist's set and I was always messing with that. It revolved around making a light bulb work and making buzzers go off.

SN6: My grandpa liked to mess with things because he's in photography and he likes to take all kinds of pictures and he develops his own film. He likes doing stuff like that. I used to do that with him when I was little.

Some other students talked about doing science activities at home, primarily with their mothers.

SN2: We used to make a rainbow with water and the sun. I used to take baking soda and vinegar and put it on top of each other to create a volcano.

SN4: My mom used to do things with me. We had also done where you take a flower, a white flower and you split the stem and then you put some colored water at one end and wait for a couple of days and the color goes in the flower. My mom helped me in what I was doing, but I don't think she cared for it too much.

Many other students were getting involved in science activities at home because of their children who brought home science projects from school. Some of the students' children participated in science fairs and sought their parents' help in getting the projects ready.

P1: My son likes science and stuff. He got a microscope for Christmas, at home we have little experiments that come with the microscope.

S10: My kids' school usually once a year does a science project, they really get into that. I like to help them with that.
S10: Sometimes my kids tell me stuff, like when MacDonalds was serving their food in certain containers that the animals were eating and it was killing them. Basically they keep you informed.

S16: Well, I had done a science project with my 13-year-old son. He did one to see what happens to a bread in a black bag with no air, see how many days it takes to mold and see it the first day, second day, third day. And then we did the potato, see how long it takes for buds to come out of the potato. We did that together. It was really interesting, because he had to write down exactly what was happening to them, day by day. And my kids now in elementary, it seems that they are doing a lot of science now. But when I was in school, I can't remember doing anything like that.

S16: My son is interested in being a scientist, he has been saying that ever since he was 10, that he wants to be a scientist.

One student who had children just ready to enter school talked about the importance of her learning about science so that she could help her children with their studies.

P2: My children are getting ready to be in school where they are learning that stuff and I need to sit down with them and help them understand it and do their homework and things like that.

Most students remembered going to their mother to ask the 'how' and 'why' questions that children usually ask. The majority of these students were of the opinion that even though their mothers would not have been very knowledgeable about science they answered their questions to the best of their knowledge and always encouraged their children to ask more questions.

S4: My mom used to do things, like when you were young and you ask different questions like where does the rain come from. She would try to answer the best way she could.

S13: My mother tried to explain to me the best she could. Because she didn't ...... she quit school when she was at a younger age, she only went through 8th grade or so.
S7: My family didn’t discuss science at all. But my mother, she would look at the stars and she had me very interested in going out on starry nights and looking at the sky and she named the stars and stuff like that.

S8: We asked my mom of course. She worked all the time and when she got home she was tired, but she took time with us and she gave answers to the best of her knowledge.

The teachers interviewed expressed the opinion that many of their GED students got involved in science through their children and that some of their students expressed regret that they were never exposed to all these things when they were in school.

T4: A lot of my students have kids and I know a lot of them are involved with their children in school and so forth. So they are probably exposed to it in that way.

T6: Some parents get involved because their children have science projects in school. They ask me for references, books, and diagrams. It is more children-oriented than parent-oriented.

T8: The parents, I think they learn from their kids and that makes them feel sad sometimes because they say “I don’t remember learning that in school, I don’t remember these opportunities”.

T8: The students in my class have helped their kids with science projects and they’ll come to me and ask me for ideas and things like that. That’s neat.

T1: Once they get hold of the information the program provides they are excited and it not only improves their mind it improves their home life with their children that go to school because they are able to hold conversations about math and science and they can help them read.
The GED Program

Some of the students sampled felt that the GED program that they were in played an important role in stimulating their interest in science. Some attributed this to their perceived success in it, others to the fact that they got some exposure to what science is about through these programs.

S4: I learned a lot in the last five months, more in the last five months than I can remember learning in school and it has helped me to know.... just a lot of things.

S13: This GED program teaches you more about science than you ever knew before. It teaches me because I never knew about science because I never got that far in school.

S14: It was interesting to find out how they can blow things up to find out what causes the diseases. It was interesting to see how they find out different things about gypsy moths and different kinds of insects. Before I didn't notice these things, but now I'm more aware of nature and insects and preservation and all the different efforts going on to preserve nature.

One student felt that the interview increased her awareness of the importance of science in her life and that she had just never thought of it before.

S2: I guess I don't really think just how much science really means to us. I never thought about it in these terms until you started asking these questions. In every way ... science is useful to me.

Thus the students interviewed tied in their attitudes toward science with the relevance of science, its connections to their careers, their exposure to it in school, their feelings of achievement in science, the hands-on nature of science, the importance given to science in their homes, their GED program, and the importance of knowing about science in making them more aware of what's going on in the world around them. The factor that appears most influential in the
students attitudes is the exposure they have had to science. Most of the students were of the opinion that if they are exposed more to science they will develop more positive attitudes toward it. A couple of the teachers interviewed, expressed the opinion that their male students had more favorable attitudes toward science than their female students. However, the data did not indicate any gender differences in attitudes toward science.

The teaching and learning of science

The students sampled had a wide range of opinions about how science should be taught. The majority of the students were in favor of hands-on strategies and a more visual approach to science.

Hands-On Science

The majority of the students sampled believed that science is a subject that should be learned by a more hands-on and visual approach. They expressed the opinion that it is easier to internalize science if they can see it and actually do it than by just reading about it.

S16: I think I would probably like to learn science by ... probably more doing than reading.

S1: I guess have experiments, I think that would be one way to make it fun, have different experiments .... I think that once you do a thing, it's yours. But reading a book, if you just read about it ..... I think one should do something, then you know more about what you are doing.

SN2: I would explain it, and do experiments, I would explain it, do it on the board. I'll try to do something that's fun with it, do an experiment that's fun, because the people will be working on it, and that makes it stick in their mind more than just reading it.
S11: I'd like to do experiments and stuff where I would be hands involved. Instead of just reading, I think I would learn more.

S16: Doing and seeing is important. I think I would like it then, it would be interesting. Field trips would be nice, that's more seeing. Science is more seeing than writing.

Many students believed that by actually getting hands-involved in something, they could learn more about it. It not only held their interest, but they also remembered their learnings.

S2: I think that stood out more because we actually did it. Mostly our science projects were in the class, but we really participated in dissecting the frog.

S5: As far as science, if you really get into it, like grasping with your hands and doing different stuff, science is field trips and doing different stuff like that.

S16: I think science is more doing, because when I was in high school doing the actual act, I think I would have remembered it more.

Some students believed that science is a field that stimulates creativity and should be taught in a manner that touches on this aspect.

S3: They could be more technical about what they give us. It's a lot of reading, but when you are going into science there should be more inventive things, like hands-on things.

S8: Projects are good because they make you think.... I imagine I would learn more if I would do it with my hands instead of reading.

Thus, nearly all the students sampled felt that science is a subject that should be taught in a more hands-on and visual manner. They felt that this would not only help stimulate their interest in science but also help them to internalize their learnings. However, a very small minority of the GED programs sampled used any type of hands-on or visual approach.
Science Activities

In addition to hands-on science, many students felt that other science activities that are more visual in their approach are also effective strategies for the teaching and learning of science.

P2: Some sort of fun activities .... like going to museums. Visually learning something is better than reading it, you learn when you're experiencing it. For some reason, that's more of an easier intake than to read about it.

Group-Work

Many of the students sampled expressed the opinion that group work is an effective strategy for science because it provided an atmosphere where they could learn from each other. One aspect of adult education that is highlighted in the adult education literature is the importance of drawing on the experiences of adult learners. Many of the students felt that this strategy helped them to share their opinions and experiences and make the connection between what they were learning and their life.

S4: As far as doing experiments and stuff like that, it's good to have a whole group, just to be in it, I guess you would understand it more. Maybe I would be wrong and someone else would be right, so we can learn from each other.

S13: It all goes back to reading and discussing and building your own confidence about it.

Direct Instruction

Many students felt that direct instruction would help them in learning science. This could probably be due to these students lack of exposure to science and therefore the need for more direction from the teacher.
SN2: I would explain it, and do experiments, I would explain it, do it on the board.

S6: I just can't sit down here and read because that's boring. Unless the teacher lets us do something, or does it on the board, that's when I can learn it.

Another reason for this attitude could be that science has made so much progress since these students were last in school, they feel overwhelmed by it.

S2: Times have changed so much that the things that we were taught back in high school, the kids are doing that in elementary and middle schools now. So, I'm really out of my water here.

Pace

One factor that students highlighted as being important is the pace at which they were allowed to progress through the program. They found it very important to be allowed to proceed at a pace that they find comfortable.

P2: Go at your own study pace and let them know that they are doing a good job and if they had any questions concerning the science they were doing, that they didn't understand, I would sit with them and explain it and make sure that they understood. Let them know that you know that everybody has different levels of comprehension, so whatever speed that they have is fine. That's the best thing, not to push anybody. The best thing in any situation is to let them go at their own speed.

Science Memories

The students interviewed had a wide range of memories when it came to the science they had in school. Some students expressed the opinion that they did not remember having any
Most students remembered hands-on experiments and demonstrations, while a few remembered some topics that caught their attention.

A few students did not remember anything from the science they had done in school, some did not even remember whether they had taken science or not.

S4: I don't remember anything that I learned in school in science. I remember taking home economics and I had a class is sewing and cooking. That's about all I can remember, I cannot remember any of the science.

S13: Not that I remember. We probably had some science, I've probably just forgotten. Most I remember is English, and history, and math, and writing, and cooking class. That's about it.

Most of the students' memories centered around hands-on experiments or projects that they had done when in school.

P1: We had a lab looking at different organisms under the microscope, and some projects that we did. I did a project on mold, fungi, that stands out.... I liked it, it was interesting, I enjoyed it more than bookwork.

S1: I remember we did some projects that we had to make. And I remember one that we had to make, I think it was a telephone, but we used copper wires and a can and we had to make a doorbell, copper wires and batteries.

A few students talked about their memories connecting science in school to the science of everyday life.

S2: The experiments we had, watching bread mold and watching it outside and inside the refrigerator, things like that.
SN1: I remember studying electricity. I think it was parallel circuits or something like that. I remember, it was interesting.

S3: I remember doing a battery and bulb experiment, how we got light, and we really focused on energy a lot, solar energy. The sun creates energy and they really focused on that because that's part of our everyday life.

One student was of the opinion that the strongest memory he had of science in school was about something that he actually had opportunities to use in his life.

S3: I know one thing that stuck in my brain is like molecules and enzymes and stuff like that and positive and negative charges, that helps as far as electricity goes, that helped me as far as not blowing up things.

Many of the teachers interviewed were of the opinion that students generally have very positive attitudes toward science when they are in the elementary grades and as they progress through school, we see a decline in this. One student voiced a similar sentiment and attributed this to the fact that the hands-on project-based aspect of science in school decreases as one progresses from the elementary to the secondary grades.

S5: One time I made a tornado and I did that presentation. I think that was back in elementary not in high school or junior high, it was elementary, I made a tornado. That's the only thing really I can remember. Because in elementary they always did projects as far as science, but then in junior high less projects and in high school it's more reading than doing projects.

S5: When I was in high school I didn't care too much about science. But I have to say in junior high I liked science a bit, we did different projects, but in high school I really didn't care much about it, because I really didn't understand.

However, most of the students did not have any memory of any of the science they had in the elementary grades.
S2: I really don't remember too much about the elementary grades in science, I'm sure they gave us some, but times have changed so much that the things that we were taught back in high school, the kids are doing that in elementary and middle schools now. So, I'm really out of my water here. I really can't think about elementary, I'm sure there was something but it didn't stick.

S3: In elementary all that I remember is basically language, spelling, math, and literature. I don't really remember any science.

Many students remembered dissecting a frog. For a few this brought back unpleasant memories but other students found it interesting.

S2: I remember dissecting frogs and doing experiments.

S4: I remember the dissection, it was kind of ... I was kind of grossed and worried. We did other experiments too, I guess that's the one that stuck in my mind.

S10: I remember dissecting a frog and I hated that.

S16: The frog, I will never forget that because it showed how things work inside and that's what science does, it goes from the inside out, so I think that's interesting. And I remember we put something on a petridish and watched it grow.

SN3: Volcanoes, like everybody does a volcano. And I did a kind of dissection, it was nasty, but I enjoyed it. That's about it, I didn't really do that much in science though, just read about it.

One student shared a memory of a learning that he found particularly interesting and was sure that was why it stayed with him.

SN4: I remember we learned that if you put trees on Mars, that there's a possible chance that people can live on Mars. If you put enough trees there, because the trees breathe carbon dioxide and give out air, I remember that, that's one thing that stuck with me.
Some students linked their most prominent memories of science in school to activities in which they had to actively participate and that resulted in some feeling of accomplishment.

S14: We used to have this little wheel that we used to turn and it puts electricity off from it, and I could stand more voltage than anybody else, so that kind of stood out. That was kind of neat because I could do it better than anybody else. And pricking the finger and drawing the blood, things like that, that was kind of interesting.

S6: I can remember studying the human body. We had demonstrations to do, that made it pretty fun having to get up and do it. But most of the classes were not like that.

Thus students felt that a wide range of strategies are necessary to enhance the teaching and learning of science. Most of the students highlighted the importance of having strategies that had a more hands-on or visual approach to science. Most of the students' memories of science too centered around hands-on science or science that they could relate to in their lives.

Relevance to life

Student responses to the relevance of science to their lives spanned the gamut from no relevance to some relevance to very relevant to their lives.

Direct Application to Life

Many of the students interviewed were of the opinion that science has to do with everyday living and is therefore relevant to their lives.

S1: Sometimes I think science has to do just with everyday living.
SN1: I think science is interesting. I guess when I got out of school I thought I'd never use some of the stuff that I use now.

SN4: Because science is everyday life, you have to know some things, even little things that you learn is science and you may not even know it, but it is. So it's very important.

Many students saw the relevance of science to their lives as far as health and medicine were concerned.

P1: Science is learning about cells, and membranes, and learning about your body, like health. I like health, science and health runs together. Health was always one of my favorite subjects.

S1: I think it's important to me because I have medical problems and if it wasn't for the discoveries that science has made in the field of medicine, I might not be here talking to you. So I feel that it is very important in my life because I have to take medication everyday.

SN2: Like medication, pain medication helps me. The weather, it helps me to know what it's going to be like in the morning, to prepare what I'm going to dress. Computers, I use them everyday, cars and streetlights.

The students also saw the relevance of science in everyday chores such as cooking and cleaning.

P1: In cleaning, you need to know what you're using, especially for the environment you need to know, also whether the chemicals are poisonous of course, keeping them away from anybody they can harm.

S2: In everything, we cook, we clean, just everywhere, cleaning mostly. That's about all I'm doing now. In the kitchen, my stove is not gas, it's electricity. The things we use in the house, even cleaning solutions. I love my microwave, I like my electric stove. Just lots of things that we use everyday. I just think about when I was a child and what things are now, it's just really unbelievable that things like that can happen.
S1: Science has to do with the different equipment that we use, the different appliances in our homes and electricity.

S4: Like cooking and stuff like that, how things work, the heat and the cold in the air and stuff like that. Cooking and when I'm doing things outside.

S9: For cooking, building a house.

SN1: It is needed in our daily work, for certain jobs. I guess when I got out of school I thought I'd never use some of the stuff that I use now. For everyday use, there's things that you need to know. Like the temperature of water, basic things like that that people need to know.

S13: Well, the food you eat, the gas you put in your car. Reading the names of chemicals on a bottle, like bleach and hazard stuff that's got chemicals in it.

A couple of students talked about the relevance of science with respect to the technological advances in society.

S1: I feel that with computers, they store a lot of knowledge that is there at the touch of your fingertips. You don't have to have files to store. And I feel that with a computer you can accomplish more than you can with a typewriter.

S3: Television is an example and recycling.

S6: Computers and stuff, basically technology.

A large number of students spoke of the relevance of science with regard to gardening or landscaping.

S5: Maybe working in the yard, like in landscaping, planting flowers, taking care of animals.
SN6: It helps me with working with landscaping and things like that.

S8: For planting flowers in the spring, you may want to make compost and you need to know certain facts, what goes together and certain things that don't go together.

S11: I do a lot of houseplants and yard work. I have a lot of flowerbeds and stuff. I have 85 plants in my house. I have plants that only grow outside in the summer. I keep them all year round, growing in my house and I bring them out in the summer and I have some that I leave out all winter and they come back. I keep a snow patch to keep them warm. When we have the first snow, I keep the snow right there over the pots with the flowers in them, it keeps them warm all winter and they don't freeze and then they all come back when it all thaws out. So that's my biggest hobby, plants.

R: Well, that is a science and an art.

S11: Yes, it's a science, but I don't look at it as science, it's just something that I enjoy.

S14: I know what to do when I have a sick tree in my yard. I know what different types of growth on plants mean. I went on a walk the other day and I could see things and know a little more about them.

S16: When you plant a flower, that's science. And I don't know, a lot of what we do is science. I planted some flowers a couple of times, that was it. I can't say that I use science much outside of school. I can't say that I use it that much.

A few of the students interviewed, however, were of the opinion that they did not really see any use for science in their lives.

S17: I don't know, I have plants, things like that. But I wouldn't say that I use it.

SN2: In my own life, I just don't see how, but I do see use for science.

S7: I guess back then it was probably more important than it is now, now that I'm in a grown up state it doesn't seem to be important. I don't care about molecules, I don't care about the nucleus and the atoms and how they spread apart. It doesn't interest me anymore. I don't feel now that it has as much relevance in my life. It's like making a living and buying your food and groceries.
SN6: I did some science. It was pointless, so I didn’t pay much attention to it.

Connections to Work

Some students were of the opinion that a persons’ job is what determines how useful science is to that person.

P1: It depends especially on which field you are in. If you’re in the health field, medical field, then science is very relevant to your life. It depends on what you want to do with your life. If you want to be a doctor or a nurse or whatever in the medical field. Or even if you are a mother, I guess it would be important to know some of those things, that way you know what’s going on when taking care of kids.

S5: If you’re going to be a science teacher then it’s important to know, but in everyday life, in a job, you know like basketball players, football players, where does science come in?

However, some other students who worked in science-related fields talked about the relevance of science to their field and why it is important to them.

SN1: I work for a painting facility, so formulation’s and stuff like that, that’s all properties of chemicals and stuff like that. I work with different solvents, evaporation, how to make better paints, stuff like that.

S12: I mix chemicals, that’s part of science, water and chemicals mixed. So if I put too much in there, it becomes a cloudy film and so you have to know just the right amount to put in, the water and the chemicals, or they will form a white film and will make people sick. You have to know certain things about chemicals and how to use them.

P1: I need science in health, my field. Because I need to know more about the body, how to help the injured, the sick, the disabled. When I’m at work, washing my hands all the time, not passing germs to my residents, bacteria and bodily fluids.
One student who worked in the medical field as a nurses aide was of the opinion that even though she saw the relevance of science to her job and was aware of the science going on in her field, she was not aware of the progress made in other fields of science.

S8: There's a lot of science I'm not aware of. I wish I was more aware of what's happening outside the medical field.

Many of the teachers interviewed were of the opinion that even though their students may be using science in their jobs they do not make the connection between their jobs and science, except students who work in the medical field.

T2: I don't know if they make the connection that it would be related to science. I don't think that's an area that they give much consideration to. Other than my students who are going into health care.

Many of the students admitted that they never really thought about science and how they use it in their lives.

P1: I imagine I use science, but I probably don't think about it. It's something that you probably do like anything else that you don't even realize you're doing.

S2: I probably use it a lot, I just don't know in what ways.

S3: I know I do use it, but I don't know particularly what part of science I use.

S8: I see use for science in my everyday life, but I can't explain where right now.

S14: I never think about science in my life. I know it's important but I don't know how, unless I had cancer or something, it's probably not important. I probably do use science but don't know it. Everyday I'm learning that it's surprising how much you don't know, that you don't know that you are using science, but you don't relate to it that way. And now I'm into this dental hygiene and I figure that we use it everyday in hygiene and stuff like that.
Teachers' Perceptions

Most of the teachers believed that the students did not see the relevance of science to their lives or to their jobs.

T2: I don't really know how much relevance the students see to some of the areas of science, because of the field they're going into.

T5: They probably have little idea about the relevance of science to their lives.

R: Do you think the students understand the relevance of science to their lives?
T3: They probably would say yes, but I'd probably think no.

T6: They don't make the connection, they don't think of it as science.

T1: I think in general they feel that there's no purpose for science.

T4: I think that they think it has nothing to do with them.

P3: I don't think many of the students make the connection between pure science and applied science.

Thus, many of the students interviewed were of the opinion that they saw science as relevant to their lives and to their jobs. However, a large number of students admitted that they never thought about the relevance of science to their life. All the students who worked in the medical field appeared to be very aware of the relevance of science to their work. Data indicate that students from sites where there are group discussions were more aware of the relevance of science to their jobs and to their lives since these have been topics that were discussed in class.
Students exhibited an awareness of a range of science careers. The predominant ones identified were in the medical field, astronomy, engineering, and archeology.

P2: Nursing, and people that work in the environment and people that are in construction, making roads and building, chefs, skin divers, sea explorers ... An astronaut collecting data about what’s going on in our atmosphere.

S1: Microbiologists, chemistry, those who work in physics, archeologists, maybe doctors and the ones that are in research.

S2: Research doctors at the hospital, biochemistry people, people that work for places like Proctor and Gamble and Ross Labs. Even like my brother-in-law who works for an architectural firm and my sister who works for an electric company.

S3: Astronomy, physiology, engineers maybe ... designing new cars.

S4: Archeology, architecture, landscaping.

S10: At the hospitals, labs, stuff like that, people doing research, the weather man.

SN1: Anybody who works in the space shuttle, biology, medicine, chemistry.

SN2: Pharmacists or technologists, mechanics maybe, doctors, medical assistants.

SN3: A lab technician, that’s the only one that I can think of.

SN4: Archeologist, zoologist, doctor, and a professor.

SN5: Researchers in colleges, doctors, dentists, that’s all I can think of. Doctors, nurses, landscaping, architects.
S13: Chemistry, working in the pharmacy, doctor, nurse, astronaut, mechanic, in the food business, practically everything.

S8: Outer space, NASA, that’s the first thing that came to my mind.

S14: Teachers, science labs, you could write a book.

**Medical Field**

Many students in the programs sampled were either currently working in the medical field or had hopes of doing so in the future.

S4: Hopefully I will be going to medical school for radiology.

SN3: I’ve been wanting to be a nurse for a very long time since I was really little and I never forgot that. I just like helping people, that’s why I want to be a nurse.

S14: I worked in a factory for 19 years and it’s really hard to relate to what’s out there. Now I’m going to be a dentists assistant. And I’m learning a lot about science.

S2: I often thought that when I finish the GED test I would go into the medical field.

For the students who were currently working in the medical field or who hoped to work in this field in the future, the reasons cited for this career choice had mainly to do with the affective aspect of such careers, the ability to help people and the satisfaction derived from this.

S4: Because, physically I like to help, especially the elderly. I mean, I would not want to be a nurses aide or something like that. I had even thought about physical therapy, but that’s a 4-year course. And I thought about the hospital environment. Coming from a loud factory, the two experiences would be totally different, from loud, noisy, and dirty to something that’s kind of quiet, peaceful, and you’re helping someone. I’ll be actually able to go up to the operating room if something is broke and I’m the radiologist, I can go up
there where the doctors are putting in pins, if you break a hip or something, and I can assist them.... it's helping someone some way.

P1: I enjoy working with my residents, working with people, hands on experience, comforting people. We're a family, you become family to your residents, you care about them. I enjoy my job, I get a lot of self fulfillment in it.

S2: I work in the lab, studying the blood and learning how to do tests, learning the parts of the arm where you can draw blood, that was interesting. I really enjoyed doing it because I thought that I could do a pretty good job drawing blood without hurting the patient. I think it was very important to my patients' health.

S8: My mother was a nurses aide at a hospital, she took care of people. It's a family thing, we like to take care of sick people for some reason. You know, enjoy taking care. The benefits are when the person gets up and walks out of the hospital, walks out and gets better.

S16: I'd like to be a doctor to help people, to ease pain. Just be there so that they will know that somebody's there for them, the doctor is always there for them.

Two of the students interviewed expressed the desire to be veterinarians but this choice too focused on the affective aspect of the profession, their love for animals.

R: If you could choose to be whatever you wanted, what would you choose to be?
S10: A veterinarian.
R: Why would you choose to be that?
S10: Because I love animals. I'd be interested in it and not feel the science.

R: Why would you like to be a veterinarian?
S11: I enjoy animals.
Many students expressed the desire to follow some sort of technical career that had something to do with computers. However, the majority of these students were unclear about what exactly they wanted to do in the field. They also exhibited a very limited awareness of the field and the opportunities.

S1: I think I want to do something with computers. I feel that with computers, they store a lot of knowledge that is there at the touch of your fingertips. You don't have to have files to store. And I feel that with a computer you can accomplish more than you can with a typewriter.

One teacher commented that this was quite common. She had a lot of students who expressed an interest in computers but was of the opinion that this was because it was the latest trend and they really did not have any appreciation of what the field of computer science really is.

T2: A lot of them are interested in computers. They express an interest in that but I think that's primarily because that seems to be the current trend, and I don't know how many will continue with that. I've had students previously go thinking that computers is the way to go. And once they get into some of the computer courses they find it more difficult than they anticipated.

Teachers' Perceptions about Career Choices

Some teachers felt that not many of their students will end up in science related fields.

T3: The chances of these students going for science related careers is very slim. Most of the women talk about computer related fields, one woman is going to school to get extra work in signing for the deaf. Another woman wants to work with dental hygiene. The men want to go back to the factory from which they came.
However, many of the other teachers had some students who had entered the medical field primarily as nurses or nurses aides. They were of the opinion that the careers that their students predominantly choose are business-related or clerical.

P3: I've had only 2 go into nursing, most others go into some sort of business, or it can be the secretarial pool.

T2: Generally students who are getting their GED are not going to be going into any sort of science field, maybe occasionally but you're not going to see many of them going into the medical field unless it would be nursing. Health-related fields are the only science fields that I see. A lot of my students will go into business related careers and maybe automotive technology. A lot of them are interested in computers.

T1: I think some of them have talked to me about technical careers that would lead them to touching on science in some way. I don't think they're going to get away from that. A lot of students I've heard talk about nursing. A lot of them have talked about the culinary arts.

T7: Some of them come from the nursing field, sometimes they work in nursing homes or work with invalids. But I think that would be the closest any of them have really had in life experiences with science careers, besides caring for their own children or their own parents. As a job some of them have worked in nursing home type fields. One student did take biology and botany because he wants to go into landscaping.

T8: Actually one of my students who graduated last year was going to be a nurse and she got into the veterinary aspect, working with animals and things like that. I've had one so far, most of them are just focused on getting this done and maybe going to college. They're not really sure where they are going.

Some students were of the opinion that they would not pursue a science career because of the time and dedication involved.
SN2: I'd think about a science career, but I don't think I would pursue one. It's a complicated issue, you have to have the time to give it. I mean if you don't have the time, it's a waste of time doing it unless you want to teach, then it's a different story.

S16: My son is interested in being a scientist, has been saying that ever since he was 10, that he wants to invent stuff. I would be a scientist if I could, but I'm not thinking that broad. Being a scientist I think is so hard, it seems like it's so hard, I don't think I could be a scientist, or I could, but it would be a lot of work.

Thus the students awareness of science careers centered primarily on careers in the medical field and in astronomy, engineering, or archeology. Students who were in a science-related career were predominantly in the medical field. However, most of these students and students who hoped to be in this field in the future cited the ability to help and comfort people as the main reason for this career choice. A couple of the students cited the dedication and hard work involved as a major deterrent to them pursuing a science career. The teachers interviewed were of the opinion that only a few of their students have ever gone into science related fields and if they had, it was generally in the medical field.

Evaluation in science

High School

A large proportion of the students interviewed remembered doing reasonably well on science tests while in school. Some of these students believed it was because they liked the subject and had a positive attitude toward it while some others believed it was because they put in the time and effort to prepare for the test.

S1: I always got good grades in science... I probably got good grades because I enjoyed it, I think so. It was a likable subject when I was in school.
S2: I used to do pretty good on them....I can't remember doing too bad on tests.

S3: Tests were interesting, they were kind of fun if you were willing to know the material. It can be fun if you study it. If you don't know it, you will become frustrated. So, if you go home and study and you see those same issues pop up on the test and you know it, it creates a good self-esteem inside of you. I believe I took a voluntary test to see what I knew about science in the 11th grade. I didn't mind doing it, it was interesting because they wanted to know what minds like us were thinking, I didn't have a problem with that.

SN2: I don't mind taking tests, it's part of learning.

S14: I probably liked science tests. I guess because science came easy to me then, I probably liked it better than anything else.

S17: I liked science, I did okay on it.

SN3: Science tests, they were easy to me because science is a very easy subject, all you have to do is remember it.

Seven of the students remembered not doing too well on science tests in high school. Some of these students believed that they had a similar attitude towards all tests not just science tests while a few students believed that they were intimidated particularly by the science tests. One student was of the opinion that the reason he did not pass the science tests in school was that he didn't study for them.

S5: I think the tests were hard in high school, so that made me have a not so good attitude about it.

SN1: I think like every other kid I hated taking tests. I don't think I thought of it as any worse than the other subjects.

SN5: I would always freeze up on tests, any kind of tests

SN6: Basically flunked out on science tests.
S7: Science has always scared me, so I think I was stressed for the science tests, for fear of the unknown. Even though I had read it and I thought I knew the answers it's like, you want to know more facts. And there were a lot of things I was feeling I didn't know.

S18: I flunked science on and off, I didn't like those tests.

S12: The science test was all right. If you didn't study the science you wouldn't pass. And that's why I never passed my tests, well maybe I did pass till the 11th grade, but not a lot of them.

Three of the students had no memory of any science tests when they were in school. These students were older students, above age 40, and had no recollection of doing any science while they were in school.

S13: I don't remember taking any tests, you're taking about way back when. But we never did no science.

S8: I can't remember science tests. You know what I can't even remember having any science in high school.

S16: No, no memory at all about science tests. I'm sure we took some, but I cannot remember.

GED Science Test

Most of the students interviewed had a positive attitude towards the GED science test and felt confident about taking the test.

S1: I think it would be interesting to take the test to see what I know about science and see where I need to go, what I need to study. Well, I feel good about it because I know that I am learning something and once I take the test I would know what I need to study in order to learn more about science. I don't feel bad about taking the test.
S2: I did the practice test in the book and I don't think I did real bad on it. So I must have been interested in something there. I think I did pretty good on it. I think I'll do okay. When you are thinking of putting what you're saying in everyday life and going back and asking the question with common sense.

S5: When I was in high school I didn't care about science at all, but then I came here and I see now that I am passing science or I have passed in the pre-test, you know, learning more about science and I'm comfortable with it. I used to think science tests were hard until I came here and started reading, and it really is all about reading, reading and understanding science. If you read the material and know it, the test will be easy. I mean it's not hard at all, it's just understanding the material.

SN4: Actually I feel fine about it, it's a test that I have to take to better myself and I'll take it. I guess I'd say I feel the same about science than the rest of the test. Because if it's hard I would be challenged and I love the challenges.

S6: When the time comes I'll know enough about science to do it.

Some students professed to being anxious about the test. For some of these students it was a general anxiety about the whole GED test while for a few this anxiety was specifically directed towards the science portion of the test.

S2: Actually I don't like being tested in the first place, that's why I'm going to be here longer. I just want to be absolutely sure that I know something about each thing that I'm doing. So when it comes to the test I can settle down and not be too nervous.

SN6: I think I need to learn a lot about science before I can take the GED test, the science part. I'm just afraid of the science, I'm one person who does not like chemistry very much.

Many students just wanted to get the GED test over with. This test was very important to the students in terms of it's being a requirement for most jobs. For some students, since this test meant a whole lot more than any other test they have done before, they felt more anxious about it.
S3: I really don't have a feeling for it, I just want to take it and get it over with. I'll be a little nervous while taking it, because I won't know whether the answer I jot down is right or wrong. I'll feel better after I've seen my results.

SN5: I'm ready to prepare for it, I just want to take this GED and get it over with.

S7: Well, this test means a lot more right now.

S14: It's probably a little nerve-racking now. It will be real stressful probably because I don't feel I'm ready for it, but it will be all right. I think I will be a little nervous. It's scary because you want to pass it, so it stresses you out some.

Most of the students interviewed had the same attitude towards the science portion of the GED test as they had towards the rest of the test. A couple of students admitted to feeling more anxious about the science portion than the other parts of the test. In general, the parts of the test that the students appeared to have the most anxiety about were the reading and the math.

S12: I think science would be okay if I understood what the words mean. But the hardest test to take is the writing.

S14: I'd say right now it's pretty much the same as the other tests, it's whatever you have the most knowledge in that is probably the easiest for you.

S10: I'm more scared about the math and the English because that's what they require the most. I was told that for science, you basically read the passage and then you have your answers from there.

**Teachers' Perceptions**

Three of the teachers were of the opinion that students felt more anxiety about the science part than the other parts of the test.
T8: Definitely science and math are the two areas that they don’t want to take. But I’m not saying that they don’t like science, I’m just saying it causes some anxiety because of the unknown. They don’t really know what to expect.

T8: Well, it’s like anything else, they hate tests. I can’t think of anybody that actually enjoys a test. I think they feel like they don’t know what to expect. It’s not like math, it’s not as clear cut where they feel like they know what they are going to be doing when they go into the test. They kind of feel like it’s going to be another reading activity and they hope that they will be able to read the material and understand the material. Whereas in the other areas like math and writing, you know it’s going to be grammar, syntax and you know it’s going to be on fractions and percentages. While in science you’re not really sure, are you going to be tested on chemistry or how much physics is there really going to be. So I think they are nervous.

T3: They feel mostly anxiety about the test. They feel it more for science because it’s a field that they feel they don’t have as much knowledge. Because they’ve asked me “how much science do I have to know?”. That’s a frequent question about the GED.

T7: They tend to have the most trouble with the science reading part of the test than with the social studies or with the literature and arts. But I think that’s only because it’s more technical. Or because they haven’t had enough science before they left school, from elementary on up. Most of them cringe when they have to take the science test because they say “Oh, I’m not good in science.” When I’m not sure that is the case at all. Maybe they are weaker in science than in social studies but again it goes back to the fact that they’ve had social studies and geography. Our schools do not do a good job of teaching our students science.

Other teachers felt that the students were anxious about the entire GED test and not just a specific portion of it.

T1: They know it’s a requirement for the GED so they feel fine with that.

T5: They just take it as that’s part of the test, just another part.
One teacher equated the confidence of the students to their proficiency in reading. One teacher believed that the anxiety students felt toward the test could be alleviated by giving them sufficient practice in test-taking skills.

T2: If you're specifically referring to the GED, I think that my students who have strong reading skills feel pretty confident, because I emphasize that the science portion of it is related to their reading ability and as long as they have the test taking skills and strong reading skills, I feel that they think they will be successful. For those who have weaker skills, I think that they find, they feel that it's going to be a difficulty just because they feel uncomfortable about the general area of science and if their reading skills are not what they should be then you definitely are going to find science intimidating. I think the better readers are able to work through that even though they may be unfamiliar with the science and may not have been successful in science, I think they can work through that because we emphasize their positive advantage in having high reading skills. But if you combined the intimidation of science along with poor reading skills, you have some real problems to overcome.

T4: Tests intimidate them period, when they first come. After they're here for a while I do have to say that they kind of get used to it. It's like a challenge to them and they appreciate it, they actually appreciate the challenge because it shows that they're progressing. So I think that they will probably just take it like a normal day in the program because it's a day full of posttests and pretests and pretests and posttests. So I think they will be all right with it as far as the science is concerned.

T1: I have one student that just took the pretest and she thought that she was going to do worse in science than any other part of the test, and science was her best subject, she got the highest score in science and she was just amazed. She knew some of the terms so she felt comfortable in reading the passages. When you find out that it's something that you didn't know before and then you realize that you can pick it up and you learned it, it builds one's self-esteem and confidence and I think science in her case really has built part of her confidence.

Thus data indicate that even though a large number of the students interviewed did not have a favorable attitude towards science tests when they were in school, most of the students
appear to have a positive attitude towards the GED science test. One reason for this could be the
provision that they can take the test as many times as they need to, to pass it. Only two students
expressed anxiety directed specifically towards the science part of the test. For other students,
the anxiety they felt was towards the test in general because of it’s importance to their futures.

Science in society

The students interviewed had a range of opinions about the importance and place of
science in society. The overwhelming response, however, was the importance of the
environmental aspect of science and the science in the medical field.

Environmental Awareness

Some students believed that science played an important role in making people aware of
the Earth and the environment and helping people develop positive attitudes toward the
environment.

P2: People that are environmentalists that make us aware of what is needed from us as
individuals to make things better for the future.

S5: As far as the attitudes toward the Earth and the environment, in science you learn
about pollution, different stuff like that. You learn to treat the Earth with a good attitude.

S14: Before I didn’t notice these things, but now I’m more aware of nature and insects
and preservation and all the different efforts going on to preserve nature.

S10: Teaching people to start cleaning up around the area, start recycling more, not
putting trash all over the streets and other people’s yards.
Many other students believed that science was important in coming up with inventions that help the environment.

S3: As far as automobiles, cutting the bad fumes with catalytic converters, and trash, that's science, containers and recycling, that's all science. Chemicals, how bad they are how they hurt the Earth.

S14: Probably the land-fills, recycling, probably recycling would be the best example. Trying to keep the pollution out of the air and not burning stuff, using something on cars that would control pollution.

These students believed that they got this information about the environment from television and from the materials they were exposed to in the GED program.

Medical Field

The applications of science that were immediately recognized by the students were it's applications in health and in the medical field. Many students talked about the important strides in the field of medicine as one of the most important applications of science in society. Many students talked about the advances made in the treatment of cancer and AIDS specifically.

P1: Diseases, in what can help diseases, like HIV, heart disease, epidemics, trying to find cures and the different drugs invented in trying to cure diseases.

S10: At the hospitals, labs, stuff like that.

S1: I guess I keep getting onto medicine, because science helps in a lot of medications, without them people would not live as long as they live. Science plays a part in food, in nutrition.

S2: The one I would deal with the most is medicine. It's very important in the hospitals and labs, that's the big part for me.
S5: Working with different animals, find out cures to different diseases, finding out about diseases.

S4: The medical part of science, when you're out and you see someone who can't breathe and you want to perform CPR or if someone is in an accident, maybe losing a lot of blood, and just from the stuff you see on TV, like tying something tight around it, something like that.

SN2: How they know how to treat anybody, you know, the medicine. So that's the most important part of science, it's in the doctors position, that's the most important, medicine.

SN4: They've been finding stuff for cures for cancer and other diseases and stuff. Actually we need science a lot, if we didn't have it we wouldn't have a cure for ... well, we don't really have a cure for common cold, but I mean we have drugs for AIDS and stuff like that, and they're working on some kind of cure for cancer.

S8: Without science we wouldn't know how to cure cancer or AIDS, we wouldn't know anything about that. How would a doctor know what they were looking for when they operated on a patient. Right now, they're experimenting, trying to prolong life with AIDS.

S14: And the cure's they're working for on AIDS. And they're working on a cure for cancer and they supposedly nearly found one.

S14: They got a new thing out on fat now, and I think this was on rats, they gave certain rats and they never gained no weight. And now they're going to try it on us when it's perfected so we will not have obese people. I think the pill for obesity, that's good, of course there's always probably a side-effect.

S16: When they put the ear on the back of the rat and they're making new skin now for burn victims, the grafting and the cloning. It's making the future better, it's improvement, improving life, that's what it is. Just medicine in general, finding cures for fatal illnesses, is very important. And they are doing so much.

One student talked enthusiastically about the strides made by science in phlebotomy, her field, which have helped her perform more efficiently at her job.
S2: Diseases and the way we do tests, as to how we did them years ago, everything is so much easier now as far as, in my case, drawing blood, we used certain instruments at one time, they improved all of those, different needles. It makes our lives easier as far as the patients.

One student expressed her displeasure at the fact that scientists often make certain claims about things that have direct relevance to people's lives and then later rescind those claims. In her opinion this caused confusion in the minds of people as to the potential harmful effects of different substances or foods. This student also demonstrated an awareness of various health-related issues in society.

S14: I think it's important but I also think they make a lot of mistakes. They do a lot of experiment, maybe I've got the wrong idea, but they try different things to see if it works and they come out sometimes with things that they don't really know. Like they say that cranberry causes, and this is one thing that came out, that cranberry causes cancer, the skin of a chicken can cause cancer. Too many eggs makes too much cholesterol in your body. And then they come right back later on and they're saying none of these things are true now.

Thus some students exhibited an awareness of current advances in the medical field. All these students stated that they got their information from television and that even though they were interested in keeping up with what is going on in the medical field, television was their only source of such information.

Engineering and Technology

Some students expressed an awareness of the applications of science with respect to advances in engineering and technology.
P2: People that work on roads, fixing roads.

S3: Catalytic converter on a car, how gas burns through the car, the man that created the stop light, the person who invented the car, airplane.

S4: Construction and building homes and gardening.

S4: How we came about getting as far as we are with computers, I mean from typewriters and how cars are made.

SN5: To grow crops, the fields, that's science. How they use science to grow more food, stuff like that. The new machines and new technology.

S6: Computers and stuff, basically technology.

**Household Applications of Science**

Some students talked about the applications of science as far as everyday living. These applications involved cooking, cleaning, repairing appliances, and gardening.

S2: The things we use in the house, even cleaning solutions.

S5: Maybe working in the yard, like in landscaping, planting flowers, taking care of animals.

S4: Building homes and gardening and landscaping.

S4: Someone outside doing some outside work. Or if someone comes into your home and your furnace is out and he's repairing it, or just anything that's kind of work that's being done in the outside besides like in the home, cooking and stuff like that, anything that's being done outside.
SN6: Like if someone mows the grass and they would think it's going to dry but with science you can figure out how to put soil and stuff down to make it grow and for people that grow plants, they would know how to grow plants and different kinds of soil products.

S9: Some have to use science or chemistry to measure, some use it for cooking, some for building a house.

Thus the students' awareness of the applications of science in society largely focused on science in the medical field and the role of science in conserving the environment. Students believed that they gained knowledge of the advances science had made in the medical field primarily from the television while they gained knowledge of the environmental aspect of science from the television and from the materials they are exposed to in the GED program.

Science issues

Awareness of Science Issues

Many students stated that they did not know anything about any science or environmental issues. However, when they were asked about specific issues such as cloning, they did exhibit a very limited awareness of it mostly from programs on television. Other students exhibited an awareness primarily of environmental issues and certain issues in the medical field.

P2: I guess the ecosystem, the environment, the smoke factories and how they can solve the problem, things that affect us with illnesses and diseases from the chemicals that it gives out in the air, the ozone problem.

S13: The issue they had that time about the waste ... the dump in the southern part of Ohio. How it was giving people cancer and things like that, all the toxic stuff. The rain forests and the oil spills that they have in the ocean which is very bad for the animals in the ocean. And the rain forests, why do they have to cut down all the trees, plants that people never got to study or anything like that. And the land fills, cans and plastics, recycling, there are a lot of issues out there.
S14: We've got to conserve the Earth, conserve water. The land fills, plastics, recycling, the pill for obese people, trying to change their habits, keeping the pollution out of the air and not burning stuff. If you cut a tree down, put a new tree there so that the land does not erode, not polluting the air so that our kids can live a little better.

P1: What most catches my interest is when a drug is recalled. Like Seldane, that was on TV last night. That catches my attention. Also things that are going on in the environment in some parts of the world.

S14: I think it's important but I also think they make a lot of mistakes. They do a lot of experiment, maybe I've got the wrong idea, but they try different things to see if it works and they come off sometimes with things that they don't really know. Like they say that cranberry causes, and this is one thing that came out, that cranberry causes cancer, the skin of a chicken can cause cancer. Too many eggs makes too much cholesterol in your body. And then they come right back later on and they're saying none of these things are true now.

S1: The nuclear waste, where in the different states they store nuclear waste.

Some students stated that they have heard about different issues, however they did not really have any knowledge or information about them.

S3: I have heard people talk about acid rain. I haven't really read about it, I'm not much of a reader. I watch television before I read the papers.

S4: The ozone layer, I don't know much about it. I know it's something that's wrong, I just don't know what it is.

SN4: I've heard of it, I've heard of global warming, I've heard of everything, but I just never knew where the information was.

One student stated that it was her children who kept her informed about different issues in society.
S10: Sometimes my kids tell me stuff, like when MacDonalds was serving their food in certain containers that the animals were eating and it was killing them. Basically they keep you informed.

When asked specifically if they knew anything about genetic engineering and cloning, a lot of students said that they had never heard anything about it. Many other students said that they had heard something about it on television but they were not sure exactly what it was about. However, these students did have opinions about it. A few of the students stated that they had been following the debates and had a reasonably good understanding of the issue. While some of the students were firmly against the whole concept of cloning, most of the students who said they were aware of it, were aware that it could have beneficial applications and that it had to be used carefully.

S1: One thing that stands out is the cloning. I heard about that, I thought it was amazing that they took the gene from one thing and made something else. It was a surprise, a shock. I don't think that humans should be cloned, I think that only God should make human beings, not man. The rest of it, like the cloning of the sheep and the animals, I haven't thought much about that.

S4: I can't see what the purpose is, I mean cloning one animal or something with another. I can't see the meaning behind that I mean what are they trying to prove or what are they trying to create. God created man and his animals so it's like they're trying to change what the Lord has already provided. I've seen it twice on TV, just little parts so I don't really know what it's all about.

S13: I think God put you here. But I don't think you should try to clone something that you are going to be messing around with because it might get into somebody's wrong hands who wants to do something drastically different with it instead of trying to use it for science.

S8: I don't even know if there is some kind of fantastic science behind that, some Jeckyl and Hyde kind of thing. The sheep, cloning that sheep. I don't even know how they do it, I have to check it out.
S14: Well, you could prepare more food, you could clone cows and stuff, you could have more good food to eat.

SN4: I think as far as animal lives, if there is a small proportion of the animal, then it’s right for that. But for humans, I don’t think so.

SN5: I don’t like it. It depends on how they’re going to use it. If they’re going to abuse it, they shouldn’t have anything to do with it.

SN1: I guess cloning is the big one right now. I don’t know everything about it, but I think it is very interesting and it can help society, but it has to be used carefully.

One student stated that he was not aware of what is going on in science because he had not been watching the television lately.

SN3: There’s not too many things about science going on these days. Not that I know of, because I haven’t been watching TV.

Thus the students appeared to have an awareness of those issues that had received widespread media coverage on television. However, most students admitted that even though they were aware of these issues they did not really have a good understanding of them.

Research

All the students interviewed were of the opinion that spending money on scientific research is necessary. However, they believed that research dollars should be spent wisely to enhance the quality of life. Most students referred to research in the medical field as the kind of research that would benefit humanity.

S3: I feel that if it is going to help society, I’m okay with it. If it’s positive, if it is going to be a waste or nonsense, I’m not for it. Like for AIDS research, I’m all for that. But I don’t like to think that we use our money to kill animals, because I’m sensitive to animals.
P1: Research is coming up with solutions that affect humans, coming up with solutions and cures, dealing with pollution. We all have to live in this world, so I see my money being used wisely for that.

S1: I guess if they didn't get the money, they couldn't do the research. So I guess in order to do research, they need to get the money to do that.

SN1: I think it's necessary, I don't have a problem with that. Medicine is a big issue.

S8: As long as it's doing society some good, it's curing. Someday it will be a cure and then again it may not. You just have to take the chance.

Media

Most of the students interviewed stated that they got all their information about science applications and science issues from the media. However, very few of the students interviewed read for pleasure. Therefore most of their information was gleaned through the television. Most students stated that they enjoyed watching nature shows the most.

S18: I don't read too much, I don't like reading that much.

S1: I was reading in a magazine something about how they discovered a body that had been buried for years and the body was pretty much preserved. I enjoy reading about that and when they do different archeological digs, when they find different artifacts and all that, I find that interesting.

S5: I might flip on the discovery channel and watch different things like the animals and how they live, their environment, how they prey, what they have to do to survive, different stuff like that.

S13: The nature shows are pretty good, I generally watch that.
S13: Sometimes when the teacher has a paper she talks about it, or I might just want to read it in the paper myself or hear about it on the radio.

S7: I like the discovery channel and the learning channel.

S14: I hear about these issues mostly on the TV.

One student expressed the opinion that his limited knowledge of science issues was due to the fact that he did not have time to tune in to the news.

S6: I don't have much time so I don't get to watch the news.

**Citizenship**

For most students, the idea of being a good citizen centered around honesty, helping other people, volunteering and helping the community, obeying laws, and in general getting along with people.

SN4: You can volunteer, go into different communities, take children outside and teach them.

SN5: You got to have a positive attitude and you need to know a lot about government, about people and about yourself.

SN6: To be able to work hard and get along with people.

S13: To be in the right frame of mind about different issues and different things and to look at what other people are doing instead of trying to judge and take sides.

S7: Honesty, a love of fellow man, that's awfully important. And if you have honesty and love of fellow man you will be a good citizen. And of course, love of the country you are living in.

S11: Very open-minded, not judgmental of anything or anybody.
S12: Helping other people.

S8: You got to have a sober mind, you have to be honest, and you have to have a little spiritual good in there to be a good citizen, you have to have compassion for people, getting along with people.

S16: I think they would have to be kind, responsible for their actions, considerate of others, participate in activities outside their home, obey the laws.

For many others effective citizenship involved taking care of the environment. This could be by personally taking steps to conserve the environment and beautify their community to voting people into office who would pay attention to these things.

S7: You will be able to beautify the country, plant things, make it clean, be an environmentalist.

S14: Loyal to your country and you should know the history of the country, law-abiding. Again we go back to the landfills, the plastics, the recycling. If you cut a tree down, put a new tree in so that the land don't erode, things like that. The environment, not polluting the air so that our kids can live a little better.

S14: Again you go back to the environment. I'm sure there's some of that on the voting. If who you vote in ... if you vote the wrong person in, he may not take care of the area or press the issues that are important.

S16: Science can help a person be a better citizen because science really involves the Earth and the environment. You want to pick someone in leadership that wants improvement, wants the best and improvement. You want somebody that cares about things that are going around, the Earth and everything. Just with the progress science has made, you want someone that's really interested in such things. I would want someone who is interested in people and their welfare and their health, so I would vote for someone who is really interested in finding cures and making improvements.
When asked if learning about science would help people become better citizens most students thought that it would. However, responses concerning the ways in which it would help people become better citizens all centered around making people aware of environmental issues and helping them treat the environment better.

S5: I would think so. It will make you protect your environment, you know, the Earth.

S9: I think a lot of people should start cleaning up around the area, start recycling more, not putting trash all over the streets and other people's yards.

SN2: Because you think of the environment, and when you think of the environment you will treat it better. You won't walk on the street and throw everything around, the knowledge of it will be important.

S10: Not strewing things, taking care of the environment.

Only one student expressed the opinion that learning about science could help her in exercising her vote on different issues.

S7: Okay, when they ask about the rain forests, if you don't know anything about it, you can't vote for it, you know, vote against what they are doing there, it's not something you should guess about.

Teachers' Perceptions

Two of the teachers believed that their students in general were not very aware of issues important in society today.

T4: I think that when they pick up the newspaper they read about the weather. I don't think they look at the news too much unless you bring it out to them and draw it to their attention. I'm not going to say all of them, but most of them are that way.
T7: They are probably not real aware. I don’t want to say that they’re isolated, but they don’t read the newspaper, they aren’t tuned in to current events on the news on the TV. They’re just not, they just never have been and they just generally are not.

Some other teachers believed that their students had some general awareness of environmental issues because of the media coverage of these issues.

P3: I think the media have done a good job on the environment. Many of them (the students) are aware of different environmental issues. When we were going on with the acid rain that was coming out of Canada because we were burning coal, many of them knew what was going on. It is surprising that they zero in on the environmental issues, everything else is kind of sidelined.

T2: They are aware of certain issues that are on the news. But then again I don’t know if they make the connection that this is science-related or if it is just newsworthy.

T6: They are aware of issues generally through the TV. They think of it more as newsworthy current events rather than science, like the comet and cloning.

T8: I don’t think they are aware at all. I would say they have minimum knowledge from what they see on TV.

Some teachers talked about what they currently did or what they could do to increase students’ awareness of different science and environmental issues.

T5: If we emphasize environmental issues, that could have an influence on them.

T2: I really don’t know how aware my students are, we haven’t discussed it. In other programs where I taught where I did more classroom teaching, these would become topics that we might even write essays on, or at least discuss in class, current events, that kind of thing. I don’t get to do that with this class.
T6: The students do talk about it, it gets discussed in the classroom if it makes the news. If we had more time, there is tremendous interest, we could use it not towards the GED but towards their interest in science.

T7: I bring in things and just by some of the comments, the students tell me that it makes them more interested in learning what's going on in the world around them.

Thus students exhibited an awareness about science and environmental issues to varying extents. Most of the students got their information about such issues from the television and some of them got this information by reading. Many students' ideas of citizenship centered around taking care of the environment. The teachers in the programs sampled felt that they could use discussions in the programs to increase students' awareness of these issues.

Discoveries/Inventions

Many of the discoveries and inventions that the students considered as being important were advances made in the medical field.

S16: When they put the ear on the back of the rat and they're making new skin now for burn victims, the grafting, and the cloning, when they're talking about it like this, it's the future, it's making the future better, it's improvement, it's improving life. Medicine, finding the cure for fatal illnesses.

P1: Like HIV and heart disease, different epidemics, trying to find a cure for this disease, and the different drugs invented in trying to cure diseases.

S1: A lot of the medications, without them people wouldn't live as long as they live.

S2: Progress in diseases, the way we do tests compared to how we did them years ago. Everything is so much easier now, as far as, in my case drawing blood. We used different instruments at one time, they improved all of those, different needles, to make our lives easier as far as the patients. I've seen a lot of different changes in the hospital, inventions, which I didn't see before.
SN4: They've been finding stuff for cures for cancer, and other diseases, medicine for AIDS, stuff like that.

SN3: A cure, not really a cure, but something for breast cancer, trying to find a lot of different cures, for AIDS.

SN4: Medicine technology. If we didn't have some of the stuff we have today, I don't think half the people would be here.

S8: Experimenting, trying to prolong life with AIDS.

S14: Well, if they found the pill for obesity, I think that's good, of course there's always probably a side effect. I think they're working on a cure for AIDS, and a cure for cancer and supposedly they nearly found one, that was on TV the other night.

S16: The skin grafting, that's very important. Medicine in general, finding the cures for fatal illnesses.

The other scientific discoveries and inventions that the students saw as being important were the various appliances that make everyday life easier.

S1: The different equipment that we use, the different appliances in our homes, electricity, all of that.

S2: As opposed to when I was a child there are a lot of things that are important to us. Like my microwave, my electric stove, everything in life actually that we use everyday. I just think about when I was a child and what things are now, it's just really unbelievable that things like that can happen. Especially with cloning, now that's really way out as far as I'm concerned.

SN2: Computers, cars, streetlights, all the developments.

S3: The catalytic converter on the car, the stop light, the person who invented the car, the airplane, space and a lot of technology that they have come out with. The person that invented the microphone, amplifier and all that.
S4: Probably back before I was born, how we got electricity, the telephone, how we came about getting as far as we are with computers, coming from typewriters, cars, just about everything that's happening today.

SN5: How they use science to grow food and stuff like that.

Thus students did not appear to be knowledgeable of recent discoveries and inventions other than those in the medical field. This knowledge was mainly gained through television programs that highlight many medical breakthroughs.

**Self efficacy**

The students exhibited a wide range of responses in terms of their perception of their ability to be successful in the domain of science. A couple of students were of the opinion that they did not have what it takes to be successful in science.

S16: My son is interested in being a scientist, has been saying that ever since he was 10, that he wants to invent stuff. I would be a scientist if I could, but I'm not thinking that broad. Being a scientist I think is so hard, it seems like it's so hard, I don't think I could be a scientist, or I could, but it would be a lot of work.

S14: I think it would be very interesting. And the reason I said I don't know how easy it would be for me is that at this age you get frustrated easily, things upset you easily, or at least I speak for myself. It seems like change is very hard for me, to readapt is very hard. It could be very frustrating if I couldn't find the answers.

S10: I don't think I would be a leader in science.
R: If you become a veterinarian you would be doing science all the time.
S10: That's because I would be interested and not feel the science.
A few students were very confident about their ability to do science related tasks.

P1: I think I have the ability. I also have the knowledge, education, medical terminology. Education helps a whole lot.

S4: It would come easy because I’m interested, it would be something that I enjoy doing.

SN4: I think I could do it. I think if you gave me something right now to do and it was science related, I would be able to, or at least I would try to do it.

S3: I have good ability. Some people come out with the gift to do science and I feel I am one of them. I guess I just didn’t pursue it the right way.

S3: If you take away their robe and their job then they’re just like us. If we had the chance we’d probably be experimenting new things, you can never know what the mind can conjure up.

However, the majority of the students felt that at the time they were not well equipped to be successful in the domain of science but with exposure to it and an increase in their knowledge about science they could be successful in the future.

P2: I never really liked science, and I never really was good at it. I think that with enough concentration and enough confidence I could learn the majority of it, especially what’s important.

S1: Well, with the education that I have I think it probably would be hard. But I think that with knowledge and the more you do it, it probably would be easier to do.

S3: If I would get there I would like it, but I know it takes so much time and dedication. Because I feel that the mind that I have can probably help the world see new things and how different my project probably would be to everyone else.

S5: I’d need to read more about it, learn more and see what it’s really about. I could see myself doing something in the future, but right now, no.
S9: I probably could do it, but it would take a while to know everything.

SN3: I would have to read back on it, because I haven’t been in science for so long.

S8: Well, right now, no ability at all. Right now I’m into science just a little bit, but if I would bet into science, really get into science, then I would have the skills.

S16: I think if I get interested, I could do it.

Thus a few students were confident about functioning successfully in the domain of science. However, the majority of the students felt that they needed more knowledge about science and more exposure to it in order to increase their confidence.

Scientists and people who use science

Image of Scientists

Many of the students interviewed had a stereotypical image of scientists.

P1: Someone in a lab, working with a microscope, coming up with hypothesis, with solutions for problems.

P2: Somebody with a white coat and real serious looking, real distinguished looking, very intelligent, very well educated, and definitely interested in their job.

S3: A man in a robe messing with electricity.

S5: White hair and glasses. A long white coat, one of them long sticks in his had and a cluttered desk.

SN1: Guy in a white coat with a whole lot of testtubes.
SN2: Kind of old, in the lab or something, or in the environment outside trying to find something. He's always working on something in the ground or something in the Earth.

SN3: Gray haired dude with a gray mustache, gray beard.

SN4: Chemicals in the lab, a white coat, different numbers on the chalk-board.

SN6: In a big white coat in a lab with all kinds of chemicals, all kinds of tools and equipment and him working with it.

S13: Someone with hair standing on the top of their head (laughs). Scientists will be there in their labs trying to figure out a cure for diseases, how to save more water, and stuff like that.

S6: Someone with a uniform, and gloves and a mask on maybe.

S16: The white coat, the aging face with wisdom. They're always working, always absorbed in what they are doing, and always trying to figure out stuff.

S17: Glasses, older. They just look like scientists, with a little white thing on.

S18: A nerdy looking guy with glasses.

For other students their image of a scientist included someone working on research and very committed to their work.

S1: An outstanding person, a person that contributes a lot to humanity. They have to have a lot of knowledge, they come up with different cures, they come up with different inventions that make life easier for us today.

S2: Someone with test tubes, which isn't always the case. Just someone who is always thinking and always doing things to make things better. A person like that who really enjoys what they are doing and they're really interested and really into it.
S14: Somebody well educated. I don't think of them as weird because we see a lot of movies where these guys are far out. I think they are just like you or me, probably overworked.

S8: A scientist is a person that studies, does research to get an answer, experiments. A person that went to college and took up all this science, but wants to do research and invent something.

S7: Trying to discover a cure for diseases.

SN5: Someone constantly thinking and trying to better themselves, better their country.

S4: In a room, doing an experiment. But I know that that's not all there is to science. As far as rocket tests and stuff like that, I imagine a man standing there in a suit or something, or other types of science, archeologists studying the rocks.

S9: Someone who is doing new experiments and inventing something new.

**Qualities a Scientist Should Have**

The qualities that were most often cited as being necessary for scientists included knowledge and a good education.

S14: They have to have a lot of knowledge. They have to care about people too. Very serious because they're into what they are doing.

S8: He should have a Ph.D. Of course you don't have to have a Ph.D., but it is better to have a little authority behind what you invent or discover.

S13: You need to have the knowledge, the education, and the wish to be a scientist.

SN6: Learn how to use chemicals and stuff like that. And have a lot of knowledge before he starts messing with things.
SN2: Basic knowledge, the will to do all these things, the knowledge and the willingness to do it.

P1: Knowledge, awareness, experience in the area of what they are studying, education in health, science, biology.

S1: They should have knowledge.

S10: They should have a high education, know a lot of science. Someone who is patient, who can try things over and over again.

SN1: Thorough, very thorough, well educated, and with a very open mind.

SN3: They should know a lot about the Earth.

A few of the students felt that scientists need to be very intelligent in addition to having other qualities such as knowledge and patience.

S16: Very smart, lot of patience, and a very long attention span.

S6: You have to have a brain.

P2: Intelligence, responsibility, dedication to their work.

S5: I believe a scientist has to be smart, I mean really smart, and energetic, positive and brainy. He has got to have a good brain.

However, most of the students believed that intelligence is overrated and that if anyone has a real interest in being a scientist, they should have no problem in doing it.

SN2: It has nothing to do with intelligence.

SN5: Anyone can be anything that they really wanted to be.
S6: You can do anything that you want to do, you just have to have the determination to do it.

S3: If you take away their robe and their job then they're just like us. If we had the chance we'd probably be experimenting new things, you can never know what the mind can conjure up.

In addition to knowledge and education, the students interviewed highlighted other qualities such as respect, patience, dedication, curiosity, and values as being important for scientists.

S14: They have to care about people too.

S7: I believe that scientists should have a higher power other than themselves. They should have respect and honesty.

SN5: Good morals and good values so that they wouldn't do or create bad things.

SN4: I think they should be more connected with the Earth itself, want to know all about life and not just for the money. Wants to learn for other people too as well. And does it because they really want to and not because somebody has to do it.

P2: Intelligence, responsibility, dedication to their work. I imagine you have to be dedicated to the work, you can't get funding for something and then halfway through it think that this is boring.

S1: They should have knowledge, they should have understanding, love, they should be compassionate, they should be humble. They probably would have the desire to do something to help humanity.

S2: They should be always reaching for something higher. Their minds should always be prepared to go higher than where they are and study things they don't understand.

S3: Good adaptation to life, definitely before he starts experimenting and stuff like that, he should know what he is dealing with before he gets involved with it.
S4: They're more interested in what people just take for granted. They go beyond that to find out where, why, and how, what makes it work. More ambitious about what they study.

**People Who Use Science**

The most common perception among the students about people who use science were people working in labs or people doing research and astronauts.

S16: People working in a big laboratory.

S14: People who work in the lab, or people out with the rockets and space shuttles.

SN3: Lab technician.

S1: People that work in different labs, scientists, astronauts. Probably someone trying to find a cure for some of the different diseases that there is no cure for.

S10: People doing research, the weather man.

S8: Right now I'm thinking about outer space, NASA, experimenting and doing scientific stuff out there.

SN1: Anyone who works in the space shuttles.

Other perceptions included archeologists, people working out in the environment, and people in the medical field.

S13: I would picture an archeologist, on a dig.

SN6: Researchers in colleges, doctors, dentists.
SN4: I guess the weather man trying to figure out what's coming next, how the weather is, how warm it's going to be today or tomorrow. Trying to figure out if we're going to have a tornado or if it's going to be flooded.

SN5: Someone using a computer or something.

P1: Someone working on pollution. Someone working on different types of gas that we can use in our car that can cut down on pollution, cut down acid rain. Someone working on solutions, someone working on animals that are suffering because of pollution, someone working on incidents such as oil spills, getting the oil out of the water, and those kind of things.

S5: The zoo guy that works with different animals, finding out cures to different diseases.

S5: Someone outside, doing some outside work. Or if someone comes into your home and your furnace is out and he's repairing, or just any kind of work that's being done outside besides like in the home, cooking and stuff like that.

After giving the question some thought one student replied that she used science in her job which was in the medical field all the time and in her opinion just about every field uses some sort of science.

S2: I guess I've never really thought about it. And in my case I've done it all along, but I just never really thought about it as science. All the people we talked about, like the engineers, the architects, the medical field. You really don't think about it unless someone raises the question like you did. Just about every field uses some part of science I guess. To use science people have to be curious and have to want to look for things and be interested in all things.

Thus the most common perceptions about people who use science included scientists, researchers, other people working in laboratories and astronauts. Some students highlighted other ways in which people use science including working in the environment, working in the medical field, archeologists, and meteorologists.
Thus we see a lot of similarity between the attitudes of students who have not had any science in the GED program and those who have had some science preparation. An exception to this is the attitudes of students in programs where there is classroom discussion about current science topics and programs that incorporate innovative strategies such as field trips. Students in these programs exhibited a greater awareness of the relevance of science to their lives and to the world and eagerness to learn more about it.

The next chapter discusses findings from this research effort and their implications as well as recommendations for further research in this area.
CHAPTER 5

DISCUSSION AND IMPLICATIONS

These days science education is getting a lot of attention at the elementary and secondary level. There is an abundance of research conducted in this area and numerous efforts have been initiated to enhance the quality of science education in schools. Recent reform efforts at the national level have focussed these efforts and highlighted the importance of this field. However, these efforts are primarily in the elementary and secondary arena. Conspicuous by their absence are similar efforts in the adult education arena.

This research effort aimed at documenting different strategies for science education in GED programs along with students' and teachers' perceptions of these. It also explored GED students' attitudes toward various aspects of science. This section discusses findings from the research and their implications.

Instructional Strategies

The predominant strategy used in the GED programs in all areas of the GED was individual reading of published GED materials followed by answering questions based on those materials. This appears to be an outcome due to the nature of the current GED tests. At the majority of GED sites the emphasis was clearly on reading strategies at the expense of understanding and internalization of the knowledge acquired. Only a couple of the students
interviewed thought that individual reading was an appropriate strategy for the science portion of the program. Overwhelmingly the students preferred a more visual approach to science including hands-on experiences that would get them involved with the subject.

However, when incorporating hands-on strategies it is imperative to keep in mind that there is a big difference between going through the motions of a hands-on experiment and actually learning something from it. In the case of GED students, if the students do not feel that they are acquiring useful knowledge or process skills that they can apply to their own lives, hands-on experiences generally do not impact either their knowledge base or their attitudes toward science. Therefore GED teachers should be wary of falling into the trap of selecting hands-on activities and demonstrations because they are easy to do or fun rather than for their usefulness in developing conceptual understanding or higher level thinking (Roth, 1989). Other visual approaches included field trips which appear to be an efficient strategy for exposing students to the science taking place in their community and if well designed can help students see the relevance of science to their own lives. Students reacted positively to field trips and experiences from which they gain insights or information that they can use directly in their own lives.

Students also exhibited varied preferences for a variety of strategies depending on their preferred mode of learning. While a couple of students preferred individual reading, the vast majority of students interviewed preferred hands-on science experiences, field trips, and group work. Surprisingly, a large number of students preferred direct instruction and interaction with the teacher and other students to an individualized approach. Many GED students felt that the quality of their learning could be enhanced by working collaboratively with other students as this facilitates sharing of knowledge and experiences and could help the students build upon the knowledge and experiences of others in the group. According to Knowles (1980), cooperative group work can help adults serve as one another's resources in a learning event. Since accumulated life experiences differ from adult to adult, a group of adults possess a rich variety of life experiences and knowledge that could be used for the benefit of the entire group.
While highlighting the importance of using a combination of instructor-centered and learner-centered approaches in adult education, Merriam and Cafarella (1991) state that in order to achieve this balance the instructor must be capable of assuming a variety of instructional roles and using a wide range of formats and techniques. Using a wide range of strategies would address the learning style preferences of most individuals in a group. Addressing the individual learning styles would enhance the quality of education for these individuals. Many researchers advocate teaching to accommodate different learning styles (Neill, 1990). Research conducted by Yager and Bonnstetter (1990) has shown that students of teachers who are armed with a vast quantity of strategies for effective teaching are able to use the concepts and processes of the science they encounter better than students found in traditional classes and have superior attitudes concerning science and science learning. This aspect of positive attitudes and transfer of learning is especially important in the case of adult students in GED programs who have experienced academic failure in the past and who place a lot of importance on the applicability of their learnings to their lives. In GED programs, learning style inventories could be used to generate awareness of individual learning preferences and strengths and weaknesses as teachers and learners.

Professional Development and Interaction Among GED Teachers

Many GED teachers cite lack of time and resources as major obstacles to incorporating innovative strategies in their programs. However, there are few teachers who have accomplished this to some degree or another without much extra expenditure of time or resources. The data indicate that the quality of the science education experience of students in GED programs is largely influenced by the science teaching in these programs. Therefore strategies to influence the science teaching in GED programs through professional development opportunities for the
teachers could prove invaluable in enhancing the quality of the science education aspect of these programs. These opportunities could include visits to exemplary GED sites and visits to secondary science classes.

The teachers interviewed expressed the desire to be able to share resources and ideas with other teachers. Increased interaction among GED teachers on an informal or formal basis could facilitate the sharing of time and resources. In addition, interaction could facilitate sharing of experiences and insights gained during incorporation of new strategies so that teachers can build on each others experiences to enhance their own programs without having to go through the trial runs and mistakes that other teachers have gone through. This, in the long run, would lead to more efficient use of limited time and resources.

Interaction among GED teachers and sharing of resources, experiences, and ideas can be facilitated by workshops and conferences that focus specifically on the GED. Many teachers interviewed stated that although they gained useful information and were able to interact with other teachers at the Adult Basic Education conferences they attended, these conferences were not specific to the GED and thus limited their ability to interact with other GED teachers. Since the GED contains specific subject areas such as science and social studies, it is different from general adult basic education that generally focuses on reading and math. Most teachers interviewed stated that the workshops they had attended were primarily in reading and math and they had not had opportunities to attend science workshops and so were not as aware as they should be of what was going on in the field of science education. Many expressed a desire to be able to attend science workshops that would provide them with ideas and techniques that they could directly incorporate into their programs without having to spend a great deal of time and resources in gathering information on these. These workshops would prove invaluable in the case of GED teachers many of whom have a very limited science background and are themselves not comfortable in the domain of hands-on science.
An interesting finding is that very few of the GED teachers had had any formal training in adult education. According to Merriam and Cafarella (1991) this in fact characterizes much of adult learning since only a small percentage of teachers, administrators, program developers, and others have had any formal training in adult education and therefore much of adult learning is carried out without reference to what is known about how adults learn. The practice of adult education in GED programs can be enhanced by dissemination of this knowledge to GED teachers through workshops and inservices.

Relevance and Application to Life

Many studies in science education at the secondary education level highlight the importance of making science relevant to the students. This study found that this is especially important in the case of GED students. Many students felt that unlike students in school, they have experienced life and therefore look for the relevance in things that they read or study. For them, learnings are not ends in themselves or knowledge acquired for future applications. They are looking for opportunities to enhance the quality of their daily life. For many, this means having the opportunity to apply their learnings to everyday life. If they encounter science that they feel is of use to them, it can contribute to their sense of its personal relevance and emotional involvement, and give purpose and meaning to their learning. Research in the secondary education arena has found that students need science that involves ideas and experiences that they can use in their daily lives that helps them understand and deal with real world issues (Yager, 1988). Furthermore, according to Knowles (1980), there is a change in time perspective as people mature, from future application of knowledge to immediacy of application, thus making adults more problem-centered than subject-centered in learning. Reporting on research on the type of activities that adults were involved in, Merriam and Cafarella (1991), concluded that subject matter directly useful to the performance of everyday tasks and obligations accounted for the most significant block of the total activities recorded. Therefore it is not just important to use
examples from everyday life, it is equally important to use examples that students recognize from their life and can take back and apply to their everyday life. Many students look for this application and when they see it, it fosters a sense of ownership of useful knowledge. GED teachers need to be aware that while education for children and young adults is basically preparatory, preparing them to be adults, the learning in which adults engage arises from the context of their lives.

Although published GED materials contain an abundance of examples that students recognize from their lives and from the world around them, they do not necessarily make the connection between science and their everyday life, especially if they do not see any application for it in their life. Students who are exposed to science primarily through reading science materials rarely see the connection between what they read and their own lives. However in sites that have a lot of interaction between students and teachers via group discussions, students appear to have a greater appreciation for the applicability of science to all aspects of their lives including their jobs. An effective means of helping students make the connections between science and their own lives appears to be group discussions. In a group discussion the instructor can act as a facilitator and guide the students toward making the connections between science and everyday life themselves with the aid of other materials such as newspapers and videotapes. In researching the social climate of adult learning situations, Ennis (1989) reported that learners indicated that discussions of problems or topics of interest expanded their understanding of the content and assisted them in placing the information within a relevant context in their own lives. Therefore teachers who use classroom discussions do not have to rely on published GED materials to help students see the relevance of science to their own lives.

Confidence and Self-Improvement

In addition to highlighting the importance of making science relevant to their lives, the GED students interviewed expressed interest in increasing their awareness of the world around
them. Some students expressed satisfaction on acquiring some knowledge that made them appear more knowledgeable to the people around them in addition to the personal satisfaction of knowing something about their surroundings. Other students reported feeling dumb when they did not know anything about a topic being discussed by people around them and a sense of confidence when they knew enough to participate in these conversations. Research has indicated that adult students cite improving their self image and gaining confidence in themselves and their ability to deal with people as one of the positive outcomes of going back to school. In the first national study of participation in adult education activities, Johnstone and Rivera (1965) concluded that the major reason cited for participation was to become a better-informed person. One approach that appears to be successful in helping GED students become better informed people is the use of strategies such as group discussions and field trips that bring to light the role of science in the world around them. These strategies are being used effectively in some programs to make the students aware of not only their surroundings but also science issues important in society today. Teachers who used these strategies reported that once students get involved in classroom discussions about relevant issues, it not only increases their awareness of the world around them but also increases their thirst for more such information.

Science Issues in Society

The GED students and teachers interviewed agreed that published GED materials and the strategy of individual reading in GED programs are not effective in fostering an awareness of science issues in society. In some programs, teachers have tried to bridge this gap by facilitating group discussions using materials extraneous to the GED program such as newspapers, news magazines, and video recordings of documentaries. One program used field trips in conjunction with group discussion to achieve this. Students in these programs demonstrate a greater incidence of awareness of science issues in society than their counterparts in other programs. These students also expressed an interest in increasing this awareness. This awareness not only
works toward the science education goal of helping students be better informed citizens, it also increases confidence and enhances self image by fostering an ownership of useful and relevant knowledge and information.

Formal Schooling Experience

Most of the students in GED programs have not had much science in high school and many admitted to remembering very little or none of the science they had. In addition many of these students were in high school in the sixties and seventies and early eighties where the approach to science education was very different from what it is today. In education literature from the 1980s conclusions were drawn that at the high school level there had been a general lowering of science and mathematics requirements for graduation across the country and that several indicators demonstrated that students at that time were less prepared in science than in the past (Simpson, 1982). Many of the students in GED programs went through the limited high school science that they had in that era and missed out on the opportunities in science education available to high school students today.

The reform efforts of the eighties and beyond focused on developing scientifically literate citizens who understand the interrelations between science, technology, and society and are able to use their knowledge in personal decision-making. Many students in GED programs went through high school before this period of reform and have not been exposed to this aspect of science education. Students remembered doing experiments and projects in the lower grades but having less and less of these as they progressed through school. Research indicates that most students, by the end of the ninth grade, exhibit near neutral motivation and attitudes toward science and for the most part do not take any further science courses after meeting the minimum requirements (Ogens, 1991). Therefore it is important in GED programs where the students are getting a second chance at getting a quality education that teachers use findings from
contemporary research to enhance their teaching. Teachers need to be made aware of the reform efforts in education today especially those in science education since many of them do not have a background in science or science education.

Data indicate that students believe that if they were exposed to more science, they would have a more favorable attitude toward it. Many students do not recall having any science in high school and therefore are intimidated by it. These students also expressed the need for the science they learn to be relevant to their lives. Exposing these students to science that they can connect to and use in their everyday life, could foster more positive attitudes toward science.

Learning Disabilities

Many of the teachers expressed the opinion that they are not equipped to deal with some of the learning disabled students that they have in their programs. The proportion of adults with disabilities lacking a high school diploma is 3 times higher than the 15% rate among non disabled adults (Westberry, 1994). A large number of these adults find their way into GED courses in order to earn a GED diploma to qualify for more jobs. However, most GED teachers do not have adequate opportunities for professional development in learning disabilities. These professional development opportunities are necessary for adult educators to develop an awareness and understanding of this population and to serve them better (Ross-Gordon, 1989).

In addition most of the teachers were not aware of any special provisions for learning disabled students taking the GED test. Although it is not well known among adult educators, GED test administrators can provide guidelines and an application form for special needs testing accommodations. The GED technical manual also contains information on such accommodations:
Some candidates, because of their physical, psychological, or learning disabilities, may not have the opportunity to demonstrate their knowledge and skills under standard testing conditions. In such cases, the GED Testing Service allows for the administration of the GED Tests with special accommodations. Examples of these accommodations include special conditions such as extended time, private testing, frequent breaks, use of a calculator, or testing with one of the special editions of the GED Tests: audiostream, Braille, or large-print. Special accommodations are provided without additional cost to candidates. To ensure that accommodations are made only where appropriate, GEDTS requires extensive professional documentation of the need for special editions and/or accommodations (ACE, 1995, p.5).

Many teachers were of the opinion that even though some of their learning disabled students are competent enough to work in the workforce, they are obstructed in doing so because of their failure to successfully complete the GED. These teachers thought that some of these students may never pass the GED. However, no test taking strategy has been developed specifically for GED candidates with learning disabilities (Westberry, 1994). These students stand to lose out on opportunities for jobs and enhancing the quality of their lives because of the structure of the present GED test.

**New GED Tests**

The science portion of the current GED tests professes to use real-life examples and focus on technology with the aim of fostering critical thinking and problem solving skills (ACE, 1995). All the teachers interviewed were of the opinion that the current GED science test was nothing but a reading test and promoted development of good reading skills. In secondary science education right now there is an emphasis on the relevance of science to the students' lives and it's applications in society in addition to fostering critical thinking and problem solving skills. Since the GED tests profess to be equivalent to a high school diploma it is essential that they align themselves more with what is currently happening in the secondary education arena.
Moreover, the GED students interviewed overwhelmingly responded that the science they learn needs to be relevant to their lives and have applications in their lives. By nature, adult education represents a transaction where the learner is involved in all the stages of the teaching-learning process. Since the nature of the GED tests significantly influences this transaction for GED students, it is imperative that their input is used in designing the new GED tests. If the new GED tests that will be in use by the year 2000 focus on this relevance and applications of science, the published GED materials will follow suit. This would enhance the quality of the science education of adults in GED programs.

Implications for Future Research

This research effort uncovered more research needs in the General Educational Development area. Research needs to be conducted on the following topics: the effect of policy on the way programs are run on a daily basis; the effects of different instructional strategies on students' achievement on the GED, their feeling of self-confidence, their interest in pursuing a science-related career, their awareness of science related issues, and their participation in societal decision-making; the effect of different instructional strategies on the achievement and attitude of learning disabled students; the professional development of GED teachers and it's impact on their programs; the effect of enhanced interaction among GED teachers on their programs; and the relevance of GED test items to adult students' lives.

The following is a research agenda geared towards the development of the new GED science test:

January - June 1998: Conduct research exploring the effect of different instructional strategies and materials on GED students' attitudes, understanding, interest, and achievement.

June - December 1998: Conduct focus groups consisting of GED teachers, GED administrators, GED students, secondary school science teachers, secondary school students, college teachers, and representatives from industry to discuss content and strategies for science in GED programs.

1999: Use the findings from the above research to design new GED tests and new professional development programs for GED teachers.

**Summary**

This research effort aimed at documenting different approaches to adult education in GED programs and exploring GED students' attitudes toward science. Figure 5.1 is a diagrammatic representation of the resulting model. The concept that surfaces repeatedly in the data is the issue of relevance. GED students expressed the belief that their understanding of science and interest in it is strongly influenced by their perceptions of its relevance to their lives and to society around them. However, students' perceptions of this relevance appears to be influenced by the instructional approaches used in their programs, the information that they are exposed to in these programs, and the previous exposure they have had to science. The instructional approaches are in turn driven by the nature of the test and the motivation of the individual teachers in leading students toward these understandings. Professional development of GED teachers including increased interaction among these teachers leading to sharing of ideas and resources could be used to influence the outcome of a perception of the relevance of science and consequently greater understanding of and interest in it. In addition, properly designed new GED tests could be used to drive the GED curriculum in that direction.
Figure 5.1: Proposed model for GED science education
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Appendix
Appendix A

Human Subjects Review Consent Form
CONSENT FOR PARTICIPATION IN
SOCIAL AND BEHAVIORAL RESEARCH

I consent to participating in research entitled: Science in the General Educational Development (GED) program: Analyzing the science portion of GED tests and curricula and their influence on adult learners' attitudes toward science.

Dr. A. L. White or his authorized representative (Joya R. Hariharan) has explained the purpose of the study, the procedures to be followed, and the expected duration of my participation. Possible benefits of the study have been described as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Further, I understand that I am free to withdraw consent at any time and to discontinue participation in the study without prejudice to me.

Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ___________________________ Signed: _________________________ (Participant)

Signed: __________________________
      (Dr. A. White/Joya Hariharan)

Witness: __________________________

Form: HS-027
Appendix B

Student Questionnaire (Science)
Student Questionnaire (Science)

Topics

1) Demographic Information
   a) Name
   b) Age
   c) Previous educational background
   d) Work experience
   e) Current position in the program

2) Reasons for enrolling in the program

3) Description of science test and preparation for the science test

4) Positive/negative aspects of the science test/preparation for the test

5) Attitudes toward:
   a) Subject science
   b) Science teaching and learning
   c) Evaluation of science knowledge
   d) Relevance to life
   e) Importance in society
   f) Science-related issues
   g) Scientists and people who use science
   h) Science-related careers
   i) Self-efficacy in the domain of science
   j) Science and citizenship

6) Suggestions for improving the GED science course

7) Future goals and expectations
Questions for Interviews With Students (Science)

1) Demographic information:
   a) Name
   b) Age
   c) What is your educational background? i.e. What prior education did you have before joining the 
      GED program
   d) What is your work experience? i.e. What jobs have you had or do you currently have?
   e) When did you join this GED program? When did you take or when are you planning to take the 
      GED test? Where are you in the program? i.e. For what portions of the GED test have you had 
      preparation?

2) What made you decide to take the GED test? Do you know of other GED programs? Why did 
   you choose this program?

3) Now we'll be talking specifically about the science portion of the GED. 
   Have you seen practice science tests? What do you think about them, i.e. about their content, 
   how easy or difficult, how much and what type of preparation you need for the test? Do you think 
   the tests can be improved, if so how?

4) Have you had any preparation for the GED science test in this program? Could you describe it 
   to me, i.e. what is done to prepare students for the science test? What do you think are the good 
   points and the not-so-good points of this preparation? What do you think can be done to improve 
   the science portion of the GED course?
   What do you think is important for people teaching science to pay attention to? 
   If you were asked to teach science to students like yourself, how would you go about it so that 
   students learn as much as possible, enjoy it, and feel confident?

5) Now I'm going to ask you some questions about your feelings towards various aspects of 
   science.
   a) If I asked you what do you think Science is, or explain the word “Science” to someone who 
      knows nothing about it, what would you say? 
      What do you feel about science, do you like it, dislike it, or are you neutral towards it? 
      What makes science different from other subjects? For example, literature or history? 
      When you think about the field of science, what topics or ideas come to mind?
   b) What are some of the important things in your life? What are some of the important things 
      about this GED program? 
      Do you think science is important? Why? How important do you think science is to society in 
      general? Does science have practical applications in society? If yes, can you name some? 
      How important is science to you in your daily life? Do you use any science in your daily life? If 
      yes, can you give me some examples. Do you find any of the science you learn here in your GED 
      preparation useful in your life? Do you think the science you learn here is relevant to you?
   c) I'd like you to think back to your school days. What do you remember most about school? 
      What classes do you remember? 
      Do you remember any of your feelings about science and science-related activities when you 
      were in the elementary grades or in middle school?
What did you feel about science tests when you were in the elementary grades or in middle school? What did you feel about science tests when you were in high school? What do you think of the science you learned in high school? Did you like or dislike science in school? Do you think that what you learned in science in school is important? Why? Is it important in your life? How?
Can you recall one particular experience that stands out in your memory, maybe a lecture, a lab, a demonstration, or an activity that you did or saw? What were your feelings at that time?

d) What do you like to do in your free time? Tell me about some science activities that you have done outside of school (such as museum visits, science fairs, etc.)? What are some other ways that you have learned science or done science outside of school? Did you learn any science at work, at any of your jobs?

e) I would like you to think back to when you were a child. What are some of the things you remember doing as a child? Do you remember doing any science-related activities as a child at home? Did you visit science museums when you were a child? What did your parents or other people at home think about science when you were a child? What do they feel about science now?
When you were little, you must have asked questions about how things work or related questions. Who did you ask these questions to? Do you remember anything about the explanations given to you when you asked such questions?
What would your parents or other people at home feel or have felt about you pursuing a science-related career?

f) Are you interested in reading, or watching TV, or listening to the radio? What topics do you like to read about or watch or listen to?
Are you interested in hearing or reading about science-related issues in the media, such as in books, newspapers or on TV. Can you name some science-related issues that you have read or heard about? (global warming, pollution control, acid rain, genetic engineering) Can you tell me something about it? Do you discuss these issues with anyone? If yes, with whom do you discuss them? Recently there has been a lot of talk about cloning. Are you aware of it, if yes, what are your views about it?
Do you learn about any of these issues in the science preparation you get here for the GED? Can you name some scientific discoveries/inventions that are important. What is important about them? Can you name any scientists?
What do you feel about taxpayers paying the money needed to do scientific research?

g) If I ask you to picture a scientist, what comes to mind? Do you think scientists are similar or different from other people such as you or me? If different, why are they so? What attributes or qualities do you think a scientist should have?

h) What career would you choose if you could do anything you wanted to? Why? Do you think science would be a part of this career?
Can you name some science-related careers? What do you think about yourself pursuing a science-related career? If you are, why did you choose this career and what do you feel about it? If not, why not?

i) What do you think of your ability to do science-related work? How easy or how difficult would you think that would be? How do you think you would like it?
How do you know when you are doing or using science. If I asked you to picture somebody doing or using science, what comes to mind? What qualities do you think a person needs to have in order to do or use science?
j) What knowledge or attitudes do you think a person needs to have to be a good citizen? Do you think that learning about science can help you be a better citizen? If yes, how? Do you think the science you learn here in the GED program can help you be a better citizen? If yes, how? Do you think that learning about science can help you when you have to vote on different issues? If yes, can you give me an example. Do you think any of the science you learn here in the GED program can help you vote on different issues? If yes, can you give me an example.

6) How do you feel about taking science tests in general? How do you feel about taking the GED science test?

7) Finally, one last question, what are your plans for the future, educationally or career-wise?
Appendix C

Student Questionnaire (Non-Science)
Student Questionnaire (Non-Science)

Topics

1) Demographic Information
   a) Name
   b) Age
   c) Previous educational background
   d) Work experience
   e) Current position in the program

2) Reasons for enrolling in the program

3) Attitudes towards:
   a) Subject science
   b) Science teaching and learning
   c) Evaluation of science knowledge
   d) Relevance to life
   e) Importance in society
   f) Science-related issues
   g) Scientists and people who use science
   h) Science-related careers
   i) Self-efficacy in the domain of science
   h) Science and citizenship

4) Future goals and aspirations
Questions for Interviews With Students (Non-Science)

1) Demographic information

a) Name

b) Age

c) What is your educational background? i.e. what prior education did you have before joining the GED program?

d) What is your work experience? i.e. What jobs have you had or do you currently have?

e) When did you join this GED program? When are you planning on taking the GED test? For what portions of the GED test have you had preparation?

2) What made you decide to take the GED test? Do you know of other GED programs? Why did you choose this particular program?

3) Have you seen any GED science practice tests? If yes, what do you think about it? Is it easy or difficult? How much and what type of preparation do you think you need for the GED science test?

4) Have you had any preparation for the science portion of the GED test in this program?

5) What do you think is important for people teaching science to pay attention to? If you were asked to teach science to students like yourself, how would you go about it so that students learn as much as possible, enjoy it, and feel confident about it?

6) Now I'm going to ask you some questions about your feelings towards various aspects of Science.

a) If I asked you what do you think Science is, or explain the word "science" to someone who knows nothing about it, what would you say? What do you feel about science, do you like it, dislike it, or are you neutral towards it? What makes science different from other subjects? For example, literature or history? When you think about the field of science, what topics or ideas come to mind?

b) What are the most important things in your life? What are the most important things about this GED program? Do you think science is important? Why? How important do you think science is to society in general? Does science have practical applications in society? If yes, can you name some? How important is science to you in your daily life? Why? Do you use any science in your daily life? if yes, can you give me some examples.

c) I'd like you to think back to your school days. What do you remember most about school? What classes do you remember? Do you remember any of your feelings about science and science-related activities when you were in the elementary grades and in middle-school? What did you feel about science tests when you were in the elementary grades or in middle school? What did you feel about science tests when you were in high school? What do you think of the science you learned in high school? Did you like or dislike science in school? Do you think what you learned in science in school is important? Is it important in your life?
Can you recall one particular experience that stands out in your memory, maybe a lecture, a lab, a demonstration, or an activity that you did or saw? What were your feelings at that time?

d) What do you like to do in your free time? Tell me about some science activities that you have done outside of school (such as museum visits, science fairs, etc.)? What are some other ways that you have learned science or done science outside of school? Did you learn any science at work, at any of your jobs?

e) I would like you to think back to when you were a child. What are some of the things you remember doing as a child? Do you remember doing any science-related activities as a child at home? Did you visit science museums when you were a child? What did your parents or other people at your home think about science when you were a child? What do they feel about science now? When you were little, you must have asked questions about how things work or related questions. Who did you ask these questions to? Do you remember anything about the explanations given to you when you asked such questions? What would your parents or other people at your home feel or have felt about you pursuing a science-related career?

f) Are you interested in reading, or watching TV, or listening to the radio? What topics are you interested in reading about or watching or listening? Are you interested in hearing or reading about science-related issues in the media, such as in books, newspapers or on TV. Can you name some science-related issues that you have read or heard about? (global warming, pollution control, acid rain, genetic engineering) Tell me something about it. Do you discuss these issues with anyone? If yes, with whom do you discuss them? Recently there has been a lot of talk about cloning. Are you aware of it, if yes, what are your views about it? Can you name some scientific discoveries/inventions that are important, What is important about them? Can you name any scientists? What do you feel about taxpayers paying the money needed to do scientific research?

g) If I ask you to picture a scientist, what comes to mind? Do you think scientists are similar or different from other people such as you or me? If different, why are they so? What attributes or qualities do you think a scientist should have?

h) What career would you choose if you could do anything you wanted to? Why? Do you think science would be a part of this career? Can you name some science-related careers? What do you think about yourself pursuing a science-related career? If you are, why did you choose this career and what do you feel about it? If not, why not?

i) What do you think of your ability to do science-related work? How easy or how difficult would you think that would be? How do you think you would like it? How do you know when you are doing or using science. If I asked you to picture somebody doing or using science, what comes to mind? What qualities do you think a person needs to have in order to do or use science?

j) What knowledge or attitudes do you think a person needs to have to be a good citizen? Do you think that learning about science can help you be a better citizen? If yes, how? Do you think that learning about science can help you when you have to vote on different issues? If yes, give me an example.
7) How do you feel about taking science tests in general? How do you feel about taking the GED science test?

8) Finally, one last question, what are your plans for the future, educationally or career-wise?
Appendix D

Teacher Questionnaire
Teacher Questionnaire

Topics:

1) Demographic Information:
   a) Name
   b) Teaching Experience including number of years teaching GED courses

2) Reasons for students entering the GED program

3) Description of the science test (content & format). Positive/negative aspects of the test. How it can be improved. Students' perceptions of the test. Teacher training for new tests.

4) Preparation done for the science tests. Students' perceptions of this preparation. Ways preparation can be improved

5) Direct effect of preparation and tests on students lives

6) Student attitudes to science.
   a) Attitudes to science in general. Reasons. Gender issues
   b) How traditional schooling, work-experiences, or home environment have influenced these attitudes.
   c) Student attitudes towards relevance of science to life and importance in society
   d) Students awareness of science-related issues, scientific discoveries, scientists
   e) Students' self-efficacy in the domain of science

6) Interaction with other GED teachers

7) Professional Development opportunities

8) Perceptions of scientific literacy

9) Perceptions of secondary science education reform efforts
Questions for Interviews With Teachers

1) Demographic Information:
   a) Name
   b) What teaching experience do you have?

2) What would you say are the reasons that students are taking the GED tests or are enrolled in this program? Do students know of other GED programs? Would you know why they chose this program?

3) What are your perceptions of the GED science test (it's content, format, and purpose)? What do you think of the format of the test as far as students with learning disabilities are concerned? What do you think are the objectives of the GED science test? What skills do you think the test promotes? Do the tests correspond to their stated purpose (critical thinking, reasoning skills, problem solving)? Which aspects of the test do you like? Why? Which aspects of the test do you not like that much? Why? What do your students feel about the science test? Do you have any suggestions for improving the tests (including suggestions for the objectives and lasting outcomes of the test)? If you were asked to design the GED science test, what would be some of the significant features? As I have mentioned, the GEDTS in Washington D.C. plans on coming out with new GED tests in the year 2000. What are your feelings on this matter? How would this affect you and your students? What do you feel should be the objectives of any new tests?

4) How do you determine what sort of preparation the students need for the GED science test? Do you assess learning disabilities when students enter the program? What strategies do you use with learning disabled students? How do you prepare your students for the GED science tests? What do your students feel about the preparation they receive for the science test? If you were asked to single-handedly design a GED program for these students (i.e. you make all the decisions), with no real constraints of time and resources, what would be some of the significant features of such a course? What would be some significant features of the science portion of such a program? Do you think more hands-on science activities would be beneficial to these students? Do you think more direct instruction would be beneficial? Do you think group-work would be beneficial? Do you think field trips would be beneficial?

5) What impact do you think the GED science tests and preparation for these tests have on students' lives (short-term or lasting effects)? Do you think that the science test or preparation for the test is relevant to students' lives?

6) Now we are going to focus on students' attitudes towards science.
   a) What do you think your students feel about science in general? Do you have any ideas on what causes or influences these attitudes? How do you think their traditional schooling experience or work experience has influenced these attitudes? Do you think their home environment or family has anything to do with their attitudes toward science? What do they feel about the relevance of science to their daily lives or it's importance to society in general? Do you think there are any gender differences in student attitudes towards science?
b) How aware do you think your students are about science-related issues in society? Does the science preparation they get here address any science or environmental issues? How aware are they of scientific discoveries and scientists? How do you think your students perceive scientists (are they normal people or are they different in some way)? Do you know of any science-related activities that your students engage in? Do your students talk to you or to other students about educational activities that they engage in outside the program?

c) What do you think is the possibility of these students pursuing science-related careers? (percentage)? What careers do you think they would pursue?

d) How would you describe your students feelings about operating in the domain of science? Do they have feelings of self-efficacy or would they think they could not or would not want to?

e) How would you describe your students feelings towards being tested in science in general? How would you describe your students feelings towards the science GED test?

f) Do you think that the science preparation that students get for the GED can help them become better citizens? Can it help them better exercise their democratic rights, e.g. voting on different issues?

7) What is your perception of the term "scientific literacy"?

8) There is a lot of emphasis on reform right now in secondary science education. What are your perceptions of the current reform efforts?

9) Do you have any interaction with other GED teachers (at the same site or at different sites)? Do you discuss problems, resources, or strategies with other GED teachers? If yes, what do you feel about such interactions? If not, would you like to have such interaction with other GED teachers?

10) Do you have access to opportunities for professional development, such as workshops etc.? Do you have any ideas on resources or opportunities that can be made available to you that would help you in your work?