Experimental evaluation of an environmental conservation technology instructional unit

Linda Susan Whent
Iowa State University

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Experimental evaluation of an environmental conservation technology instructional unit

Whent, Linda Susan, Ph.D.

Iowa State University, 1990
Experimental evaluation of an environmental conservation technology instructional unit

by

Linda Susan Whent

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

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For the Graduate College

Iowa State University
Ames, Iowa

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Throughout modern history, national security has meant safeguarding our homeland from military threats. But increasingly, environmental concerns are fostering regional tensions and threatening stability between neighbors. Water supply arguments between nations and between states within the United States have caused increasing tensions. Fear of ozone depletion and global warming are receiving world attention (Satchell, 1989). New global environmental coalitions are replacing the old adversarial military alliances which could lay the foundation for a more cooperative and secure world. "Americans are more concerned than ever about the quality of their lives. We've come to expect the highest possible standard of well-being for ourselves and our children, and any threat to that well-being, real or imagined, evokes a strong response" (Barrick, 1989, p. 1). However, many conservationists are alarmed by the lack of public awareness concerning ecological imbalance and human impact on the environment. As a nation enjoying one of the highest standards of living in the world, and as one that has generated many life-saving and labor-saving devices, the lack of action to prevent the destruction of natural resources and the vast disruption of the environment is indeed ironic. If there is to be a change in public awareness of and commitment to ecological balance, there must be movements toward changing public values and positive decision-making by the public concerning conservation issues (Allison & Carrington, 1980).

In agriculture production, the 1970s were seen as a time of prosperity and expansion of the use of land. The 1980s were seen as the time of recession, where farmers increased the use of chemical-intensive practices to get the most out of their land often with disregard
for soil conservation and ground water quality. Recent economic and environmental issues have raised many questions as to the validity of continually improving and expanding "conventional" farming practices. Some suggest a "revolutionary" approach under the banner of sustainable agriculture rather than current production systems. A primary force behind the alternative farming movement is agriculture's role in non-point sources of pollution of groundwater. It has been argued that modern, intensive farming methods cause increased erosion that cannot be sustained at current production levels. A new vision for agricultural production is that the 1990s will be the decade of the environment (Barrick, 1989).

The issue of environmental conservation has received much publicity on Capitol Hill. U.S. Senator Wyche Fowler proposed a farm bill last year that aimed at curtailing the use of agricultural chemicals, regardless of the result in terms of production of food and fiber (Ferguson, 1990). Tennessee Senator Albert Gore, introduced a legislative package he called the Strategic Environment Initiative (SEI). Nationally, this bill focused on transportation efficiency, alternate fuel sources, reforestation, recycling and reduction of ozone-depleting chemicals. Internationally, the bill was designed to help Third World nations obtain energy-efficient technology, develop environmentally sustainable industries and agriculture, and promote high-yield, low-tech farming on marginal land (Satchell, 1989). U.S. elder statesman, George Kennan stated "The greatest and most important of these (issues for cooperation between the two superpowers), without question, is that of environmental protection and improvement on a planetary scale" (Satchell, 1989, p. 52).

Research by the American Farmland Trust indicated that a majority of farmers around the country were using many of the practices implied by sustainable agriculture. Research by Paul Lasley, rural sociologist at Iowa State University, indicated similar farming patterns in
Iowa. Lasley stated, "Farmers are doing a lot of things to reduce their input use" (Pins, 1990, p. 2J).

Many believe the future of sustainable agriculture hinges on the development of new technologies. Dr. Will D. Carpenter, Vice President for Technology, Monsanto, stated "We have progressed to a point where widespread famine has been avoided—mostly through the discovery and acceptance of beneficial new technologies" (Ferguson, 1990, p. 16). Walter Fehr (1989), Professor of Agronomy at Iowa State University, said he believes that "Biotechnology and sustainable agriculture are essential for each other." He went on to say that "Biotechnology and sustainable agriculture cannot work independently of each other. If we do, alternative management systems will not progress through the application of new knowledge in the biological sciences" (Fehr, 1989, p. 2). Carpenter stated that bioengineering will yield plants that can grow in salty soils, have higher resistance to heat or cold, diseases, pests and drought, and/or have increased nutritional content, lower saturated fats and better taste. He said that "The greatest obstacle to the development of commercial biotechnology products is public ignorance, suspicion and fear" and that "education is the key" to changing these perceptions. Humankind is not effectively served by running from technology nor by blindly attacking it, but rather, by each of us committing to effective education of ourselves and those around us (Ferguson, 1990, p. 17). An independent crop consultant, Dan Bradshaw stated "there are no easy answers; not black and white when dealing with crop production, environmental issues, farm economics and food safety. It is a matter of balance and reason" (Ferguson, 1990, p. 17). He went on to say "We must build today for a better agriculture tomorrow" (Ferguson, 1990, p. 17). "Continued incremental growth and even quantum advances are within our grasp, but not without some real educational efforts" (Ferguson, 1990, p. 17).
Stanbury and Coulter (1986) advocated that the U.S. food and agricultural system rests on two vital bases—natural resources, and science and technology. Bentley (1986) suggested that there is a great concern about the adequacy of the United States natural resources base to sustain continued expansion of the agricultural industry. He further stated that Americans often take their relationship with the environment for granted.

The 1985 Food Security Act addressed the need for a national policy on soil conservation. Regulations within the 1985 Farm Bill require farmers to protect their land against erosion in order to remain eligible for farm program benefits. Degeneration of water resources is also a major issue facing society. Iowa formulated state legislation to address groundwater problems in 1987. National and state policies focusing on soil and water issues reveal the need for expanded conservation education initiatives. Aldo Leopold (1960), a noted Iowa conservationist, believed that natural resources are to be loved and respected as an extension of ethics. However, the relationship between people and natural resources is commonly economic, entailing privileges but not obligations. This attitude must be changed before a sustainable agriculture can become a reality.

Bentley (1986) stated that the importance of natural resource education grows steadily with each passing year. The shifting demands of agriculture, industry, recreation, and residential needs are creating changes in land and water use. Current and future agricultural workers must have the ability to properly manage and conserve natural resources in order to maintain their usefulness (Dik, 1986). Loomis (1986), a State Conservationist with the U.S. Soil Conservation Service, advocated that vocational agriculture has a major role to play in providing education related to the mix of new technology related to natural resources. A national study in agriculture education conducted by the National Academy of Sciences, recommended that "new curriculum components must be developed and made available to
teachers addressing the sciences basic to agriculture, food, and natural resources" (Aldrich et al., 1988, p. 35).

Educators have been handed a major share of the environmental conservation educational process, which must be accomplished. Environmental education within the educational system has been seen by individuals as a science of survival, of social values change, and a common sense "need to know" subject for everyone. Nationwide, educators have begun to approach the problem (Allison & Carrington, 1980).

With the present natural resources concerns, new legislation related to natural resources, and public skepticism about new technologies, the time is right and the need is eminent for the expansion of agricultural education on environmental issues. However, most vocational agriculture programs in the Midwest do not include programmatic units of instruction in environmental conservation. Educational offerings are necessary to provide an orientation to and development of skills and knowledge in environmental conservation needed by people in agriculture. Such instruction should be designed to build upon existing environmental conservation abilities and skills possessed by high school agricultural students (Whent & Williams, 1988).

It has been a challenge for educators in vocational agriculture to keep the curriculum modern and up-to-date. More flexibility in curriculum, program design, and the requirements and activities of the FFA are essential (Aldrich et al., 1988). In general, agricultural education programs in high schools have changed little over the past decade. Such programs focus student learning on a rather limited and generally shrinking employment area of the agricultural industry, primarily production agriculture. Narrowly focused programs often give students an unrealistic view of agricultural job prospects, while failing to introduce them to other career opportunities in the agricultural sector (Aldrich et al., 1988).
Educational programs throughout the nation have been experiencing some crises. College entrance test scores, standardized basic achievement test scores, and other indicators of educational achievement suggest that students have not performed as well as educators and the general public would like. Educators have been forced to take a hard look at the quality of education in this country and to determine what measures must be taken to achieve educational excellence (Passow, 1984).

During this time of educational renaissance, new efforts are needed to reform secondary school agriculture programs and curricula to better prepare agriculture students for a wider sector of the agriculture employment market. An essential step toward achieving this goal is the development of an agricultural education curriculum which will instill higher environmental values in students, introduce them to broader agricultural career opportunities, as well as challenge them with contemporary agricultural science and technology.

Statement of the Problem

A 1987 survey of the Iowa vocational agriculture students (Whent & Williams, 1988) indicated that students' attitudes toward conservation of natural resources were less than desirable. To address this problem, an environmental conservation technology instructional unit was developed to improve student knowledge of and attitudes toward the environment, including conservation of soil, water, wildlife, and forest resources. The instructional unit attempted to capitalize on new technologies as an interest approach to learning about conservation.

The development of a curriculum to meet the changing needs of students and society, is not an end in itself, but part of a continuing process. The need for extensive evaluation of the curriculum is an important step in this continuum. Ralph Tyler (1949, p. 105) advocated
that "... many variables make it impossible to guarantee that the actual learning experiences provided are precisely those that are outlined in the learning units." Tyler went on to say that "it is important to make a more inclusive check as to whether these plans for experiences actually function to guide the teacher in producing the sort of outcomes desired." Evaluation is the process for finding out whether the curriculum is actually producing the desired results. Evaluation, if designed adequately, will identify strengths and weaknesses within the curriculum. "As a result of evaluation, it is possible to note in what respects the curriculum is effective and in what respects it needs improvement" (Tyler, 1949, p. 105).

The problem, then, with which this study was concerned was how effective the "environmental conservation technology instructional unit" was as a means of developing student knowledge about and attitudes toward natural resources.

Purpose of Study

The purpose of this study was to evaluate the impact of an environmental conservation technology instructional unit and in-service program on the attitudes and knowledge of students. The specific objectives of the study were:

1. To determine the effectiveness of an instructional unit as measured by:
   a. student knowledge of environmental conservation technology;
   b. student attitude toward natural resources conservation;
   c. teacher attitude toward natural resources conservation; and
   d. teacher attitude toward teaching environmental conservation technology.

2. Identify student variables that contribute to student success in developing knowledge of and changing attitudes toward environmental conservation technology.
3. Identify teacher characteristic and situational variables that predict student success in developing knowledge of environmental conservation technology.

4. Identify teacher characteristic and situational variables that predict teacher attitudes towards natural resources and teaching natural resources.

5. Teacher formative identification of needed improvements and modifications of the instructional materials.

**Null Hypotheses**

There is no significant difference (alpha = .05) between the experimental and control groups as to:

1. student knowledge of environmental conservation,
2. student attitudes toward natural resources,
3. teacher attitudes toward natural resources, and
4. teacher attitudes towards teaching environmental conservation technology.

**Project Background and Need for Study**

With the impact of *Understanding Agriculture: New Directions for Education* still ringing in educators' ears, the movement to reform traditional vocational agriculture programs throughout the country is well underway. Iowa is on the cutting edge of this educational reform. Agricultural education in Iowa recently adopted a five-year plan designed to improve vocational and technical education at all levels of agricultural education. The new agricultural program, implemented in 1988, is known as "Agriculture Science, Technology, and Marketing." This program recognizes that agricultural education programs in Iowa must move from a narrow, production agriculture emphasis to a contemporary
curriculum in order to prepare students for diverse careers in the changing agricultural industry. The Agriculture Science and Technology Program is based on the incorporation of technology and science into the agriculture curriculum. It builds upon the philosophic principles of vocational agriculture which include: learning by doing, leadership and personal skill development, experiential learning, problem-solving, and decision-making. The new program focuses on broadening students' knowledge of basic agricultural functions and systems, incorporating a global perspective into agriculture courses, and infusing modern technologies into the curriculum. Thus, introducing and preparing students for dynamic agricultural careers (Williams, 1988).

Recognizing the need to focus curriculum reform on environmental issues impacting agriculture, the Agricultural Education and Studies Department at Iowa State University entered into a partnership with the Soil Conservation Service to expand the teaching of conservation and natural resources in Iowa's public schools. This study contributed to the mission of the partnership by testing curriculum materials developed earlier in the research and development program. Two studies were conducted to provide a benchmark for curriculum materials development. The first study (Whent & Williams, 1988) surveyed Iowa secondary school agriculture students and teachers. The study revealed that Iowa high school students were "undecided" or only "slightly agreed" with the following statements:

1. nature replaces top soil slowly,
2. the majority of soil conservation practices are costly,
3. soil erosion harms wildlife,
4. laws are necessary to reduce soil erosion,
5. soil erosion pollutes water,
6. highly erodible land should be retired from crop production,
7. help in planning a conservation system is expensive to farmers, and
most farmers manage the application of agricultural chemicals to prevent water pollution.

An even more appalling finding was that no significant differences existed between high school freshmen and seniors in attitudes toward natural resources and conservation. The need for a comprehensive natural resources technology education initiative was revealed again in a second study by Andrews (1989), investigating the attitudes of selected Iowa farm operators toward soil and water conservation. The findings of this study indicated that farmers agree on the following points: (1) soil erosion is a problem, (2) maintaining water quality is a public concern, (3) more education on natural resources and conservation is needed, (4) strict water quality standards are needed, and (5) groundwater contamination threatens the quality of rural water. However, farmers were undecided on the following issues: (1) laws are necessary to reduce soil erosion, (2) the majority of soil conservation practices are costly, (3) most farmers manage the application of agricultural chemicals to prevent water pollution, (4) strict soil conservation standards are necessary, and (5) farmers will use soil conservation practices without being forced by the government.

Findings from both studies suggested a void in Iowa's formal educational system with regards to instruction on environmental conservation as related to agriculture. These studies helped identify conservation and natural resources principles that should be taught. During the 1988-1989 academic school year, an instructional unit on environmental conservation using technology as an interest approach to learning was developed by the researcher and project staff. The third phase of the project was the field-testing and evaluation of the instructional materials, which served as the purpose of this study. The instructional materials were modified as a the result of the evaluation.

In the past, Iowa schools have not included a natural resources technology focus in the agriculture curriculum. Our present farm economy, environmental concerns and new legislation related to natural resources strongly warranted a change in the curriculum. It is
essential that conservation education, if it is to be effective, be delivered in a multidisciplinary approach, addressing broad environmental problems and agricultural practices. National and state policies focusing on soil and water issues reveal the need for expanded conservation education initiatives.

The best educators of the adult population is, in all probability, the children. A more dramatic effect of a positive environmental education program is the education of tomorrow's citizens. It is not enough to concentrate values training and decision-making skills on legislators, engineer, scientists, and producers. The purpose of the instructional materials tested in this study was to instill environmental conservation ethics and values in the farmers and agricultural leaders of tomorrow. The key to a stable environment will lie with an educated public who will support environmentally sound decisions (Allison & Carrington, 1980).

Definition of Terms

Terms used in this study which may be ambiguous to the reader are defined as follows:

1. Agriculture Science Technology and Marketing (ASTM): ASTM is the term used to describe agricultural education in Iowa secondary schools. This term may be used in reference to teachers, students, and departments. "Vocational agriculture" and "agricultural education" are terms used in other states to describe such programs.

2. Conservation technology: refers to innovations and technologies used to manage and conserve natural resources. The main technology addressed in the instructional unit was biotechnology and its uses in environmental conservation.
3. Environmental Conservation Technology Instructional Unit: refers to a collection of printed materials which include teaching objectives, methods, activities, and informational materials that were evaluated in this study. The instructional unit was developed for use by secondary teachers of vocational agriculture. The materials focused on technology with an emphasis on biotechnology as a vehicle to stimulate student learning and career awareness related to conservation of natural resources.

4. FFA: a national organization for students enrolled in agricultural education/agribusiness. The FFA was organized in 1928 and is an integral part of the curriculum of agricultural education/agribusiness departments in public schools. Through active participation in the FFA, members learn by taking part in and conducting meetings, speaking in public, participating in contests, earning awards and recognition, and becoming involved in cooperative efforts and community improvement (FFA Manual, 1987).

5. Objective-Referenced Test: a test designed to measure mastery of learning objectives over specific instructional materials. The tasks selected are those which the instructional unit emphasizes. The items used in the test match the set of learner behaviors called for in the instructional objectives. Such a test can be a sensitive measure of what has been taught (McNeil, 1985).

6. Sustainable Agriculture: "... the appropriate use of crop and livestock systems and agricultural inputs supporting those activities which maintain economic and social viability while preserving the high productivity and quality of Iowa's land" (The Leopold Center for Sustainable Agriculture, 1989).

7. School: Iowa high schools in which the experiment was conducted. The term may also be used to represent the ASTM program or ASTM class that participated in the study.

8. Supervised Agricultural Experience (SAE): one of the three main components in the Agricultural Science and Technology program. It is a unique experimental learning program
which allows students to take the knowledge and skills learned in the classroom and apply them in an actual hands-on agricultural learning situation (Martin et al., 1987).
CHAPTER II.

REVIEW OF LITERATURE

Education, broadly defined, is the process of changing the behavior of people. To this end, volumes of curriculum materials have been developed and disseminated through countless educational programs to assist teachers in this change process. However, in rare cases have these resource materials been tested to determine their effectiveness in the teaching-learning process. Too often, materials have been developed and disseminated on the basis that they ought to do a better job, without evidence that they in fact do a better job (McCormick & Cox, 1988).

This chapter presents the theoretical framework for the study. Authors and researchers have written extensively on instructional materials including development, evaluation, in-service, and use of curriculum materials in teaching. Relevant literature was also reviewed in the areas of student interest and motivation to learn, and agriculture, biotechnology, and natural resources education.

Curriculum Materials Development

The underlying philosophy of the environmental conservation technology instructional unit evaluated in this study followed the social reconstructionists' conceptions of curriculum. Social reconstructionists are interested in the relation between curriculum and social, political, and economic development of society. Theodore Brameld (1956) outlined the distinctive features of social reconstructionism. First, he believed in a commitment to building a new culture, second, he believed that working people should control all principal
institutions and resources, and third, that the school should help the individual develop socially and learn how to participate in social planning. The primary purpose of the social reconstructionist curriculum is to confront the learner with the many severe problems that humankind faces. These problems are not the exclusive concern of 'social studies' but of every discipline (McNeil, 1985). Optimistic social reconstructionists are convinced that education can effect social change; for example, a curriculum aimed at raising social consciences about environmental concerns. Pessimists, on the other hand, doubt the ability of the curriculum to change existing social attitudes and behavior. But, both optimists and pessimists want curriculum that challenges creative thought and looks at alternate ways of accomplishing missions. They want learners to understand how the curriculum is used to define society (McNeil, 1985).

It was the intent of the instructional unit to increase student knowledge of technologies that could be used to help conserve natural resources; to create an awareness of environmental issues and develop positive student attitudes toward natural resources conservation; and to present conservation issues and encourage students to make decisions.

When discussing the development and evaluation of curriculum, it may first be useful to look at past and current philosophies in curriculum design. McNeil (1985), in a comparison of traditional and new criteria for the development and evaluation of curriculum materials, argued that former approaches involved art and politics more than technology. Curriculum development and evaluation has been a search for some general value—an important idea, problem or skill around which content activities could be organized. He advocated that newer criteria for technological curriculum making and field-testing have only recently been accepted as guides to practice. These new criteria suggest that the curriculum development and evaluation procedures should be reviewed and validated by other
developers. They should be able to be replicated and the products of replications should produce similar results. The central thrust of the revolution in curriculum is the belief that instructional materials, when used by learners for whom the materials were intended, should produce specified learner competencies. This rationale is an improvement over the old belief that curriculum materials are merely resources that may or may not be useful in an instructional situation. The two different criteria for judging instructional materials are presented in Table 1.

Table 1. Comparison of criteria for selection of instructional materials (McNeil, 1985, p. 49)

<table>
<thead>
<tr>
<th>Old Criteria</th>
<th>New Criteria</th>
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<tbody>
<tr>
<td>Do authors have professional reputations?</td>
<td>Where and how extensively have materials been tried out?</td>
</tr>
<tr>
<td>Are materials based on sound pedagogical principles? Are they consistent with</td>
<td>Is information available about the number of students who started and completed the materials?</td>
</tr>
<tr>
<td>established suggestions for instruction and practice? Will the content</td>
<td>Does the information say how much time learners of different ability spent on portions of the material and give differential results?</td>
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<tr>
<td>broaden the children/s view of the world?</td>
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</tr>
<tr>
<td>Are selections arranged by level to satisfy the needs and interests of</td>
<td>Do the materials specify intended-learner characteristics, including enumeration of prerequisites? Does the art contribute to affective learning?</td>
</tr>
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<td>children as they mature? Is the art imaginative and appealing?</td>
<td></td>
</tr>
<tr>
<td>Are type faces and sizes, lengths of lines, and space between lines</td>
<td>Are materials being revised to reflect trial results? How are student responses used in revising the material?</td>
</tr>
<tr>
<td>appropriate for the maturity of the children at each level?</td>
<td></td>
</tr>
<tr>
<td>Do materials use high quality paper, clear print, and sturdy binding?</td>
<td>How effectively do students learn specified skills? Do appropriate criterion-referenced tests show student gains?</td>
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No longer is the reputation of the developers and face validity of the materials enough. More demand is now placed on whether instructional materials have been field tested, their usability and value in creating desired results, and the rigor under which they are evaluated (e.g., the research design and the reliability of the instruments that are measuring the change in skills and knowledge) (McNeil, 1985).

The vocational education amendments of 1968 called for the development of standards for curriculum development and the development, dissemination, and evaluation of vocational-technical education curriculum materials (United States Department of Health, Education, and Welfare, 1969). Ridenour (1965, p. 31) identified the need for curriculum material development from a practical perspective when he wrote:

Because of the limitations of time, teacher ability, and the infeasibility of one person becoming proficient in so many specialized subject matter areas, there has long been a recognized need for providing help to teachers in the form of instructional materials. . . (to) eliminate the wasted duplication of search time for instructional materials by teachers.

Yet, with this wave of curriculum development, many wondered if the vast supply of instructional materials were being adopted by teachers. Several studies were initiated to assess the degree in which teachers used instructional materials. A study by Dillon and Blezek (1978) indicated that 98 percent of Nebraska vocational agriculture instructors used prepared teacher core curriculum materials, and 75 percent used study materials to some extent in their programs. Curry and Cheek (1982) reported that 75 percent of the respondents surveyed had used the nursery operations instructional materials prepared in their state. McGhee and Cheek (1985), in a Florida study, found that approximately 70 percent of the fundamental competencies in agricultural mechanics were being taught by 50 percent of the teachers. Kotrlik, Parton, and Lelle (1986), in a study to evaluate the Vocational Agriculture II curriculum in Louisiana, found that 71.8% of the topics in the basic curriculum were being taught. These observations suggest that there is a demand for
curriculum materials and teachers do use instructional units when they fit or can be modified to fit their curriculum objectives.

Research efforts regarding the form of curriculum materials most desired by teachers yielded mixed results. Householder, McGhee, and Roediger (1976) found that teachers preferred instructional materials from which to teach rather than instructional guides for planning. In contrast, Drawbaugh (1971) concluded that teachers preferred instruction guides rather than job sheets, work sheets, manuals, and workbooks. In 1976, Tillman surveyed Virginia vocational agriculture teachers to determine their perceptions of instructional materials which were developed and disseminated by the Agricultural Education Program at Virginia Polytechnic Institute and State University. Tillman determined that teachers desired instructional materials containing transparency masters, student workbooks, tear-out pages, and teachers' keys. Hilton (1975) surveyed Pennsylvania vocational agriculture teachers to identify their attitudes toward selected instructional materials. He found that: (1) teachers selected units based on the content and method of presentation, (2) teachers want complete units with teaching-learning activities, and (3) teachers desired dissemination on a direct, one-to-one basis or through a workshop setting. Howard and Yoder (1987), using a posttest-only control group design, found no significant differences between the effect of microcomputer-assisted instruction and the lecture-discussion technique of delivering instruction to ninth grade agriculture students in Pennsylvania. Birkenholz, McCaskey, Stewart, and Ogle (1987) used a posttest-only comparison group design to assess the effects of utilizing microcomputer-enhanced strategies in teaching secondary agriculture students. Findings indicated that there was no difference in student achievement between the microcomputer-enhanced teaching strategies compared with each other or a lecture/discussion teaching strategy.
Research studies have also addressed the effectiveness of various media used in the educational process. An experimental study conducted by Warfel (1976), comparing the use of lecture-filmstrip versus lecture-demonstration instructional methods found no difference between groups. Kahler (1970) used an experimental design to evaluate eight instructional techniques in Iowa. He found no difference in student achievement due the instructional methods used. Birkenholz (1982) found that curriculum guides and core curricula are forms of instructional materials which have been developed and used by vocational agriculture teachers. Zikmund (1971) found no differences in aspirations, understanding, or attitudes of Nebraska students when presented with a slide/tape media of instruction. In 1981, McCully completed a study to compare independent study to group study methods in Mississippi agriculture programs. A pretest-posttest control group design was used. The population consisted of 16 schools having vocational agriculture departments. McCully reported no significant difference between the independent study and lecture-discussion method. No significant difference was found between student and teacher opinions toward the instructional methods used in testing the approaches to learning. Richards and Reneau (1983) found no difference in the cognitive achievement of students using slide/tape media and those students taught using printed material/lecture. Scanlon and Newcomb (1983) reported that task instruction sheets help contribute to greater student achievement by organizing and structuring both the laboratory and classroom portions of a poinsettia unit. Generally, teachers felt that task instruction sheets helped make the job of teaching easier, created minimal additional work, and provided accurate information for growing a crop of poinsettias. Conclusions from these studies indicated that method of instruction is not a significant factor in student learning. However, teachers should be prepared to vary their instructional techniques to provide a wider range of learning environments in which student learning can occur. In a study of learning style variations among vocational agriculture
students, Cox, Kendall, and Sproles (1988), recommended that teachers consider incorporating additional hands-on, experiential, and actual performance activities into the first two years of instruction. Teachers should also consider incorporating additional informational lessons and multifaceted teaching strategies into the last two years of instruction in vocational agriculture. Keefe (1979) believed that teaching methods, strategies and techniques should be varied to reflect the different ways that individual students acquire knowledge and skill.

Curriculum Materials Evaluation

Since the Vocational Education Amendments of 1968, vocational agriculture teachers have had access to a variety of instructional materials, with the great majority of these materials having not gone through a thorough examination to determine if the instructional materials are meeting their objectives. Development and distribution of instructional materials is not enough to ensure teacher adoption of new materials "... publishers, usually agree that teachers need help in deciding which new and unfamiliar materials are most appropriate for their particular needs" (McNeil, 1985, p. 49). Ridenour (1965), Gliem (1976), and Kaas (1976) advocated evaluation of curriculum materials to determine their educational value. Tyler (1949, p. 105) emphasized the need for evaluation:

... many variables make it impossible to guarantee that the actual learning experiences provided are precisely those that are outlined in the learning units. Hence, it is important to make a more inclusive check as to whether these plans for learning experiences actually function to guide the teacher in producing the sort of outcomes desired. This is the purpose for evaluation and the reason why a process of evaluation is necessary after the plans themselves are developed. ... the process of evaluation is essentially the process of determining to what extent the educational objectives are actually being realized by the program of curriculum and instruction. However, since educational objectives are essentially changes in human beings, that is, the
objectives aimed at are to produce certain desirable changes in the behavior patterns of the student, then evaluation is the process for determining the degree to which these changes in behavior are actually taking place.

Much of the curriculum research efforts have focused on evaluating the effectiveness of prepared units of instruction for both students and teachers. These evaluations have differed greatly in their approach to the evaluation process. Teachers, curriculum developers, and publishers often visually appraise instructional material to determine its worth. However, several educators promoted evaluating curriculum materials in the situations for which they were intended. Geesey (1976) was a proponent of evaluating curriculum materials in the classroom. Warmbrod (1968) believed classroom teachers were in a unique position to evaluate new ideas in the situation for which they were intended.

Research conducted by Briers (1978) and Townsend (1981) and Slocombe (1983) included thorough reviews of literature on evaluation of instructional materials in vocational agriculture. Briers (1978), found that studies evaluating vocational agriculture instructional materials were both successful and unsuccessful in detecting differences between student achievement. However, he found that collectively the studies indicated that carefully designed experiments and properly constructed instructional materials combine to result in detectable differences in achievement between groups. Briers went on to say that although research procedures varied from study to study, the most popular experimental designs were the posttest-only control group design and the pretest-posttest control group design. The most frequently used criterion measure was student cognitive knowledge, student attitude, and student proficiency in performing skills (Briers, 1978, p. 38). Townsend (1981) found materials could help teachers better organize their instructional programs and would help them save valuable time. He also pointed out the need for evaluating the educational value of the materials before they are disseminated. Slocombe (1983) in his literature review on
instructional materials, found that teacher questionnaires were also used as a measure of instructional packet effectiveness and that frequently, instruments used to measure the dependent variables were constructed by the researchers.

This review of literature was for the most part limited to experimental evaluations since these studies are the most rigorous means of establishing a cause and effect relationship (Borg & Gall, 1983). However, qualitative data can be useful in the formative and summative processes of curriculum evaluation.

One commonly used measure of the effectiveness of a curriculum is the performance of students. The assessment of student mastery of skills and knowledge may also be a measure of teacher effectiveness. Thus, test results provide an indication of how much is being learned in an instructional program and how well the objectives are being mastered. In order to properly use student test scores as a measure of program effectiveness, a set of measurable objectives must be developed. These objectives should be based in part upon competencies that experts in the field and representatives of industry recognize as necessary for employment (McGhee & Cheek, 1988). A test measure of program effectiveness is the extent to which students completing an instructional program possess or fail to possess the competencies specified in the instructional objectives. Therefore, test information can be used not only to evaluate program effectiveness, but also to evaluate student mastery of instructional objectives (Glasser & Nitko, 1971). Tests composed of valid items keyed to a set of specific measurable objectives are termed criterion-referenced tests (Ivens, 1970). Tyler (1949, pp. 105 - 106) wrote:

This conception of evaluation (pretest-posttest) has two important aspects. In the first place, it implies that evaluation must appraise the behavior of students, since it is change in these behaviors which is sought in education. In the second place, it implies that evaluation must involve more than a single appraisal at any one time since to see whether change has taken place, it is necessary to make an appraisal at an early point and other appraisals at later
points to identify changes that may be occurring. On this basis, one is not able to evaluate an instructional program by testing students only at the end of the program. Without knowing where the students were at the beginning, it is not possible to tell how far changes have taken place. In some cases, it is possible that the students had made a good deal of progress on the objectives before they began the instructional program. In other cases it may very well be that the students have very little achievement before they begin instruction, and almost all of that noted at the end took place during the time the instruction went on. Hence, it is clear that an educational evaluation involves at least two appraisals—one taking place in the early part of the educational program and the other at some later point so that the change may be measured.

Birkenholz (1982, p. 11) stated "Many early experimental studies identified level of student knowledge as the most important dependent variable." An achievement test was usually employed to determine the level of student achievement. Bloom, Hastings, and Madaus (1971, p. 54) discussed the importance of this type of instrument in the instructional material evaluation process. He stated "The achievement test is an attempt to quantify achievement of students and constitutes the principle instrument in measuring the extent to which learning has occurred, as well as being a means of facilitating learning."

Many vocational educators are concerned about the validity of using traditional objective type paper/pencil tests to determine student ability and skills learned in "hands on" vocational classes. Symons and Wilson (1979) found a positive relationship between student scores on paper and pencil tests and on operational performance tests. In two cases, students received identical scores on both tests. McCormick and Cox (1988, p. 1) stated "The effect which instructional materials have on the teaching-learning process can be measured, in part, by assessing students' acquisition of knowledge. This measurement of cognitive learning can be accomplished by evaluating instruction in which teachers utilize prepared materials to plan and deliver their lessons." Richards and Reneau (1983, p. 28) recommended that "New curriculum materials should be evaluated using various methods to determine their effectiveness."
Briers (1978) used a pretest-posttest control group experimental design to investigate the effectiveness of an instructional packet on supervised occupational experience (SOE) as evaluated by student knowledge of SOE using an objective test, student attitude toward SOE, and student SOE program planning inventory. Forty beginning vocational agriculture classes in Iowa were randomly selected to participate in this study. Half were assigned to an experimental group and the remaining half were assigned to a control group. The experimental group received an SOE instructional packet and an in-service program on the use of the materials. The control group instructors were asked to teach what they normally taught their beginning students about SOE programs and were not provided with an in-service program. Briers found that students in the experimental group scored higher than the control on all three posttest measures. He advocated that a knowledge inventory, attitude scale, and program planning inventory served as valid and reliable measures of knowledge, attitude, and planning, respectively. He also recommended in-service education on the intended use of the instructional materials.

Allison and Carrington (1980) used a pretest-posttest control group design to evaluate an environmental education curriculum for the spectrum of citizens from children through adults in Virginia. Two measures were used in this study, an attitude survey and an achievement test. Pretest and posttest measures of knowledge were collected using a locally developed achievement test. The achievement test items were written to reflect the learning objectives presented in the instructional materials. This portion of the test development process was conducted to ensure content validity of the test. Attitude instruments were developed for the purpose of determining initial attitudes of students relative to environmental concerns as well as to determine changes in attitude as a result of their exposure to the instruction. Two major teacher in-service activities were conducted during this project. The data for the fourth grade students indicated that there was a statistically significant difference
between the experimental and control groups and significant change from pretest to posttest.

Townsend (1981) conducted a study to evaluate the effectiveness of an instructional packet developed for teaching beginning vocational agriculture students about leadership and FFA. "Effectiveness" was determined by: (1) student knowledge of FFA, measured by an objective test; (2) student attitude toward the FFA, measured by an attitude inventory using a 7-point Likert scale; (3) a teacher questionnaire to gather teacher demographic information; and (4) a FFA chapter activity inventory designed to assess relative activity of an FFA chapter. Sixty Iowa agricultural education departments were randomly selected and assigned to two experimental treatment groups and one control group. One experimental group received the instructional materials with an in-service session on the use of the materials. The other experimental group received only the instructional materials. The control group received neither instructional materials or in-service education and were asked to teach leadership and FFA in their usual manner. A posttest control group design was the research model used in this study. Townsend found no significant difference in student knowledge scores between the three groups. However, students whose teachers had access to the instructional materials did have a more positive attitude toward FFA than students whose teachers did not have access to the instructional materials.

In 1982, Birkenholz conducted a study to evaluate an instructional unit on agriculture/agribusiness management. He used a pretest-posttest control group design with 26 teachers in the experimental treatment group and 22 teachers participating in the control group. Student achievement level was measured by a criterion-referenced test, student attitude was measured using a semantic differential technique, and two teacher data instruments were used to collect general and specific information. The experimental treatment group received the agriculture/agribusiness management instructional unit. The control group was provided with a list of problem areas and study questions which were
included in the instructional unit. They were asked to use all instructional materials currently available to them. Neither group received in-service training. Birkenholz found students in the experimental treatment group scored higher on the knowledge test than students in the control group. However no significant difference was observed in student attitude.

In 1982, Hosseini conducted an experimental evaluation of an instructional unit on soil fertility and fertilizers. He used a pretest-posttest control group design. A group of 73 teachers were randomly divided into two groups. Nineteen teachers were chosen for each group. The experimental group was asked to teach the instructional unit. Teachers in the control group were asked to teach a soil fertility and fertilizers unit of their own. No in-service program was provided for either treatment group. A criterion-referenced test, developed by the researcher, was used to measure student knowledge, and an attitude inventory using a semantic differential technique was developed to collect affective data. An instructional unit evaluation instrument was also developed to assess teacher ratings of the materials, using a semantic differential scale and additional statements designed to elicit open-ended responses. Hosseini found that the group using the instructional packet had significantly higher test scores than the group that did not have access to the instructional unit. However, no significant difference was found between treatment group overall attitude scores after variations due to pretest scores were removed. Teachers reported the instructional unit worthwhile and technically accurate, and placed the most value in terms of reducing teacher preparation time.

The effects of a water conservation instructional unit on seventh-grade students was studied by Birch and Schwaab (1983), using a Solomon 4-group experimental design. A water conservation quiz using multiple choice items was used to measure student knowledge and a 4-point Likert-type scale was used to measure students' attitudes toward water and water conservation. They found that effects of the pretest as a learning devise was
insignificant and the instructional unit was influential in changing students' knowledge and attitudes about water use. Ogunrinde (1986) conducted a curriculum study to determine the "maturity of career choices" among students by assessing the students' knowledge of agricultural occupational information using a criterion-referenced test with Ohio freshmen and sophomore vocational agriculture students. This study used a randomly selected posttest single group design. Findings from this study suggested that students' mean score indicated a poor knowledge of occupations for which the students were preparing.

McGhee and Cheek (1985) assessed the level of student mastery of fundamentals of agribusiness and natural resources occupations in Florida schools. They measured student level of mastery using a criterion referenced test, compared level of mastery with student demographic variables, determined whether or not competencies identified in the curriculum guide were being taught in the schools, and determined the percentage of time, as indicated by teachers, that was necessary to cover the materials. This study consisted of a posttest single group design with a population consisting of 44 teachers and 1039 student volunteers. In addition to the criterion referenced test, a teacher questionnaire was developed to determine the percentage of time spent on topics related to the six major fundamental content areas. Student level of mastery on the criterion-referenced test was relatively low. As students increased in year of school they performed better on the test. Previous enrollment in agricultural classes did not influence achievement on the test, students in FFA had significantly higher scores than students not in FFA, and students planning to attend post-secondary education scored significantly higher than those who did not plan to pursue a post-secondary education after high school graduation.

Kotrlik, Parton, and Lelle (1986) studied the technical agriculture knowledge level attained by students who had completed Vocational Agriculture II in Louisiana and factors related to student knowledge attainment level. They used a posttest single group design,
using four schools. A criterion-referenced test was used to measure student knowledge. A teacher form secured demographic information and identified the basic curriculum topics being taught. They found that students had similar test scores as the Cheek and McGhee (1985) study, that FFA members scored significantly higher than nonmembers, and students with SOE projects scored significantly higher than students without SOE projects. No significant differences among student scores were observed by teacher variables.

Whent and Leising (1988) conducted a study using a posttest matched group design. A cognitive criterion-referenced test was used to assess the level of mastery of agriculture and bioscience principles by students who had completed the California basic core curriculum for agriculture. Two forms of the test were developed, one form contained bioscience curriculum and agricultural items and a second subscale consisted only of bioscience items. The bioscience objectives in the instructional materials followed closely bioscience objectives identified in the state guidelines. Agriculture teachers received two in-service sessions covering the basic core curriculum and a staff member visited each school site during the field test to collect qualitative data. Findings from this study indicated biological and agricultural students had similar bioscience knowledge. Students who were FFA members and had SOE programs scored significantly higher on the agriculture test than students who were not FFA members and did not have SOE programs. National priority (educationally, physically, emotionally handicapped or English as a second language) students made up 17% of the agriculture student group and 4% of the bioscience group. A significant difference was observed between national priority and non-priority students. No significant correlation was observed between test scores and the number of previous courses in agriculture or secondary science.

A multiphased study to develop and evaluate instructional resource units, using the principles approach of curriculum development with the inductive mode of teaching, was conducted in Arizona by McCormick and Cox (1988). They used a pretest-posttest single
group repetitive design. Thirty-two classroom units, involving 519 students, participated during the nine years of the study. Two groups of vocational agriculture teachers were employed in the study: (1) those teachers attending an in-service training program on the use of the inductive mode of teaching and use of the instructional unit and (2) teachers who did not receive the in-service training. The effects of in-service training received by teachers on student understanding was significant. These findings support previous studies reported by McCormick (1975, & 1979).

In-service Education

With the explosion of new scientific and technical knowledge being applied to the agricultural industry, new curriculum materials have flooded the educational market. However, as teachers become more and more removed from new technologies, updated instructional materials is not an answer in itself to prepare instructors to adequately teach these new materials. Long and Busby (1978) advocated that some subject matter areas that should be included in vocational agriculture curricula do not lend themselves to learning through experience, being too broad or too complex. They suggested that gaining sufficient competence in these subjects, to include them in a vocational agriculture program, requires a desire to master the subject, a willingness to study, and instruction from qualified experts.

The importance of in-service education in curriculum implementation has been emphasized in several studies including McCormick and Cox (1988) and McCormick (1975, & 1979). Gamon and Burton (1987) conducted a study to determine the difference in implementation of an instructional unit between instructors who attended an in-service program versus instructors who did not attend the in-service program. They found that teachers who attended the in-service program implemented the new instructional unit into
their regular instruction over twice as often as teachers who did not attend. Gamon and Burton also found that teachers who chose not to use the new material identified the reasons as primarily: (1) other topics deserved higher priority and (2) the teacher was not knowledgeable enough to teach the subject. Teachers also identified lack of relevant instructional materials as a major contributing factor in their decision not to teach the unit.

Approaches to providing in-service education differ from country to country; however, some parallels can be drawn with the need for in-service education of teachers when introducing new or difficult technological concepts. A survey made in the United Kingdom (UK) by Beetlestone and Teasdale (1984) on the level of awareness of biotechnology among teachers in schools, concluded that while many teachers appreciated the potential economic importance of biotechnology and claim to have an interest in incorporating it into their instruction, few have the appropriate training or experience to achieve this goal. Another UK study by Gayford (1987) addressed the development of in-service training materials related to teaching of biotechnology to improve the skills and approaches of teachers to the aspect of applied science. The study evaluated the in-service education and materials using over 200 teachers from a variety of contexts and teaching circumstances. Gayford collected qualitative data during this study. He asked the teacher participants and, where appropriate, the tutors to complete evaluation forms after the in-service program. He found that most teachers needed experience in basic microbiological techniques as well as biotechnology.

Student Interest and Motivation to Learn

"Interest is a pleasant emotion which supports constructive inquiry" (Tomkins, 1962 in Sjoberg, 1984, p. 189). Students often give interest as a reason for their vocational choice
(Sjoberg, 1983). Despite the central role of interest as a factor promoting action and motivation to learn, relatively little educational research has been done in this area. Most educational work on interest has considered it as an attitude variable; thus, research work has been primarily from a counselling perspective. "The possibility that interest plays a powerful role in guiding the selection and persistency of actions calls for a more direct approach to the study of what interest is, how it develops and how it is sustained" (Sjoberg, 1984, p. 189).

Sjoberg (1983) studied the components of interest in eight high school subject areas, as well as attitudes toward technology and vocational choice. He found that grades and interests in specific school subjects correlated positively (high achievers had a negative correlation). Another study by Sjoberg (1984) investigated the relationship among variables with special reference to how interest arises and if it influences effort and performance. Subjects in this study were 100 secondary students in natural science or technology divisions. Sjoberg's findings supported his 1983 study. He found interests and grades were strongly correlated and interest led, according to his structural models, directly or indirectly to increased effort. However, correlations between interests and effort and vocational preferences were more moderate. Sjoberg was careful to point out that positive grade-interest relationship had two sides: those who achieve well develop interest while those who achieve poorly tend to lose interest. The presence of punishment in "reward" systems can be quite important for understanding any detrimental effects of such systems on interest.

A study by Weltner et al. (1980) examined the interests of intermediate-level secondary students in certain aspects of physics and technology. A relationship was found to exist between out-of-school activities concerned with technology and natural sciences, and academic achievement as measured by students' physics grades. Lancelot (1944, pp. 31-32) wrote:
Few people have seen how large a part is played by interests in shaping the lives and careers of the young. They are the inner springs of thought and action and their influence is apparently greater by far than that of any of the forces which operate upon people from without. As an example, let us note now greatly a person's interests really affect his education. They determine what knowledge will be acquired and kept. They determine the ideals, or goals, toward which a student will strive throughout life, since ideals are born out of interests. These two together—interests and ideals are the motivating forces which determine what understandings each person will attain and what abilities he will acquire. Emotional responses and attitudes appear to depend upon all of these combined. Thus we see interests as the direct or indirect determiners of all the essential parts of true education.

The primary principle of interest is that all interest apparently has its original source in the so-called natural impulses, urges, or desires. Ten of these which seem most useful to teachers are activity, love of nature, curiosity, creativeness, gregariousness, desire for approval, altruism, self-advancement, competition, and ownership. It follows that teachers have only to appeal to one or more impulses in a manner that causes them to become really active in order to arouse interest at any time. That which is interesting affects ourselves, others and us, or humanity at large. Interest increases with an increase in related knowledge of any subject, provided such knowledge is well understood (Lancelot, 1944).

Much research has been done in educational psychology concerned with the determinants of motivation. Research suggests that motivational factors such as interest in school (Lazar & Darlington, 1982), social variables such as friendships (Hartup, 1983), and the degree of parental influence (Miller, 1988) will affect school performance. In a study by Kelly (1988), high school science students were asked to identify the factors that influenced their high school subject choice. Students identified support from parents, teachers, and friends as the strongest predictors of choice. A number of studies have suggested that student perceptions of control are related to their school achievement and their performance on cognitive measures (Dweck & Goetz, 1978; Findley & Cooper, 1983; Stipek & Weisz, 1981). The literature suggests that student performance in an area will have an impact on
student interest in that area (Bandura, 1983). Atkinson and Raynor (1978) postulated the theory of achievement motivation, stating that student needs to achieve success and their needs to avoid failure combine to produce individuals who are motivated to approach or avoid learning. Ames and Ames (1984) found that motivation is a function of one's thoughts, students expend efforts to protect their self-concept, and children who have less ability can put forth more effort to succeed. Glasser (1986) contends that students do what they do when it is seen as being satisfying to them. He suggested that if students are to do work to learn there must be a reward at the end.

Intrinsic motivation is the internal motivational state of the learner's natural and spontaneous interest in learning. Gottfried (1979), using a self-report inventory, measured pleasure inherent in school learning of fourth and seventh graders and correlated this measure with the students Stanford Achievement Test scores. The results suggested that intrinsic motivation for school learning is differentiated by subject area and that intrinsic motivation within specific subjects is a significant component of school achievement.

Ryan, Connell, and Deci (1985) derived a set of propositions about the role of intrinsic versus extrinsic motivation in educational settings, which they called "Cognitive Evaluation Theory." They placed perceptions of autonomy and competence as fundamental to intrinsic motivation. Measurement of intrinsic motivation involves feedback about student competence (informational) or feedback about the degree of choice or autonomy (control) the student possesses in a situation.

In contrast to Ryan et al. (1985), Como and Rohrkemper (1985) placed more emphasis on the study of the learner's internal cognitive process of motivation rather than on external indicators of behavior to measure motivation. They believed self-regulated learning is the center of intrinsic motivation. Self-regulated learning refers to the ways students process information and other forms of cognitive content. The highest form of cognitive
engagement, according to Como and Rohrkemper, is when students instruct themselves in appropriate mental operations and execute the appropriate cognitive activities to solve a problem of process information.

A review of literature in the area of student motivation and interest in learning would not be complete without also addressing the area of thinking. Promotion of the need to teach critical and creative thinking has received much attention in education (Butts, 1980; Moses, 1985; Presseisen, 1986; & Shanker, 1985). The National Assessment of Educational Progress (Staff, 1985) identified the need for developing imaginative, creative thinkers who would be effective in elaborating ideas and drawing understandings from what they read. Moses (1985) addressed the importance of critical and creative thinking to motivation. He went on to say that the learner should be allowed to learn by pursuing his or her own self-interests and suggested that this can only be accomplished if students achieve thinking skills.

Ritter (1988) identified the motivated student as one who believes learning is personally important, and who feels that learning is positively associated with self-concept. The ability to think appears to be closely associated with motivation as well as pursuit of interests.

From the previous literature it has been found that new innovations and technologies stimulate student interest. Students who are interested in a subject area tend to have higher academic achievement in that area. Because much of soil and water conservation is unexciting and often dry in content, the instructional unit emphasized technologies developed to conserve and manage natural resources as a vehicle to stimulate student interest and motivation to learn about conservation of natural resources.
Agriculture, Biotechnology, and Natural Resources Education

Neville Clarke, director, Texas Agricultural Experiment Station stated "Today, agriculture needs a new infusion of science and technology and new capabilities that will restore and enhance the competitiveness of U.S. agriculture in the world market place" (Clarke, 1986, p. 37). In a report by the National Research Council, it was emphasized that one of the strengths of U.S. Agriculture is the willingness of farmers to adopt proven alternatives. This constant evolution and adoption of new practices has helped the U.S. become a global leader in agricultural research, technology, and production. "Many of today's common practices were the alternative practices of the postwar era... The pattern is clear: today's alternatives are tomorrow's conventions" (Robbins, 1989, p. 25). The farmer of the future must concentrate heavily on the efficiency of resource use, reducing production costs and improving profitability and resource conservation. Many technologies will be developed to enhance crop yields and conserve natural resources. Water management and conservation technologies will improve water quality and quantity, infra-red guns will monitor plant temperature and water needs, engineering nitrogen-fixing capabilities into non-leguminous plants will reduce the cost of fertilizers and ease the pressure on natural resources, and air quality will be improved, thus reducing effects on crop yields, tree growth, and wildlife habitats (Bentley, 1986).

A continual question asked by educators in agricultural education is how to respond to the needs of students who must prepare for the technological careers of tomorrow. For many students the preparation they receive in high school is all they get. Some educators believe that reading, writing, mathematics, and science is enough of a basic education for students. However, others argue that the future job opportunities in agriculture will be in technology, and agricultural educators should prepare students for this job market. Many
professionals in agricultural education believe that the key to student preparation for careers in the agriculture sector lie in preparation emphasizing agriculture, biotechnology, environmental awareness, and global agriculture. In the Fiscal Year 1991 Priorities for Research, Extension and Higher Education report to the Secretary of Agriculture (Hayes, Hall, Mountney, West, & Bailey, 1989), it was recommended that a strong educational system is necessary to properly prepare workers for the U.S. agricultural, food, and forestry sectors. It further stated that more investments in the educational system are needed to develop scientific minds that produce the knowledge base necessary for technological improvements with minimal adverse impact on the environment.

Studies addressing the teaching of science in agricultural education have begun to evolve. Moss (1989) surveyed 107 vocational agriculture teachers to determine the extent to which science-related instruction occurs as part of instruction in the advanced program of vocational agriculture in Louisiana. He found that the greatest number of hours spent in science-related instruction was in the area of conservation (conservation included energy, natural resources and wildlife). A recommendation of Moss was that competencies in agriscience and emerging occupations and technologies should be identified and form the basis for updating the advanced vocational agriculture program in Louisiana. Roegge and Russell (1988) conducted a study to determine how well two disciplines, agriculture and biology, may be integrated in a high school agriculture setting. This purpose was accomplished by testing the effect of incorporation of biological principles instruction into a unit of instruction in vocational agriculture on student achievement and attitude scores. They found that the integrated approach was superior to the traditional approach in producing higher overall achievement. More specifically, the integrated approach increased biology achievement, had remediating effects for students with no previous high school biology, and made instruction more interesting to students.
The need for ecological global awareness and environmental conservation is tremendous. The emphasis of incorporating global education into the educational process in the United States has been a prominent part of many research efforts. A study by Gualdoni (1980) examined the status of global education concepts in America. Global education experts around the country were asked to respond to a national Delphi questionnaire. The following operational guidelines were proposed in the study: (1) global education should make students conscious of the natural resources distribution throughout the world; and (2) global education should increase student awareness of the forces creating global interdependence (problems which bind us, such as population, economics, and distribution of natural resources). This study stressed that global education is not so much a matter of content as approach. An approach that can be used in almost any grade or class to encourage students to look beyond parochial boundaries and enable them to function better in an interdependent world.

In a study by Alley (1984), the opinions of experts were gathered using the Delphi method in response to the Global 2000 Report to the President of the United States and Megatrends. Experts in American higher education were asked to state their agreement or disagreement with these two reports and to specify changes in three aspects of the general education curriculum: content, process, and outcomes. The "conclusion" statements most agreed with by the panel of experts included: we now confront a worsening global crisis of crowding, pollution, ecological stress, political instability and dwindling natural resources; and the U.S. has a key role to play in facilitating international cooperation which will determine global futures. The "outcome" statements most agreed upon by the panel focused on critical thinking skills, creative problem-solving skills, and effective writing skills, However, they also endorsed the concepts of moral and ethical development, and the development of a global world view which "anticipates future issues and alternatives." The
experts agreed the "content" of educational curriculum should focus less on memory and more on higher level cognitive functioning like problem-solving, synthesis, and application and how to make responsible value choices. They agreed that the "process" of education should assert that teaching be a facilitating process, not just an information transfer process and development of life-long learning skills should be emphasized. They endorsed less lecture and increased opportunities to integrate academic theory and real life learning.

The literature reveals that conservation of natural resources has become a national concern and is receiving attention in educational settings. However, the new wave of agricultural production is the application of biotechnology in agriculture. Genetic engineering has been termed "one of the four major scientific revolutions in this century, on a par with unlocking the atom, escaping the earth's gravity, and the computer revolution" (Clarke, 1986, p. 37). Hardy (1985) surveyed representatives from the farming, industrial, government, and academic sectors and predicted that biotechnology will account for forty percent of the innovations for crop production by the year 2005. The production of food and fiber is essential to life, and agriculture is the world's largest industry. "As a biologically based set of industries, agriculture is in the ideal position to reap the major benefits associated with the biotechnology revolution" (Clarke, 1986, p. 39).

Martin and Rajasekaran (1989, p. 243) stated that "The application of biotechnology must be shared with students of agriculture in order to educate them regarding the occupations available in the field." They surveyed agriculture teachers in the USA, regarding the infusion of the biosciences into the study of agriculture. They found that instructors were aware that the study of agriculture requires basic knowledge of the biosciences. Respondents ranked the need for additional instructional materials for teaching the biosciences as the first among all perception statements. Very high scores for expansion of competences related to methods of maintaining groundwater quality and soil conservation problems were observed.
Silva-Guerrero (1988) conducted a descriptive study to determine what should be the research priorities for agricultural education and to identify factors enhancing or inhibiting research in the profession. Sixty-two agricultural teacher education department heads and thirty-seven research experts in agricultural education were asked to indicate their perceived priority level for 109 research topics clustered in thirteen categories. Findings of this study revealed that the highest priority categories for research in agricultural education included "funding for agricultural education", "evaluation," and "international agricultural education." Research topics with the highest priority ratings included determining the new and emerging skills needed by students to work in biotechnology, high technology, and agribusiness.

Summary

The social reconstructionist concept of curriculum development has been concerned with confronting the learner with the many severe problems that humankind faces. It was the intent of the environmental conservation technology instructional unit in this study to increase student knowledge of technologies for managing and conserving natural resources. To this end, the underlying philosophy of the environmental conservation technology unit followed that of the social reconstructionist.

There is much concern about protection of the environment and conservation of natural resources throughout the nation and the world (Barrick, 1989; Satchell, 1989; & Ferguson, 1990). Global conservation and environmental concerns have taken a spotlight in the media. Federal and state legislation has been passed to enforce new conservation practices. Research has demonstrated that much of natural resources conservation lies in the development and application of new technologies. If agricultural education is to keep pace
with the technology explosion impacting the agricultural industry, it must determine skills needed by students to work in biotechnology, high technology, and agribusiness.

The need for curriculum addressing environmental conservation has been identified by numerous studies. It has been said that "The best interests of Americans lie in providing students with a curriculum that is fixed on the future—on what is possible and potential" (McNeil, 1985 p. 4). It is also argued that the best educator of the adult population, in all probability, is the education of the children, for they will be tomorrow's farmers, politicians, businesspeople and, most importantly, voters.

Much instructional materials have been developed, but remarkably few have been evaluated. The review of literature indicates that educators are concerned about the evaluation of instructional materials to ensure they are accomplishing their objectives before they are disseminated to instructors. Experimental studies which evaluated instructional materials gave mixed results. Some studies found that instructional materials were successful in increasing students' knowledge and changing students' attitudes, and other studies indicated no difference in student achievement or attitudes between treatment groups. The literature does suggest, however, that instructional materials that are effectively accomplishing their objectives and evaluated by carefully designed experimental studies, result in significant increases in student achievement.

Experimental research procedures used to evaluate instructional materials have ranged from posttest single group designs to Solomon 4-group designs. However, the most commonly used experimental design was the pretest-posttest control group.

Studies have also varied in the criterion measures used to evaluate curriculum materials. Many educators argue that the level of student knowledge is the most important dependent variable in evaluation of instructional materials. This belief is evident with the wide use of achievement tests to measure both student mastery of subject matter and program
effectiveness. The second most commonly used instrument in experimental evaluation of instructional materials is an attitude inventory or survey. Other criterion measures included student proficiency in performing skills, changes in student behavior, and teacher satisfaction. An important point made by several researchers was that new curriculum materials should be evaluated using various methods to determine their effectiveness.

The use of in-service sessions in curriculum evaluation has provided different results. Several researchers used teacher in-service programs as an experimental treatment. Although the in-service programs helped teachers become more familiar with material, some studies found no significant increase in student achievement. Other studies found that in-service education can be an effective means to incorporate new materials into the instructional program. Studies suggest that teachers need to become acquainted with new materials and their use in order to effectively teach students. Research also indicates that materials containing new terminology or unfamiliar, new technologies are most effectively used by teachers when they are taught how to use them.

Studies have supported the relationships among student interest, student learning and motivation to learn. Lancelot (1944) identified the relationship between new ideas or innovations as a way to increase interest. Intrinsic motivation has been found to be related with subject matter and student achievement on standard achievement tests. It follows that if instructional materials can appeal to one or more interests of students, then increased motivation and achievement will occur.
Following the reconstructionist concept of curriculum development, an environmental conservation technology instructional unit was developed to address a pressing global and national issue, conservation of natural resources. The instructional unit incorporated innovative scientific technologies to stimulate student learning and increase student knowledge of technologies for managing and conserving natural resources. The unit focused on technologies, including biotechnologies, that have utility in managing and conserving natural resources as a vehicle for stimulating interest and motivating students to learn conservation principles.

The purpose of this study was to evaluate the effectiveness of the environmental conservation technology instructional unit and in-service. Student and teacher attitudes toward and student knowledge of natural resources were measures of effectiveness assessed. The methods and procedures used to accomplish these objectives are described in this chapter.

Design

Evaluation of the environmental conservation technology instructional unit was based on an experimental pretest-posttest control group design (Campbell & Stanley, 1971). Schools were randomly selected and randomly assigned to two groups: an experimental group and a control group. Pretest and post test data were collected from both teachers and students. The design may be graphically represented as:
The symbols are explained as follows:

- **R** symbolizes random selection from the population and random assignment to treat groups.
- **X<sub>1</sub>** represents the experimental group in which teachers taught the environmental conservation technology instructional unit.
- **X<sub>2</sub>** represents the control group in which teachers taught an environmental conservation unit using materials generally available (only lesson titles and objectives were provided).
- **0<sub>1</sub>0<sub>2</sub>0<sub>3</sub>** and **0<sub>7</sub>0<sub>8</sub>0<sub>9</sub>** depict pretest measures including: a student knowledge pretest, a student attitude inventory, and a teacher attitude inventory.
- **0<sub>3</sub>0<sub>4</sub>0<sub>5</sub>** and **0<sub>10</sub>0<sub>11</sub>0<sub>12</sub>** depict posttest measures including: a student knowledge posttest, a student attitude inventory, and a teacher attitude inventory.
- **0<sub>13</sub>0<sub>14</sub>0<sub>15</sub>** and **0<sub>18</sub>0<sub>19</sub>0<sub>20</sub>** indicate pretest questionnaires designed to collect situational and personal information from the teachers and students.
- **0<sub>16</sub>0<sub>17</sub>** and **0<sub>21</sub>** indicate posttest questionnaires designed to collect situational and formative information from the teachers.
Population

The population for this study consisted of schools with ASTM programs within an 80 mile radius of Iowa State University. Additional restrictions were imposed so that the actual population available for the study was defined as follows:

1. Students at each school site were sophomore, junior, and senior level in high school.
2. Teachers at each school site had taught agricultural science technology and marketing (ASTM) for a minimum of three years.
3. Teachers at each school site agreed to teach a unit on environmental conservation technology during fall semester of the 1989-1990 school year.

Sample

A cluster sampling technique was used in this study. Forty schools meeting the population criteria were randomly selected from a population of 82, and randomly assigned to two groups, using a table of random numbers. Alternate schools were numerically ordered to be used as replacements if schools in the original sample could not participate in the study. Letters (Appendix A) were sent to teachers in the experimental group and the control group. An additional 30 letters were mailed to alternate schools. The letters explained the research project and teacher responsibilities, and asked them to participate, after securing permission from their school administration. Concurrently, letters were mailed to the principals of the selected schools, requesting their cooperation in this research endeavor (Appendix A). A reply form and self-addressed envelope were enclosed with each teacher letter. Of the original 40 teachers contacted, 20 teachers agreed to participate in the project, 10 coming from both groups. Ten schools from the alternate experimental sample group and
eight schools from the alternate control sample group agreed to participate. Teachers not agreeing to participate in the project indicated their unwillingness to alter their instructional program or lack of appropriate classes in which to teach the environmental conservation technology instructional unit during the specified time, as the primary reasons for not participating.

Borg and Gall (1983) recommended a minimum of 15 cases in each group to be compared in experimental research. The researcher attempted to secure 20 schools in each group to compensate for schools that may have had difficulties completing the experiment. The final sample for this study consisted of 38 schools; 20 in the experimental group and 18 in the control group. A list of schools and the number of student participants by school is presented in Appendix B.

Experimental and Control Groups

The experiment included two groups of schools, a control group and an experimental group. The control group was included to measure the effect of extraneous factors upon the posttest. The experiences of the experimental and control groups were as identical as possible with the exception that the experimental group was exposed to the environmental conservation technology instructional unit and an in-service on use of the unit, the experimental treatment. Borg and Gall (1983) advocated that if extraneous variables have brought about changes between the pretest and posttest, these should be reflected in the scores of the control group. Thus, the posttest change in the experimental group that is different from that of the control group can be attributed to the experimental treatment. According to Campbell and Stanley (1971), the threats to internal validity (history,
maturation, testing, instrumentation, regression, selection, mortality, and interaction effects) can be effectively controlled by the experimental design.

Two levels of the independent variable, the degree to which teachers had access to the environmental conservation technology instructional unit and in-service program were used in this study. The manipulation of the independent variables by the researcher is described below.

Experimental Group

Schools (teachers and students) in the experimental group received the environmental conservation technology instructional unit. Teachers in this group were provided an in-service program on the use of the instructional materials and were encouraged to use other related materials at their disposal to enhance the unit. The instructional units were distributed to teachers during the in-service program.

Instructional Unit  The instructional unit entitled "Environmental Conservation Technology" and a teacher in-service program on its use constituted the experimental treatment for this study. The unit of instruction was developed by Linda Whent, David L. Williams, and Eldon Weber as part of a natural resources education research project approved by the Iowa Agriculture and Home Economics Experiment Station. An earlier study (Whent & Williams, 1988) indicated that ASTM students in Iowa were lacking knowledge of and had less than desirable attitudes toward conservation of natural resources. They suggested that more instructional materials about natural resources were needed by ASTM teachers in Iowa.

The environmental conservation technology instructional unit focused on technologies that have utility in managing and conserving natural resources as a motivation for students to learn conservation principles. Three introductory lessons were included in the
instructional materials. The first introduced students to natural resources, the second introduced the concept of technology and set the stage for the remaining lessons covering specific areas of natural resources which were managed and conserved using innovations in biotechnology. Because of the complex nature of biotechnology, the third lesson introduced students to basic biotechnology principles. The areas of natural resources emphasized in the instructional unit included water, soil, wildlife, and forestry.

The instructional unit was developed for ASTM teachers to use with sophomore, junior, and senior high school students. Although the instructional unit was tested as a single unit in this study, lessons within the packet were designed to be used both as a single entity or separately within specific areas of natural resources instruction. For example, lessons addressing soil conversation may be used individually when teaching a unit on soils.

Lesson plans in the instructional unit followed a modified version of the Project 2000 (Kahler, Birkenholz, Hosseini, & Fard-Sarhangi, 1982) instructional materials format. Each of the lessons included a list of objectives, informational sheets, an interest approach, transparency masters, teaching procedures, student activities, alternate teaching activities, and references.

The instructional unit was designed for approximately 12 periods of instruction in higher level ASTM high school classes. The day before instruction began was used for administering the pretest and the day following instruction was used for administering the posttest. The treatment was to be administered between November 27 and December 22, 1989.

ASTM teachers in the experimental group were asked to attend an in-service program on the instructional unit on November 14, prior to the start of instruction. Copies of the instructional unit were delivered to teachers during the in-service program. The in-service education included an explanation of the background and purpose of the instructional unit,
evaluation procedures, requirements of the participants, an overview of the instructional unit, examples of approaches to teaching the lessons, a brainstorming session to generate ideas for teaching the lessons, and a discussion period. A copy of the agenda for the in-service meeting is presented in Appendix A. Three teachers in the experimental group were unable to attend the in-service program. These teachers were provided with a individualized in-service session.

Control Group

Schools (teachers and students) in the control group did not have access to the environmental conservation instructional materials nor the in-service program. In order to provide teachers in the control group with a guide, they were provided with the lesson titles and objectives included in the instructional unit. For the purpose of this study, the lesson titles and objectives were not considered a treatment. Teachers were asked to teach the lessons using instructional materials at their disposal. The lesson titles and objectives are presented in Appendix D.

Instrumentation

Eight instruments were developed to measure the dependent variables and to record personal, situational, and formative data. Three instruments were developed to measure student variables: an agriculture student information sheet, an agriculture student natural resources attitude inventory, an agriculture student environmental conservation technology pretest and posttest. Data from student instruments were collected directly on machine scored answer sheets. Five instruments were developed to be completed by the teachers: an agriculture teacher natural resources attitude inventory, a teacher information form, a
class/student situational form, a post instructional information form, and a daily instructional reporting form. (A copy of each instrument is presented in Appendix C). Descriptions of the instruments are presented in the following section.

**Student Instruments**

**Agriculture Student Information Sheet** The student information instrument was designed and administered as a pretest to collect student situational and demographic information. The instrument consisted of 10 items developed by the researcher. Students were asked to respond to alternative or filled in the blank items.

**Agriculture Student Natural Resources Attitude Inventory** The student attitude inventory was used as a pretest and posttest measure of student attitudes toward conservation of natural resources. The attitude scale consisted of 30 statements modified from an agriculture student natural resources instrument used in 1988 by Whent and Williams. The instrument was field-tested during the fall of 1987. Analysis revealed a reliability (coefficient alpha) of .80. Selected items were modified or rewritten by the project team. The instrument was designed to elicit a response of agreement or disagreement to items using the following 9-point Likert scale:

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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Slightly Disagree</td>
<td>Undecided</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Agree</td>
<td></td>
<td></td>
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Items on the scale were identical for the pretest and the posttest.

**Agriculture Student Natural Resources Test** An objective-referenced test of 35 multiple-choice items with four alternatives each was used to assess student knowledge about environmental conservation technology. The test was used as a pretest and a posttest, with items arranged in a different order during each administration. Test items were developed by
the researcher. To insure proportional coverage of instructional materials by test items, one item was included for each learning objective in the instructional unit. Attention was given to writing test items to parallel the cognitive level (described by Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) of the learning objective. The test was reviewed by project staff and an ASTM teacher for content validity. The instrument was field-tested by thirty ASTM students in a school not participating in the experiment. Distractor and item analysis and reliability measures were generated from these data. The field-test yielded a KR-20 reliability coefficient of .76. Test items with item difficulty values ranging between 30 and 70 percent result in higher item discrimination and thus better separate students according to levels of achievement. Items with item discrimination values in the range of .20 to .39 are generally considered to be satisfactory in classroom testing. They discriminate among students on their level of achievement and therefore add to test reliability. Item discrimination values above .40 provide very good discrimination (Test and Evaluation Services, 1989). Thus, a good rule of thumb would be to require the discrimination value, "r" to be .20 or higher (Brown, 1983). Items for the agriculture student natural resources test were selected with an item difficulty between 30 and 70 percent and an item discrimination value above .20. Items with low discrimination values were rewritten. The test consisted of 35 typed items, reproduced similar in design to a teacher-made test to achieve face validity. Test reliability and item analyses were measured and are reported in Chapter IV.

Teacher Instruments

Agriculture Teacher Natural Resources Attitude Inventory  This instrument was designed to measure teacher's attitudes toward natural resources conservation and attitudes toward teaching environmental conservation technology. The inventory was administered as a pretest and posttest. Teachers were asked to respond to 35 statements using a 9-point
Likert scale (identical to that in the student natural resources attitude inventory). The teacher attitude inventory consisted of two subscales, one subscale consisted of 29 items developed to measure attitudes toward natural resources, a second subscale consisted of six items developed to measure teacher attitude towards teaching environmental conservation technology. Items on the first subscale were identical to the first 29 items on the student attitude inventory.

**Teacher Information Form**  This form collected personal data from teachers. These data included years of teaching experience, knowledge of natural resources conservation, the degree to which they enjoy and teach environmental conservation, and past experiences or situations that have influenced them in teaching. Two items asked open-ended questions about teaching environmental conservation.

**Class/Student Situational Form**  Situational information specific to the class in which the unit was taught was collected using this instrument. Teachers were also asked to identify students with educational or physical handicaps that would inhibit them from performing at the level of their peers.

**Post Instructional Teacher Information Form**  Data pertaining to length of instruction time and student reactions to the instructional unit were collected using this instrument. Open-ended questions were included to gather summative information.

**Daily Instructional Reporting Forms**  This instrument was used by teachers in the experimental group only. Teachers were asked to keep a daily log while teaching the instructional unit. The daily reporting forms were used to collect qualitative data. Teachers were asked to record written comments after teaching each lesson, describing problems or successes they may have encountered. These comments were used in improving and modifying the instructional materials.
Collection of Data

In order to ensure equal treatment of groups, pretest and posttest instruments were mailed to both groups along with detailed directions. Mailing for both groups occurred at the same time. During the in-service program, teachers in the experimental group reported the number of students who would be receiving testing materials. Teachers in the control group reported the number of students to be included in the study on a mailed form. ASTM teachers, in both the control and experimental groups, were asked to give the pretest the day before beginning instruction for the experiment, and mail all pretest materials to the researcher immediately after completion of testing. Posttest materials were mailed to teachers before their projected completion dates. The experiment, including posttesting, was to be completed before the 1989-1990 Christmas break. However, due to severe weather conditions, many schools were closed during the final days of the experiment; consequently, most schools completed instruction and administered the posttests after the two week holiday break.

These procedures yielded data from 35 schools, or a 92 percent return. The study included 18 schools in the experimental group with 144 students and 18 teachers, and 16 schools in the control group with 122 students and 16 teachers.

Analysis of Data

The data gathered from the ASTM teachers and students were checked, coded, and entered into a data file on the main frame computer at Iowa State University. The statistical procedures used to summarize and analyze the data were the following:
1. The statistical package used in analyzing the data was the Statistical Package for the Social Sciences (SPSSx).

2. Only completed data from students, taking both the pretest and posttest were used in the analyses. Individual student scores were used to generate school means as schools served as the experimental unit.

3. Items on the attitude inventories designed to elicit negative responses were recoded for data analysis purposes. Thus, providing uniform responses for calculation of individual and group means.

4. Dependent variable data gathering instruments, including the pretest and posttest forms of the attitude inventory and the agriculture student knowledge test, were analyzed for reliability. Coefficient alpha, used to estimate reliability for items using an interval scale, was employed to estimate the reliability of the attitude instruments. An estimate of reliability was made using the Kuder-Richardson Formula 20 for the categorical items on the knowledge test and subscales. Item analysis measures including item difficulty and item discriminating power were also measured.

5. Descriptive statistics and analysis of covariance were used to analyze data on the student and teacher attitude inventories.

6. Counts and frequencies were tabulated for student, teacher, and class variables. Chi-square analyses were used for tests of independence and t-test analyses were used to determine differences between groups regarding personal and situational variables.

7. Mean knowledge test scores were computed for each participating school. Analyses of covariance were used to determine differences between groups using pretest scores as a covariate. Paired t-test analyses were employed to determine differences between pretest and posttest results within groups.
8. The enter method of multiple regression analysis was used to identify significant independent variables which contributed to dependent variables. Stepwise regression was used to identify specific student and teacher independent variables which contributed to student posttest scores, and student and teacher attitude scores.

Limitations of the Study

The population consisted of all schools within an 80 mile radius of Iowa State University that had an ASTM department, and that had ASTM teachers who have been teaching ASTM for three or more years. Generalizations and inferences from the sample to this population can be made without hesitation. However, statistical inferences cannot be extended to include all schools with ASTM programs in Iowa. Yet, some research findings may have logical implications for other Iowa schools meeting the criteria above.

Summary

An environmental conservation technology instructional unit was developed to address conservation of natural resources; incorporate innovative scientific technologies to increase student occupational awareness and stimulate student learning; and to increase student knowledge of technologies for managing and conserving natural resources. The unit focused on technologies, including biotechnologies, that have utility in managing and conserving natural resources as a vehicle in stimulating student interest and motivating them to learn conservation principles.

The study was conducted during the fall and winter of the 1989-1990 school year, to evaluate the effectiveness of the environmental conservation technology instructional unit.
The instructional unit was designed for upper level ASTM students. The effectiveness of the unit was measured in terms of student knowledge of environmental conservation technology, student attitudes toward environmental conservation, teacher attitudes toward natural resources and teaching environmental conservation technology.

A pretest-posttest control group design was used in this study. The experimental group received the instructional unit and an in-service program; the control group received a list of environmental conservation technology lesson titles and objectives to guide their teaching. The lesson titles and objectives received by the control group were not considered a treatment in this study.

Data were analyzed using SPSSx statistical package for the social sciences. Descriptive statistics were used to describe teacher and student personal and situational variables. Inferential statistics were used to determine differences between groups and pretest and posttest scores, and identify independent variables which contributed to posttest knowledge and attitude scores.
CHAPTER IV.

FINDINGS

The purpose of this study was to evaluate the effectiveness of an environmental conservation technology instructional unit. Schools with ASTM programs and within an 80 mile radius of Iowa State University were randomly selected to participate in this study. Additional selection criteria included teacher willingness to teach the unit in ASTM classes, and having a minimum of three years ASTM teaching experience. Half of the schools selected were assigned to the experimental group and the remaining half of the schools to the control group. The experimental group received the environmental conservation technology instructional unit and an in-service program. The control group received only an outline of lesson titles and learning objectives.

Data collected from the two groups were as follows: (1) personal and situational information from the students, (2) personal and situational information from the teachers, (3) student knowledge of environmental conservation, (4) students' attitude toward natural resources conservation, (5) teachers' attitude toward natural resources conservation, (6) teachers' attitude toward teaching environmental conservation technology, and (7) experimental group teachers' reactions to the instructional unit.

Results of data analyses are presented in four sections: (1) descriptions and analyses of personal and situational characteristics of the agriculture students; (2) descriptions and analyses of person and situational characteristics of the agriculture teachers; (3) analyses of dependent variable data-collection instruments; and (4) inferential statistical analyses and testing of hypotheses comparing results of the experimental and control groups.
Student Characteristics

Schools were randomly selected and randomly assigned to experimental and control groups. A cluster sampling technique was used to collect student data. Since all students in a class were sampled, and only one agriculture class was sampled per school, the school was considered to be a cluster.

Student dependent and independent variables were reported on answer sheets for machine scoring. In order to give an accurate report of the student data, it was necessary for the researcher to recode some of the student answer sheets. Only student answer sheets containing correctly completed pretest and posttest data were used in data analyses.

When nonequivalent groups are used in a pretest-posttest control group design, as much similarity as possible should be established between experimental and control groups. To accomplish this task, data on student characteristic and situational variables were collected. A series of tables are presented to report data on independent student variables. Since these variables were not influenced by the treatment, experimental units were considered to be students rather than schools.

Frequencies and percents related to ethnic background of students and types of students are presented in Table 2. Over ninety-seven percent of the students enrolled in agricultural education classes participating in the study were of white ethnic background. Less than one percent of the students were Hispanic, Asian, American Indian or other minority ethnic groups. Almost eighty-seven percent of the students were male and thirteen percent were female. Ninety-five percent of the students were judged to have no serious learning disabilities by their teachers. The remaining five percent were identified by their instructors as having serious learning disabilities. Chi-square analyses of gender and learning ability revealed a small chi-square values suggesting that these variables were
Table 2. Student ethnic background, gender, and learning ability by group

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<tr>
<th>Variable</th>
<th>Experimental</th>
<th></th>
<th>Control</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>%</td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
</tr>
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</tr>
<tr>
<td>Ethnic Background</td>
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</tr>
<tr>
<td>White</td>
<td>139</td>
<td>52.5</td>
<td>117</td>
<td>44.5</td>
<td>256</td>
<td>97.3</td>
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<tr>
<td>Hispanic</td>
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<td>2</td>
<td>.8</td>
<td>2</td>
<td>.8</td>
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<tr>
<td>Black</td>
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<td>.4</td>
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<td>0</td>
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<td>.4</td>
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<td>American Indian</td>
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<td>.4</td>
<td>1</td>
<td>.8</td>
<td>2</td>
<td>.8</td>
</tr>
<tr>
<td>Other</td>
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<td>.4</td>
<td>1</td>
<td>.4</td>
<td>2</td>
<td>.8</td>
</tr>
<tr>
<td>Total</td>
<td>142</td>
<td>54.0</td>
<td>121</td>
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<td></td>
</tr>
<tr>
<td>Gender</td>
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<td></td>
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</tr>
<tr>
<td>Male</td>
<td>116</td>
<td>45.3</td>
<td>106</td>
<td>41.4</td>
<td>222</td>
<td>86.7</td>
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<td>Female</td>
<td>19</td>
<td>7.4</td>
<td>15</td>
<td>5.9</td>
<td>34</td>
<td>13.3</td>
</tr>
<tr>
<td>Total</td>
<td>135</td>
<td>52.7</td>
<td>121</td>
<td>47.3</td>
<td>256</td>
<td>100.0</td>
</tr>
<tr>
<td>Missing cases</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Severe Disability</td>
<td>136</td>
<td>51.1</td>
<td>116</td>
<td>43.6</td>
<td>252</td>
<td>94.7</td>
</tr>
<tr>
<td>Severe Disability</td>
<td>8</td>
<td>3.0</td>
<td>6</td>
<td>2.2</td>
<td>14</td>
<td>5.2</td>
</tr>
<tr>
<td>Total</td>
<td>144</td>
<td>54.1</td>
<td>121</td>
<td>45.5</td>
<td>266</td>
<td>100.0</td>
</tr>
<tr>
<td>Missing cases</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chi-square</td>
<td>.044</td>
<td></td>
<td>p</td>
<td>.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>.83</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

chi-square = .05 p = 1.00
independent from the group. A chi-square analysis was not calculated on student ethnic background due to the low cell frequencies.

Over 58 percent of the students participating in the study lived on farms. Another 11 percent lived in a rural area, but not on farms, and 31 percent lived in a town or city. A frequencies table and chi-square analysis of these data are presented in Table 3. The chi-square analysis found student location of residence was independent from group membership.

Table 3. Residence of students by group

<table>
<thead>
<tr>
<th>Place of residence</th>
<th>Group</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental</td>
<td>f</td>
<td>%</td>
<td>Control</td>
<td>f</td>
</tr>
<tr>
<td>On a farm</td>
<td>79</td>
<td>29.9</td>
<td></td>
<td>73</td>
<td>27.7</td>
</tr>
<tr>
<td>Rural area/no farm</td>
<td>16</td>
<td>6.1</td>
<td></td>
<td>13</td>
<td>4.8</td>
</tr>
<tr>
<td>Town or City</td>
<td>48</td>
<td>18.2</td>
<td></td>
<td>35</td>
<td>13.3</td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>54.2</td>
<td></td>
<td>121</td>
<td>45.8</td>
</tr>
<tr>
<td>Missing cases = 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chi-square = 2.46</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These findings are different than those reported by Slocombe (1983). Slocombe randomly selected schools from North Central and South Central Iowa. He found that 64.6 percent of the students lived on farms; 11.8 percent lived in rural areas, but not on farms; and 23.6 percent lived in towns or cities. These findings indicate that the percent of town and
urban students compared to farm students enrolling in agricultural education changed slightly over the past seven years, with the suggested trend of fewer students living on farms and more students living in towns or cities.

Table 4. Student grade level by group

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Experimental</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>Grade 9</td>
<td>6</td>
<td>2.4</td>
<td>13</td>
</tr>
<tr>
<td>Grade 10</td>
<td>25</td>
<td>10.2</td>
<td>37</td>
</tr>
<tr>
<td>Grade 11</td>
<td>43</td>
<td>17.5</td>
<td>23</td>
</tr>
<tr>
<td>Grade 12</td>
<td>57</td>
<td>23.2</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>131</td>
<td>53.3</td>
<td>115</td>
</tr>
</tbody>
</table>

Missing cases = 20

chi-square = 12.25, p = .01

Grade level was a student characteristic which was not independently distributed among groups. Experimental group schools had more juniors and seniors than control schools. Results of the chi-square test for independence, presented in Table 4, revealed a significant chi-square value of 12.25 (p = 0.01). Teachers were asked to teach the instructional unit to upper class students (sophomore thru senior). However, these statistics reveal that 19 of the 246 students were freshmen. This diversity of students may be explained by the tendency of many secondary agricultural education classes to have a
combination of students from different grades. Also, some teachers may have determined that teaching the instructional unit to the most appropriate class was of higher priority than selecting only classes with upper level students.

Some studies have found a relationship between student performance on criterion-referenced tests and participation in FFA and SAE activities (Whent & Leising, 1988; Whent & Williams, 1988; & Kotrlik, Parton, & Lelle, 1986). Approximately 15 percent of all students participating in this study had never been FFA members. This is a slight increase from the study by Slocombe (1983), using a similar population. He identified only 12.4 percent of all students as never being an FFA member. Whent and Williams (1988) found that 15.8 percent of ASTM students surveyed in Iowa had never been a member of FFA. However, students who reported they were FFA members, most often reported frequent or high FFA involvement. This data suggests when students join FFA they tend to be active in the organization. This study found that 20 percent of the students never had an SAE program. The results of the two chi-square analyses found FFA and SAE involvement were independent of group. Thus, the findings suggest that the students in the two groups were homogeneous with reference to self-reported FFA involvement and SAE experiences. Results of these analyses are presented in Table 5.

The time students spend in agriculture classes, on FFA activities, and/or on activities directly related to natural resources and conservation may influence their knowledge and attitudes towards conservation of natural resources. Five student variables were measured on continuous scales: (1) semesters of enrollment in agriculture classes, (2) semesters of natural resources instruction, (3) semesters of participation in FFA, (4) number of SAE programs, and (5) number of SAE programs emphasizing natural resources. Findings indicated that the mean semesters of agriculture classes for the student participants was 3.78 and mean semesters of FFA was 3.43. The total number of SAE programs for all students in the study
Table 5. Degree of FFA and SAE involvement by group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>Control</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>FFA Involvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not in FFA</td>
<td></td>
<td>20</td>
<td>7.5</td>
<td>21</td>
<td>7.9</td>
</tr>
<tr>
<td>Rare involvement</td>
<td></td>
<td>6</td>
<td>2.3</td>
<td>9</td>
<td>3.4</td>
</tr>
<tr>
<td>Some involvement</td>
<td></td>
<td>20</td>
<td>7.5</td>
<td>17</td>
<td>6.4</td>
</tr>
<tr>
<td>Frequent involvement</td>
<td></td>
<td>52</td>
<td>19.6</td>
<td>44</td>
<td>16.6</td>
</tr>
<tr>
<td>High involvement</td>
<td></td>
<td>45</td>
<td>16.9</td>
<td>31</td>
<td>11.7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>143</td>
<td>54.0</td>
<td>122</td>
<td>46.0</td>
</tr>
<tr>
<td>Missing cases = 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>chi-square = 2.46</td>
<td>p = .65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAE Involvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never had a SAE</td>
<td></td>
<td>27</td>
<td>10.2</td>
<td>28</td>
<td>10.6</td>
</tr>
<tr>
<td>First SAE</td>
<td></td>
<td>33</td>
<td>12.5</td>
<td>29</td>
<td>11.0</td>
</tr>
<tr>
<td>Two SAE's</td>
<td></td>
<td>49</td>
<td>18.6</td>
<td>30</td>
<td>11.4</td>
</tr>
<tr>
<td>Over Two SAE's</td>
<td></td>
<td>6</td>
<td>2.3</td>
<td>9</td>
<td>3.4</td>
</tr>
<tr>
<td>Several SAE's</td>
<td></td>
<td>28</td>
<td>10.6</td>
<td>25</td>
<td>9.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>143</td>
<td>54.2</td>
<td>121</td>
<td>45.8</td>
</tr>
<tr>
<td>Missing cases = 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>chi-square = 3.88</td>
<td>p = .57</td>
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</tr>
</tbody>
</table>
was 1.77, and the mean number of SAE programs with a natural resources component was 0.42. Results of t-tests employed to test for differences between the experimental and control groups on these variables are presented in Table 6. The experimental group was significantly greater than the control group regarding the following variables: (1) semesters of agriculture, (2) semesters of natural resources instruction, and (3) semesters of FFA participation. These differences between groups may be attributed to the greater number of juniors and seniors in the experimental group compared with the control group. Students who were juniors or seniors had more opportunity to take agriculture classes, participate in FFA, and initiate SAE programs.

Table 6. Results of t-test comparisons of selected student characteristic means by group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>t-value</td>
<td>Probability</td>
</tr>
<tr>
<td>Semesters of Ag.</td>
<td>4.14</td>
<td>2.46</td>
<td>3.42</td>
<td>2.15</td>
<td>2.49</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Semesters of natural resources instruction</td>
<td>2.31</td>
<td>2.36</td>
<td>1.66</td>
<td>1.47</td>
<td>2.74</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Semesters in FFA</td>
<td>3.89</td>
<td>2.66</td>
<td>2.97</td>
<td>2.35</td>
<td>2.97</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Total SAE Programs</td>
<td>1.66</td>
<td>1.48</td>
<td>1.89</td>
<td>2.12</td>
<td>1.03</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Natural resource SAE programs</td>
<td>0.40</td>
<td>0.83</td>
<td>0.43</td>
<td>1.00</td>
<td>0.35</td>
<td>0.73</td>
<td></td>
</tr>
</tbody>
</table>
Student variables were analyzed using the enter method of multiple regression analysis to identify significant variables which may contribute to student dependent variables. A stepwise regression procedure was then employed to identify student characteristic and situational variables that contributed to student posttest knowledge scores. The results are presented on Table 7. Analyses identified three variables with significant values, allowing them to enter the prediction equation. These variables were: (1) semesters of FFA membership, (2) semesters of participation in soil and crop judging teams, and (3) degree of involvement in FFA. Because student involvement in FFA was a categorical variable, dummy coding was used for this analysis, resulting in one category, rare FFA involvement which negatively contributed to posttest scores. Thus, knowing a student's semesters of FFA membership, semesters of participation in soil and crop judging teams, and degree of involvement in FFA can help determine the student's posttest scores with an associated variance of .07 (adjusted R²).

Table 7. Regression analysis of selected student variables and student posttest knowledge scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>Multiple R</th>
<th>Adjusted R²</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semesters of FFA</td>
<td>.20</td>
<td>.20</td>
<td>.03</td>
<td>.00</td>
</tr>
<tr>
<td>Semester of FFA soil &amp; crops judging teams</td>
<td>.14</td>
<td>.27</td>
<td>.07</td>
<td>.00</td>
</tr>
<tr>
<td>FFA involvement (rare)</td>
<td>- .13</td>
<td>.28</td>
<td>.07</td>
<td>.00</td>
</tr>
</tbody>
</table>
Stepwise regression analyses were used to identify student independent variables which contributed to student pretest and posttest natural resources attitude inventory scores. Data presented in Table 8 revealed that three variables had significant values, allowing them to be entered into the prediction equation for pretest student attitude scores. These variables were: (1) semesters of student participation in soil or crop judging teams, (2) rare FFA involvement (negative contribution), and (3) number of SAE programs. The second analysis revealed five variables with significant values, allowing them to be entered into the prediction equation for posttest student attitude scores. These variables were: (1) semesters of agricultural instruction, (2) high FFA involvement, (3) the gender of the student being a boy (negative contribution), (4) grade in school, and (5) semesters of participation in FFA soil and crop judging. More specifically, these findings indicate that knowing a student's participation in FFA soil and crop judging teams, involvement in FFA, and number of SAE programs can help determine the student's pretest attitude toward natural resources with an associated variance of .07 (adjusted R^2). Similarly, knowing a student's semesters of agriculture instruction, FFA involvement, gender, grade in school, and semesters of participation in FFA soils and crop judging teams can help determine the student's posttest attitude score with an associated variance of .12 (adjusted R^2).

In summary, the analyses of student data revealed that the two groups of students were homogeneous in: (1) ethnic background, (2) place of residence, (3) gender, (4) learning ability, (5) FFA involvement, (6) SAE involvement, (7) number of SAE programs, and (8) number of SAE programs with a natural resources component. Groups were heterogeneous in: (1) student grade level, (2) semesters of agriculture classes, (3) semesters of natural resources instruction, and (4) semesters of FFA membership. FFA participation and semesters of soil and crop judging team participation appeared to contribute significantly to student posttest scores.
Table 8. Stepwise regression analysis of selected student variables and natural resources attitude scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>Multiple R</th>
<th>Adjusted R^2</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pretest attitude inventory</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester of FFA soil &amp; crops judging teams</td>
<td>.21</td>
<td>.21</td>
<td>.03</td>
<td>.00</td>
</tr>
<tr>
<td>Rare FFA involvement</td>
<td>-.16</td>
<td>.26</td>
<td>.06</td>
<td>.00</td>
</tr>
<tr>
<td>Total SAE programs</td>
<td>.13</td>
<td>.29</td>
<td>.07</td>
<td>.00</td>
</tr>
<tr>
<td><strong>Posttest attitude inventory</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semesters of agriculture instruction</td>
<td>.24</td>
<td>.24</td>
<td>.05</td>
<td>.00</td>
</tr>
<tr>
<td>High FFA involvement</td>
<td>.15</td>
<td>.28</td>
<td>.07</td>
<td>.00</td>
</tr>
<tr>
<td>Gender (boy)</td>
<td>-.17</td>
<td>.33</td>
<td>.10</td>
<td>.00</td>
</tr>
<tr>
<td>Grade in school</td>
<td>.18</td>
<td>.37</td>
<td>.12</td>
<td>.00</td>
</tr>
<tr>
<td>Semesters of FFA soil &amp; crops judging teams</td>
<td>.14</td>
<td>.38</td>
<td>.12</td>
<td>.00</td>
</tr>
</tbody>
</table>
Teacher and Class Characteristics

Thirty-five teachers representing the same number of schools were involved in the experiment. Eighteen teachers used the environmental conservation technology instructional unit (experimental group) and sixteen teachers followed an environmental conservation technology unit outline which included only lesson titles and objectives, using their own methods and materials (control group). The following discussion and series of tables describe selected teacher and school variables.

Teachers were asked to self-rate their knowledge of natural resources on pre-survey and post-survey instruments. Only three percent of the teachers reported they had no knowledge of natural resources, nine percent said they had slight knowledge, 24 percent reported average knowledge, 51 percent reported they had above average knowledge, and 12 percent stated they had high knowledge of natural resources. This is similar to the findings of Whent and Williams (1988). Group t-test analyses revealed no significant differences between experimental group and control group teachers on their pre-survey self-rated knowledge of natural resources. Also, no significant differences were observed between groups on their post-survey knowledge ratings. Thus, the two groups were homogeneous regarding teacher pre-survey and post-survey self-rated knowledge of natural resources. These findings are reported on Table 9A. Paired t-test analyses revealed no significant differences within the experimental and control groups regarding pre-survey and post-survey teachers natural resources knowledge ratings. These results showed no change in teacher's self-rated natural resources knowledge from pre-survey to post-survey for either experimental or control groups. Results of the paired t-test analyses are reported on Table 9B.
Table 9A. T-test analysis of teacher’s self-rated knowledge of natural resources by group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (n=17)</td>
<td>Mean (n-14)</td>
</tr>
<tr>
<td>Pre Survey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-rated knowledge of natural resources</td>
<td>3.71</td>
<td>3.44</td>
</tr>
<tr>
<td></td>
<td>1.16</td>
<td>0.89</td>
</tr>
<tr>
<td>Post Survey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-rated knowledge of natural resources</td>
<td>4.00</td>
<td>3.29</td>
</tr>
<tr>
<td></td>
<td>0.79</td>
<td>1.27</td>
</tr>
</tbody>
</table>

Table 9B. Paired t-test analysis of teachers pre-survey and post-survey self-rated knowledge of natural resources within groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Pre-survey (Mean)</th>
<th>Post-survey (Mean)</th>
<th>SD</th>
<th>t-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>17</td>
<td>3.71</td>
<td>4.00</td>
<td>0.79</td>
<td>1.23</td>
<td>.24</td>
</tr>
<tr>
<td>Control</td>
<td>14</td>
<td>3.36</td>
<td>3.27</td>
<td>1.27</td>
<td>-.21</td>
<td>.84</td>
</tr>
</tbody>
</table>
Table 10. Time of day students received natural resources instruction by group

<table>
<thead>
<tr>
<th>Hour</th>
<th>Experimental</th>
<th></th>
<th>Control</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>8:00 am</td>
<td>1</td>
<td>2.0</td>
<td>3</td>
<td>8.8</td>
<td>4</td>
<td>11.8</td>
</tr>
<tr>
<td>9:00 am</td>
<td>2</td>
<td>5.9</td>
<td>1</td>
<td>2.0</td>
<td>3</td>
<td>8.8</td>
</tr>
<tr>
<td>10:00 am</td>
<td>5</td>
<td>14.7</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>14.7</td>
</tr>
<tr>
<td>11:00 am</td>
<td>3</td>
<td>8.8</td>
<td>1</td>
<td>2.0</td>
<td>4</td>
<td>11.8</td>
</tr>
<tr>
<td>12:00 noon</td>
<td>2</td>
<td>5.9</td>
<td>1</td>
<td>2.0</td>
<td>3</td>
<td>8.8</td>
</tr>
<tr>
<td>1:00 pm</td>
<td>1</td>
<td>2.0</td>
<td>6</td>
<td>17.6</td>
<td>7</td>
<td>20.6</td>
</tr>
<tr>
<td>2:00 pm</td>
<td>4</td>
<td>11.8</td>
<td>2</td>
<td>5.9</td>
<td>6</td>
<td>17.6</td>
</tr>
<tr>
<td>3:00 pm</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>5.9</td>
<td>2</td>
<td>5.9</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>52.9</td>
<td>16</td>
<td>47.1</td>
<td>34</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Missing cases = 2

chi-square with modified cells = 1.95

p = .16

Teachers were asked to report the time of day they taught the environmental conservation technology unit. Frequencies and percents of the time of day instruction was provided to students by group are presented in Table 10. Data were modified to reflect two groups for chi-square analysis: (1) morning instruction and (2) afternoon instruction. This chi-square analysis revealed a chi-square value of 1.95 (p = .16). Thus, suggesting the time of day students received instruction was independent of the group.

Data for the variables: (1) years teaching experience, (2) length of class period, (3) percent of natural resources in the agriculture curriculum, (4) percent of students who include a natural resources component in their FFA activities, and (5) percent of agriculture students
who include a natural resources component in their SAE programs are presented on Table 11. The mean years of teaching for all participating teachers in this study was 11.7. This finding is similar to the study by Whent and Williams (1988), which found that the mean number years of teaching experience for ASTM teachers in Iowa was 11.5. The mean percent of agriculture curriculum devoted to natural resources was 15.2. This is slightly higher than the mean of 13.1 found by Whent and Williams. The mean percent of students incorporating a natural resources component into their SAE programs was 15.7. No significant differences were observed using a t-test analysis between experimental and control groups for the variables named in Table 11. Thus it was concluded that the groups were homogeneous with regards to these variables.

Table 11. Results of t-test comparisons of selected school situational means by group as reported by teachers

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (n=144)</td>
<td>SD</td>
</tr>
<tr>
<td>Teaching experience (years)</td>
<td>10.41</td>
<td>9.30</td>
</tr>
<tr>
<td>Length of class period (minutes)</td>
<td>46.00</td>
<td>2.91</td>
</tr>
<tr>
<td>Degree of natural resources in curriculum (%)</td>
<td>13.00</td>
<td>5.53</td>
</tr>
<tr>
<td>Natural resources components in FFA(%)</td>
<td>34.76</td>
<td>35.41</td>
</tr>
<tr>
<td>Natural resource Components in SAE (%)</td>
<td>12.00</td>
<td>10.24</td>
</tr>
</tbody>
</table>
The pretest and posttest teacher surveys asked open-ended questions to collect qualitative data about the teacher, class, and instructional materials. Up to three responses per question were collected from teachers. A list of questions, answer summaries, and frequency of responses are presented in Table 12. Teachers were asked to list experiences, materials and/or events which had caused them to expand their teaching of natural resources in their agricultural programs. The answers most identified by teachers were: (1) current news items in the media about conservation of natural resources, (2) personal concern for the environment, (3) availability of instructional materials on natural resources and conservation and in-service activities during teacher conferences, and (4) the recent conservation emphasis in government programs. The second question asked teachers the subject area(s) in natural resources/conservation they most enjoyed teaching. Twenty-seven teachers identified soil conservation as the natural resources subject they most enjoyed teaching, followed by water and wildlife conservation. Teachers may have listed soil and water conservation due to the attention these subject areas were receiving in the news media, groundwater and soil emphasis in government programs, and the increased number of instructional materials and teaching models available.

Class variables were also collected from teachers. Teachers were asked to record the name of the class in which the natural resource instructional materials were taught. A list of the class titles and frequencies are presented in Table 13. Eight agriculture classes were titled vocational agriculture I through vocational agriculture IV, five classes were titled agriculture science, and two classes used the title agriculture science technology and marketing. Three courses emphasized natural resources, three courses taught plant science and agronomy, and six courses emphasized farm management and agribusiness.
Table 12. Teacher open-ended responses about teaching natural resources

Question: Please list experiences, materials, etc. which have caused you to consider expanding the teaching of natural resources in your agricultural program.

<table>
<thead>
<tr>
<th>Cause of expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Current news items in the media about conservation of natural resources</td>
</tr>
<tr>
<td>8 Personal concern for environment, feelings and beliefs</td>
</tr>
<tr>
<td>5 In-service activities during teacher conference</td>
</tr>
<tr>
<td>5 Availability of instructional materials on natural resources and conservation</td>
</tr>
<tr>
<td>4 Emphasis of government programs in area or state</td>
</tr>
<tr>
<td>4 Teaching a course on natural resources in vocational agriculture</td>
</tr>
<tr>
<td>3 Graduate courses in conservation of natural resources</td>
</tr>
<tr>
<td>2 New technologies in area of natural resources</td>
</tr>
<tr>
<td>1 Visiting with other instructors who have successfully incorporated natural resources into their programs</td>
</tr>
<tr>
<td>1 Other in-services and programs</td>
</tr>
<tr>
<td>1 Written materials on natural resources</td>
</tr>
<tr>
<td>1 Relate soil and water conservation of other resources, i.e., wildlife</td>
</tr>
<tr>
<td>1 Working in another area of conservation</td>
</tr>
<tr>
<td>1 BOAC program</td>
</tr>
<tr>
<td>1 Pheasants forever</td>
</tr>
<tr>
<td>1 Educational environmental computer programs</td>
</tr>
<tr>
<td>1 Filmstrips and video tapes on natural resources and conservation</td>
</tr>
</tbody>
</table>

Question: What subject area(s) in natural resources do you most enjoy teaching?

<table>
<thead>
<tr>
<th>Subject area</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 Soil conservation</td>
</tr>
<tr>
<td>16 Water</td>
</tr>
<tr>
<td>14 Wildlife</td>
</tr>
<tr>
<td>3 Biotechnology</td>
</tr>
<tr>
<td>2 Chemical Safety</td>
</tr>
<tr>
<td>2 New technologies in conserving natural resources.</td>
</tr>
<tr>
<td>2 Energy</td>
</tr>
<tr>
<td>1 Rural recreation</td>
</tr>
<tr>
<td>1 Forest</td>
</tr>
<tr>
<td>1 Land stewardship</td>
</tr>
</tbody>
</table>
Table 13. Title of courses in which the environmental conservation technology unit was taught

<table>
<thead>
<tr>
<th>f</th>
<th>Course title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Vocational agriculture I and II</td>
</tr>
<tr>
<td>5</td>
<td>Natural resources-conservation</td>
</tr>
<tr>
<td>5</td>
<td>Ag science II through IV</td>
</tr>
<tr>
<td>4</td>
<td>Agribusiness</td>
</tr>
<tr>
<td>2</td>
<td>Farm management/Business management</td>
</tr>
<tr>
<td>2</td>
<td>Vocational agriculture III and IV</td>
</tr>
<tr>
<td>2</td>
<td>ASTM</td>
</tr>
<tr>
<td>2</td>
<td>Animal science</td>
</tr>
<tr>
<td>1</td>
<td>Soils and conservation</td>
</tr>
<tr>
<td>1</td>
<td>Agronomy</td>
</tr>
<tr>
<td>1</td>
<td>Environmental Science</td>
</tr>
<tr>
<td>1</td>
<td>Plant Science</td>
</tr>
<tr>
<td>1</td>
<td>Crops and soils</td>
</tr>
<tr>
<td>1</td>
<td>Ag 2000</td>
</tr>
</tbody>
</table>

Open-ended questions about the instructional unit were addressed on the teacher post instructional information form. The questions, summary of answers, and frequencies are presented in Table 14. When asked how their students reacted to the environmental conservation technology instructional unit, fourteen teachers had positive responses, three teachers had neutral responses, and five teachers said that biotechnology was emphasized too much, the unit was too long and/or it was difficult to get students motivated. One teacher felt he needed more knowledge about biotechnology before teaching the unit.
Table 14. Teacher posttest responses to student's reaction to the environmental conservation technology instructional unit

<table>
<thead>
<tr>
<th></th>
<th>Students' reactions to the unit as reported by teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Positive attitude, did quite well, enjoyed the unit, and were interested</td>
</tr>
<tr>
<td>3</td>
<td>Biotechnology and new technology was interesting</td>
</tr>
<tr>
<td>2</td>
<td>Very interested in subject, excited, drew attention to natural resources</td>
</tr>
<tr>
<td>2</td>
<td>Fairly well or O.K.</td>
</tr>
<tr>
<td>2</td>
<td>Biotechnology emphasized too much, students did not take an interest in it</td>
</tr>
<tr>
<td>2</td>
<td>Unit was too long--students were not interested in school</td>
</tr>
<tr>
<td>1</td>
<td>Learned a great deal</td>
</tr>
<tr>
<td>1</td>
<td>Neutral</td>
</tr>
<tr>
<td>1</td>
<td>Difficult to get students motivated</td>
</tr>
</tbody>
</table>

Teachers in the experimental group were asked to keep a daily log of their responses to teaching the environmental conservation technology instructional unit. They were asked to record what worked or did not work and suggest improvements and changes to the materials (these teacher suggestions were used to improve and modify the instructional unit before wider dissemination). A summary of teacher responses, by lesson, are presented on Table 15.
Table 15. Comments and suggestions for improvement of the instructional unit

Lesson 1. Identifying Natural Resources and Their Relationship to the Agriculture Industry

Teachers reported they had good discussions with students about definitions and categories of natural resources. Most teachers stated the homework assignment worked well, however a few teachers needed more explanation. Many teachers need a more thorough explanation of transparencies 3 and 4. One teacher believed the reading level was too high. Some suggestions for alternate activities and resources were provided.

Lesson 2. Recognizing New Technologies and Their Use in Conserving Natural Resources

Most teachers reported brainstorming new technologies was enjoyable and worked well. Students were very interested in new mechanical technologies to conserve natural resources. The handouts were good. A few teachers needed a more detailed list of new technologies, especially biotechnology. Two teachers thought the reading level was too high.

Lesson 3. Defining Biotechnology and Its Use in Conserving Natural Resources

Teachers reported that the three areas of biotechnology provided good definitions of biotechnologies, but needed more practical examples. The glossary worked very well. One teacher suggested more terms for the glossary. Teachers identified the history of biotechnology as too detailed; however, some suggested it provided for good discussion. A few teachers suggested the reading level was too high. Several teachers ordered tissue culture sets and reported success in teaching tissue culture. Three teachers reported their students were motivated to do additional activities to learn more about biotechnologies. Two teachers suggested there were too many transparencies.

Lesson 4. Conserving Soils Through Biotechnology

Teachers enjoy teaching this unit. Many teachers indicated the unit included good materials and worksheets on soil erosion, the nitrogen cycle, and pesticides. Teachers thought this unit was a good review of soils; one teacher suggested more background materials on soils were needed. Another teacher said students were very interested in the biopesticide section. Teachers also provided suggestions for activities and references.

Lesson 5. Conserving Water Resources Using Biotechnology

Many teachers reported that the hydrologic cycle worked very well. They thought the lesson a good review for students who had previously had instruction on groundwater. Teachers stated that the information sheets were good and students learned from them. Teachers suggested more worksheets or combination information-worksheets would be helpful. Drainage wells and their problems should be emphasized more.

Lesson 6. Conserving Forest Resources Using Biotechnology

Teachers reported that they need more background information and that students need examples that are relevant to them. This was a small unit and needs to be expanded with less reliance on transparencies. Teachers reported the questions were effective.

Lesson 7. Conserving Wildlife Using Biotechnology

Teachers reported the lesson was good and covered what teachers felt was important. Students were very interested in the subject area and good class discussion resulted. A teacher suggested students brainstorm pesticides harming wildlife. Facts about how wildlife is in danger in Iowa should be included.
Teachers were asked to teach the environmental conservation technology instructional unit for twelve periods, using two additional days for pretesting and posttesting. On a post inventory, teachers were asked to report the mean number of periods they taught the instructional unit, and if they did not have enough time, how much time they felt would be needed to complete the unit. Table 16 presents the means for each group regarding these variables and the results of two t-test analyses. The control group reported a mean of 19 class periods spent teaching the instructional unit and the experimental group reported a mean of 15. The control group felt they needed 35 class periods to adequately cover the materials, while the experimental group felt they needed 25 class periods. No significant differences were observed between groups regarding: (1) time spent teaching the environmental conservation instructional materials and (2) the time teachers felt necessary to adequately cover the materials.

Table 16. Number of periods teachers taught the instructional unit and the number of periods they believe were needed to adequately cover the instructional unit

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group</th>
<th></th>
<th></th>
<th>t-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental</td>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean (n=17)</td>
<td>Mean (n=14)</td>
<td>SD</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Periods instructional unit was taught</td>
<td>15.29</td>
<td>19.43</td>
<td>2.66</td>
<td>19.54</td>
<td>0.79</td>
</tr>
<tr>
<td>Periods needed to teach the unit</td>
<td>24.67</td>
<td>35.43</td>
<td>8.56</td>
<td>32.68</td>
<td>0.85</td>
</tr>
</tbody>
</table>
The final question asked of teachers was whether the instructional materials were at an appropriate level for their students. Twenty-eight teachers responded yes and two teachers responded no. Frequencies and percentages by group are presented on Table 17.

Table 17. Appropriateness of the instructional level of the environmental conservation technology unit

<table>
<thead>
<tr>
<th>Appropriate Level</th>
<th>Treatment group</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental</td>
<td>Control</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>Yes</td>
<td>16</td>
<td>53.3</td>
<td>12</td>
<td>40.0</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>3.3</td>
<td>1</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>56.7</td>
<td>13</td>
<td>43.3</td>
</tr>
</tbody>
</table>

The enter method of multiple regression was used to identify teacher and class variables which contributed to teacher attitude and student knowledge. Stepwise regression analyses were then calculated to identify independent teacher variables that contributed to both teacher and student dependent variables. Stepwise regression analysis found that one teacher variable contributed negatively to teacher posttest attitudes scores. The percent of natural resources included in teachers' curriculum contributed negatively to their attitude toward natural resources. The result of this analysis is presented in Table 18. It was expected that the higher the natural resources component in the agricultural curriculum the more positive the teacher's attitude toward natural resources. It was postulated that teachers who have high conservation values and were concerned about the environment would include
more environmental conservation instruction in their agricultural curriculum. No teacher or class variable contributed to teachers' attitude toward teaching natural resources.

Table 18. Stepwise regression analysis of selected teacher and class variables with teacher posttest natural resources attitude scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>Multiple R</th>
<th>Adjusted R²</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest Teacher Attitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent natural resources in the curriculum</td>
<td>-.38</td>
<td>.38</td>
<td>.12</td>
<td>.03</td>
</tr>
</tbody>
</table>

Two stepwise regression analyses were calculated to examine teacher independent variables which contribute to student posttest knowledge scores. For these analyses, the dependent variable included the mean student score by school for the total environmental conservation technology test and the natural resources subset of the knowledge test. Findings are reported in Table 19. Two stepwise regression analyses revealed a significant value for one teacher variable: the mean positive attitude of the teachers on the pretest attitude inventory toward teaching natural resources and conservation. More specifically, the mean attitude of the teachers toward teaching natural resources was found to significantly contribute to student achievement on both the total environmental conservation technology knowledge test and the subscale natural resources knowledge test with an associated variance of .17 and 22 (adjusted R²), respectively. When teachers have a positive attitude toward teaching a subject, they may be more interested and enthusiastic about the subject matter and this interest is projected to the students. Also, interested teachers may put forward more effort in promoting student learning of the subject.
Table 19. Stepwise regression analyses of teacher pretest attitudes toward teaching natural resources and student posttest scores.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multiple Beta</th>
<th>Multiple R</th>
<th>Adjusted R²</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental conservation technology test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean attitude of teachers toward teaching</td>
<td>.44</td>
<td>.44</td>
<td>.17</td>
<td>.01</td>
</tr>
<tr>
<td>natural resources and technology (pretest)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural resources subset test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean attitude of teachers toward teaching</td>
<td>.49</td>
<td>.49</td>
<td>.22</td>
<td>.00</td>
</tr>
<tr>
<td>natural resources and technology (pretest)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In summary, teacher and class categorical variables were independent of the group. There were no significant differences between the teacher and class variables for experimental and control groups. The random selection and assignment of schools to groups yielded homogeneity between the groups for the selected variables. Results of teacher and school analysis were similar to past studies, sampling similar populations. The environmental conservation technology instructional unit was tested in a variety of classes. Teachers reported that most students were interested in the materials and learned a great deal. Teachers identified they most enjoyed teaching soil, water, and wildlife conservation. Experiences which influenced teachers to increase natural resources instruction in their curriculum were: (1) natural resources concerns in the media, (2) their personal concerns for the environment, and (3) the availability of conservation instructional materials and in-service programs on the materials. A summary from the daily instructional reporting forms suggested that teachers were generally satisfied with the instructional materials, but some modifications were needed.
Stepwise regression analyses identified two teacher variables that could be used in predicting posttest scores. The variable "percent of natural resources component in the agriculture curriculum" was a negative contributor to teacher posttest attitudes toward natural resources. The variable "attitude of teachers toward teaching natural resources positively contributed to student posttest knowledge scores."

Instrument Characteristics

The reliability of instruments used in the study were tested and the results are presented in the following sections.

Environmental Conservation Technology Test

Pretest and posttest forms of the knowledge test contained the same items. However, items were randomly rearranged from pretest to posttest. Both pretest and posttest forms of the knowledge inventory instruments were analyzed for reliability and item analysis using both experimental and control group student scores. Summary statistics calculated for the objective-referenced test are shown in Table 20.

The reliability coefficient (KR-20) was .82 for the knowledge pretest and .89 for the knowledge posttest. Students answered 53 percent of the items correctly on the pretest and 60 percent of the items correctly on the posttest. The mean item difficulties were .52 and .55 for the pretest and posttest forms of the criterion-referenced test, respectively. Item difficulty ranged from 20 to 80 percent on the pretest and 35 to 73 percent on the posttest. Items in the medium range of difficulty, 30 - 70 percent, result in higher item discrimination and thus better separate students according to levels of achievement (Test and Evaluation Services, 1989). The mean item discrimination is the correlation between the student response on the
item and the student's total score on the test. This statistic reflects the extent to which test items discriminate between knowledgeable and less knowledgeable students (Hosseini, 1983). The mean discrimination value was .38 and .47 for the pretest and posttest, respectively. Items with .40 or above provide very good discrimination (Test and Evaluation Services, 1989). Individual item analysis indicated that all 35 items had positive discrimination values and ranged from .11 to .62.

Table 20. Descriptive summary of environmental conservation technology objective-referenced test

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean score (raw score)</td>
<td>18.61</td>
<td>20.93</td>
</tr>
<tr>
<td>Standard error of measurement</td>
<td>2.61</td>
<td>2.58</td>
</tr>
<tr>
<td>Variance</td>
<td>39.59</td>
<td>57.08</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>6.29</td>
<td>7.68</td>
</tr>
<tr>
<td>Mean item difficulty</td>
<td>.52</td>
<td>.55</td>
</tr>
<tr>
<td>Mean item discriminating power</td>
<td>.38</td>
<td>.47</td>
</tr>
<tr>
<td>KR - 20 reliability estimate</td>
<td>.82</td>
<td>.89</td>
</tr>
</tbody>
</table>

The environmental conservation technology knowledge test was divided into two subscales. One subscale consisted of 12 items developed to measure knowledge of technology and biotechnology. The other subscale consisted of 23 items developed to measure knowledge of natural resources. Summary statistics calculated for the two subscales are presented on Table 21. The reliability coefficient (KR-20) was .78 for the natural resources subscale pretest and .84 for the natural resources subscale posttest. Students
answered 56 percent of the items correctly on the pretest and 60 percent of the items correctly on the posttest. The mean item difficulties were .55 and .57 for the pretest and posttest subscales, respectively. Item difficulty ranged from 30 to 76 percent on the pretest and 35 to 75 percent on the posttest. The mean discrimination values were .42 and .48 for the pretest and posttest natural resources subscales, respectively. Individual item analysis indicated that all 23 items had positive discrimination values and ranged from .14 to .65 on the pretest and .27 to .72 on the posttest.

The pretest technology subscale had a low reliability coefficient (KR-20) of .62 and a higher reliability coefficient of .71 on the posttest. Students answered 47 percent of the items correctly on the pretest and 59 percent of the items correctly on the posttest. The mean item difficulties were .47 and .56 for the pretest and posttest subscales, respectively. Item difficulty ranged from 20 to 71 percent on the pretest and 41 to 73 percent on the posttest. The mean discrimination values were .40 and .49 for the pretest and posttest natural resources subscales, respectively. Individual item analysis indicated that all 23 items had positive discrimination values and ranged from .21 to .55 on the pretest and .33 to .65 on the posttest. Although the reliability coefficient of .62 was somewhat low for the technology pretest, other indicators of test effectiveness such as item difficulty and discrimination were at appropriate levels. Student scores ranged between 0 and 10 on the technology pretest resulting in a leptokurtic distribution. The most important statistic was the mean item discriminating power. A mean pretest item discriminating power of .40, with a range of .21 to .55 should provide good discrimination between student's knowledge. After students had acquired more knowledge of technology, the posttest provided better discrimination between knowledgeable and less knowledgeable students. The posttest of this instrument produced an acceptable reliability coefficient. The reliability coefficients of both technology
Table 21. Descriptive summary of knowledge test subscales: technology and natural resources

<table>
<thead>
<tr>
<th>Natural resources subscale</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean score (raw score)</td>
<td>12.96</td>
<td>13.90</td>
</tr>
<tr>
<td>Standard error of measurement</td>
<td>2.14</td>
<td>2.09</td>
</tr>
<tr>
<td>Variance</td>
<td>21.03</td>
<td>26.79</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>4.59</td>
<td>5.18</td>
</tr>
<tr>
<td>Mean item difficulty</td>
<td>.55</td>
<td>.57</td>
</tr>
<tr>
<td>Mean item discriminating power</td>
<td>.42</td>
<td>.48</td>
</tr>
<tr>
<td>KR - 20 reliability estimate</td>
<td>.78</td>
<td>.84</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology subscale</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean score (raw score)</td>
<td>5.74</td>
<td>7.02</td>
</tr>
<tr>
<td>Standard error of measurement</td>
<td>1.59</td>
<td>1.53</td>
</tr>
<tr>
<td>Variance</td>
<td>5.28</td>
<td>8.02</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>2.30</td>
<td>2.83</td>
</tr>
<tr>
<td>Mean item difficulty</td>
<td>.47</td>
<td>.56</td>
</tr>
<tr>
<td>Mean item discriminating power</td>
<td>.40</td>
<td>.49</td>
</tr>
<tr>
<td>KR - 20 reliability estimate</td>
<td>.62</td>
<td>.71</td>
</tr>
</tbody>
</table>

Pretest and posttest may be affected by the small number of items making up the subscale. It was also hypothesized by the researcher that test items covering new information may cause students to become frustrated and not put their full effort into responding to the items. After
receiving instruction, there is greater likelihood that students will concentrate on answering
the items correctly.

Table 22. Reliability estimate (Cronbach's alpha) for the student and teacher attitude
inventories.

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student natural resources attitude inventory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of items</td>
<td>30.00</td>
<td>30.00</td>
</tr>
<tr>
<td>Cronbach's Alpha</td>
<td>.77</td>
<td>.77</td>
</tr>
<tr>
<td>Mean</td>
<td>6.32</td>
<td>6.31</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>.82</td>
<td>.95</td>
</tr>
<tr>
<td><strong>Teacher natural resources attitude subscale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Items</td>
<td>29.00</td>
<td>29.00</td>
</tr>
<tr>
<td>Cronbach's Alpha</td>
<td>.61</td>
<td>.74</td>
</tr>
<tr>
<td>Mean</td>
<td>7.45</td>
<td>7.39</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>.61</td>
<td>.71</td>
</tr>
<tr>
<td><strong>Teacher attitude toward teaching</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>natural resources subscale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Items</td>
<td>6.00</td>
<td>6.00</td>
</tr>
<tr>
<td>Cronbach's Alpha</td>
<td>.81</td>
<td>.86</td>
</tr>
<tr>
<td>Mean</td>
<td>7.56</td>
<td>7.73</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>.99</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Student and Teacher Natural Resources Attitude Inventory

Both the student and teacher natural resources attitude inventory were used as pretest and posttest. A reliability estimate using Cronbach's coefficient alpha provided a measure of .77 for both pretest and posttest of the student natural resources attitude inventory. The teacher natural resources attitude inventory consisted of 35 statements using the same 9-point Likert scale as the student's inventory. The first 29 items on the teacher's attitude inventory was identical to that of the students. The remaining six items consisted of statements about teaching natural resources. The instrument was divided into two subscales, one measuring attitudes towards natural resources and the other measuring attitudes toward teaching natural resources. Cronbach's alpha reliability analysis of the natural resources subscale attitude inventory revealed .61 and .74 for the pretest and posttest, respectively.

Pretest and posttest analysis of the attitude inventories measuring teacher attitudes toward teaching natural resources revealed a Cronbach's alpha reliability measure of .81 and .85, respectively. Results of these procedures are presented in Table 22.

In summary, the analyses of the dependent variable data gathering instruments revealed that the knowledge inventory had good internal consistency as measured by KR-20 reliability coefficient for categorical items. The natural resources subscale also had good reliability. Analysis of the technology pretest subscale revealed a lower reliability than desired, however the item discrimination and difficulty were good. The student and teacher natural resources attitude instruments were found to have acceptable reliability, but reliability results for the teacher natural resources attitude pretest was also lower than desired.
Inferential Analyses and Testing of Hypotheses

The purpose of this study was to evaluate the effectiveness of an instructional unit on environmental conservation technology. The objectives of the study were to (1) determine if use of the instructional unit would significantly increase student knowledge of environmental conservation technology compared to instructional materials currently used by ASTM teachers, and (2) determine the impact of the instructional unit on student attitudes toward natural resources.

Because the dependent variables were assumed to be influenced by the treatment, school means were used in these analyses. Therefore, schools were considered as the experimental units.

Comparison of Student Knowledge Scores

The null hypothesis tested were as follows:

\( H_{01} \): There is no difference between posttest scores for the groups after variations due to pretest scores are removed.

\( H_{02} \): There is no difference between pretest and posttest scores within groups.

Analysis of covariance was used to determine if the use of the instructional unit significantly increased students' knowledge of environmental conservation technology. Two F-values are reported in Table 23. The first F-value revealed the difference between groups on the covariate. The experimental and control groups had significantly different pretest or covariate scores. The second F-value reveals the difference between group posttest scores after adjusting for the covariate. A significant difference was observed between experimental and control groups on knowledge posttest scores after adjusting for pretest scores. From this
The researcher rejected $H_0$ and accepted $H_A$. The experimental group learned significantly more about environmental conservation technology than the control group.

Table 23. Analysis of covariance for knowledge scores of groups, using the pretest as a covariate

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pretest response</td>
<td>1</td>
<td>46.15</td>
<td>46.15</td>
<td>5.25</td>
<td>.03</td>
</tr>
<tr>
<td>Treatment adjusted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for covariate</td>
<td>1</td>
<td>47.97</td>
<td>47.97</td>
<td>7.78</td>
<td>.01</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>191.07</td>
<td>6.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The environmental conservation technology test consisted of 35 items. The experimental group ranged from 30% to 71% correct answers on the pretest, and 37% to 81% on the posttest. The mean percent correct for the pretest and posttest was 56% and 66%, respectively. Thus, schools in the experimental group had a 10% increase in knowledge scores. The control group ranged from 35% to 60% correct answers on the pretest and 29% to 63% on the posttest. The mean percent correct for the pretest and posttest scores were 50% and 53%, respectively. The control group showed only a 3% increase in knowledge scores. Paired t-test procedures were used to test for significant differences between knowledge pretest and posttest means within the groups. A t-value of 7.45 ($p = .00$) indicated a significant difference between pretest and posttest means for the experimental group. Therefore, the researcher rejected $H_0$ and accepted $H_A$; the experimental group had a significant increase in knowledge of environmental conservation from pretest to
posttest. However, no significant difference was observed between pretest and posttest means of the control group. Thus, the researcher failed to reject Ho. These findings and group means are presented in Table 24.

Table 24. Paired t-test analyses of pretest and posttest knowledge scores by group

<table>
<thead>
<tr>
<th>Treatment Groups</th>
<th>n</th>
<th>Pretest</th>
<th>SD</th>
<th>Posttest</th>
<th>SD</th>
<th>t-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>18</td>
<td>19.78</td>
<td>3.35</td>
<td>23.26</td>
<td>3.53</td>
<td>7.45</td>
<td>.00</td>
</tr>
<tr>
<td>Control</td>
<td>16</td>
<td>17.44</td>
<td>2.45</td>
<td>18.61</td>
<td>3.70</td>
<td>1.60</td>
<td>.13</td>
</tr>
</tbody>
</table>

Use of technology (biotechnology) to conserve natural resources was a main focus of the instructional unit. Because there is little biotechnology instructional materials available to agriculture teachers and the fact that the natural resources knowledge test contained 12 questions related to technology, a second analysis was done using two knowledge subscales. One subscale included twelve questions about technology, and the other included twenty-three questions about natural resources. Table 25 provides the results of this analysis. Two analyses of covariance were calculated, one using the technology subscale of the posttest scores and the other using the natural resources subscale of posttest scores. Both analyses used subscale pretest scores as the covariate. The analysis of covariance revealed no significant differences between groups on knowledge of natural resources. However, a significant difference between experimental and control groups was observed for knowledge of technology. These findings indicate that the difference between experimental and control
groups on the environmental conservation technology knowledge test was due to students' knowledge of technology, not natural resources.

Table 25. Analyses of covariance of both the natural resources and technology posttest subscales by group, using the pretest subscales as covariates

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural resources subscale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre natural resources</td>
<td>1</td>
<td>1.11</td>
<td>1.11</td>
<td>.91</td>
<td>.35</td>
</tr>
<tr>
<td>Treatment adjusted for covariance</td>
<td>1</td>
<td>11.05</td>
<td>11.05</td>
<td>2.62</td>
<td>.12</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>130.56</td>
<td>4.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology subscale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre technology</td>
<td>1</td>
<td>45.62</td>
<td>45.62</td>
<td>53.51</td>
<td>.00</td>
</tr>
<tr>
<td>Treatment adjusted for covariance</td>
<td>1</td>
<td>9.90</td>
<td>9.90</td>
<td>11.61</td>
<td>.00</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>26.43</td>
<td>.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The experimental group mean percent correct on the natural resources subscale for pretest and posttest was 60% and 67%, respectively. Thus, schools in the experimental group had a 7% increase in natural resources knowledge scores. Schools in the control group had mean percent correct natural resources pretest and posttest scores of 53% and 54%, respectively. The control group showed only a 1% increase in natural resources knowledge. The experimental group had mean technology subscale pretest and posttest...
scores of 50% and 66%, indicating a 16 percent increase in technology knowledge. While the control group had technology subset pretest and posttest percentage scores of 45 and 51, respectively, indicating a 6% increase in technology scores. These data and group ranges are summarized on Table 26.

Table 26. Natural resources and technology subscale scores and ranges

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Range %</th>
<th>Mean % Correct</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
</tr>
<tr>
<td><strong>Experimental group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural resources test</td>
<td>30 to 75</td>
<td>48 to 82</td>
<td>60</td>
<td>67</td>
<td>7</td>
</tr>
<tr>
<td>Technology test</td>
<td>28 to 65</td>
<td>54 to 85</td>
<td>50</td>
<td>66</td>
<td>16</td>
</tr>
<tr>
<td><strong>Control group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural resources test</td>
<td>43 to 73</td>
<td>29 to 69</td>
<td>53</td>
<td>54</td>
<td>1</td>
</tr>
<tr>
<td>Technology test</td>
<td>31 to 69</td>
<td>29 to 64</td>
<td>45</td>
<td>51</td>
<td>6</td>
</tr>
</tbody>
</table>

Paired t-test analyses were calculated to determine differences between pretest and posttest groups on the technology and natural resources subscales of the knowledge test. Table 27 presents the results of these analyses. A significant difference was observed between pretest and posttest technology scores for both experimental and control groups. Therefore, Ho was rejected and Ha was accepted. The experimental group was significantly different on the natural resources subscale of the knowledge test; however, no significant difference was observed between control group pretest and posttest natural resources scores. Therefore, for the control group, the researcher failed to reject Ho.
Table 27. Paired t-test comparison of pretest and posttest technology and natural resources subscale scores by group

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>n</th>
<th>Pretest mean</th>
<th>SD</th>
<th>Posttest mean</th>
<th>SD</th>
<th>t-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental Group (Raw Scores)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural resources subset</td>
<td>18</td>
<td>13.73</td>
<td>2.49</td>
<td>15.30</td>
<td>2.41</td>
<td>3.80</td>
<td>.00</td>
</tr>
<tr>
<td>Technology subset</td>
<td>18</td>
<td>6.04</td>
<td>1.12</td>
<td>7.97</td>
<td>1.26</td>
<td>11.41</td>
<td>.00</td>
</tr>
<tr>
<td><strong>Control Group (Raw Scores)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural resources subset</td>
<td>16</td>
<td>12.19</td>
<td>2.21</td>
<td>12.50</td>
<td>2.63</td>
<td>.52</td>
<td>.61</td>
</tr>
<tr>
<td>Technology subset</td>
<td>16</td>
<td>5.44</td>
<td>1.04</td>
<td>6.08</td>
<td>1.29</td>
<td>2.67</td>
<td>.02</td>
</tr>
</tbody>
</table>

In summary, analysis of covariance was used to test for differences between experimental and control groups as to knowledge of environmental conservation technology, using pretest knowledge scores as a covariate. Significant differences were observed between experimental and control groups on the knowledge test. Further analyses found that the difference between group knowledge scores was on knowledge of technology, rather than knowledge of natural resources. Differences between pretest and posttest knowledge scores occurred in both measures of knowledge for the experimental group, but only for technology knowledge in the control group.

**Comparison of Student Attitude Scores**

The student attitude inventory consisted of 30 statements about natural resources. Students responded to the statements using a 9-point Likert scale. School means were calculated from these data and used for inferential analyses.
The null hypotheses tested were as follows:

\( H_03: \) There is no difference between groups' student attitude posttest scores after variations due to student attitude pretest scores are removed.

\( H_04: \) There is no difference between pretest and posttest student attitude scores within groups.

Analysis of covariance was used to determine differences between groups regarding student attitudes toward natural resources on the posttest attitude survey, using the pretest attitude survey as a covariate. Table 28 presents the results of the analysis of covariance for these variables. No significant differences were observed between groups on student attitudes toward natural resources and conservation. The researcher failed to reject \( H_0 \). This analysis suggests that the experimental treatment had no affect in changing student attitudes towards natural resources and conservation.

Paired t-test analyses were employed to determine differences between pretest and posttest means. No significant difference was observed in experimental or control group attitudes toward natural resources. The researcher again failed to reject \( H_0 \). The results of these analyses are presented on Table 29.

Table 28. Analysis of covariance of group attitude scores, using the pretest attitude inventory as the covariate

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-attitude score</td>
<td>1</td>
<td>46.15</td>
<td>46.15</td>
<td>5.25</td>
<td>.03</td>
</tr>
<tr>
<td>Treatment adjusted for covariance</td>
<td>1</td>
<td>.01</td>
<td>.01</td>
<td>0.05</td>
<td>.82</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>5.37</td>
<td>.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 29. Paired t-test comparison of pretest and posttest student attitude toward natural resources using group means

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>n</th>
<th>Pretest mean</th>
<th>Posttest mean</th>
<th>t-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student natural resources mean</td>
<td>18</td>
<td>6.45</td>
<td>6.47</td>
<td>0.13</td>
<td>0.89</td>
</tr>
<tr>
<td>attitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Control Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student natural resources mean</td>
<td>16</td>
<td>6.28</td>
<td>6.32</td>
<td>0.70</td>
<td>0.50</td>
</tr>
<tr>
<td>attitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In summary, no changes in student attitude were observed between experimental and control groups or between pretest and posttest scores within groups. The mean score of both groups was just over 6.0 on a 9-point Likert scale. The number six represented "slightly agree" on the Likert scale. This mean indicated that students were in slight agreement with the natural resources items, but there was room for further changes of natural resources attitudes through education. Past studies of Iowa secondary vocational agriculture students have provided similar findings. Hosseini (1982) and Birkenholz (1982) both found a change in cognitive knowledge between experimental and control groups in similar experimental studies, however, neither found significant changes between groups regarding measurements of the affective domain (attitude). It is postulated that a three week instructional period is not sufficient time in which to change student attitudes.
Comparison of Teacher Attitude Scores

The teacher attitude inventory consisted of two subscales: (1) a natural resources attitude subscale consisting of 29 items and (2) a teaching natural resources attitude subscale consisting of six items. Teachers responded to this instrument using the same 9-point Likert scale as the students.

Analysis of covariance was used to determine differences between teachers' responses on the attitude inventory between the experimental and control groups. The hypotheses tested were as follows:

- **H05**: There is no difference between groups' teacher attitude posttest scores after variations due to teacher attitude pretest scores are removed.
- **H06**: There is no difference between groups' teacher posttest attitude toward teaching environmental conservation technology after variations due to teacher pretest scores are removed.
- **H07**: There is no difference within groups between pretest and postest attitude scores.

Analyses of covariance were used to determine differences between experimental and control group teacher posttest attitude scores. The summary of analyses of covariance for each subscale is presented on Table 30. No significant difference was observed between groups regarding teacher posttest attitudes, using pretest attitude scores as covariates. Therefore, the researcher failed to reject Ho. More specifically, this finding revealed no significant differences between teachers in the experimental and control groups regarding their attitudes toward natural resources or their attitudes towards teaching natural resources.

Paired t-test analyses were employed to determine differences between teachers' pretest and posttest mean attitude scores on the two subscales of the instrument. No significant differences were observed between teacher pretest and posttest scores regarding teacher attitudes. Therefore, the researcher failed to reject Ho. Specifically, teacher attitudes toward natural resources conservation, and attitudes toward teaching environmental
Table 30. Analyses of covariance of teacher attitude inventory mean scores by group

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
</table>

**Natural resources attitude subscale**

<table>
<thead>
<tr>
<th>Covariates</th>
<th>DF</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>pretest attitude score</td>
<td>1</td>
<td>.09</td>
<td>.09</td>
<td>.24</td>
<td>.63</td>
</tr>
<tr>
<td>Treatment adjusted for covariance.</td>
<td>1</td>
<td>.49</td>
<td>.49</td>
<td>2.12</td>
<td>.16</td>
</tr>
<tr>
<td>Error</td>
<td>30</td>
<td>7.04</td>
<td>.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Teaching natural resources subscale**

<table>
<thead>
<tr>
<th>Covariates</th>
<th>DF</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre technology</td>
<td>1</td>
<td>1.65</td>
<td>1.65</td>
<td>1.74</td>
<td>.20</td>
</tr>
<tr>
<td>Treatment adjusted for covariance.</td>
<td>1</td>
<td>0.03</td>
<td>0.03</td>
<td>.03</td>
<td>.86</td>
</tr>
<tr>
<td>Error</td>
<td>30</td>
<td>27.43</td>
<td>.91</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

conservation did not change from pretest to posttest. Group means and t-values are presented on Table 31.

In summary, there were no differences between experimental and control groups regarding teachers attitudes towards natural resources and teaching natural resources. No significant differences were observed between teachers' pretest and posttest mean scores on either attitude subscale.
Table 31. Paired t-test analyses of teacher pretest and posttest natural resources and teaching natural resources attitude scores by group

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>n</th>
<th>Pretest mean SD</th>
<th>Posttest mean SD</th>
<th>t-value</th>
<th>Probability</th>
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</thead>
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<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Natural resource attitude</td>
<td>33</td>
<td>7.44 0.61</td>
<td>7.39 0.71</td>
<td>0.63</td>
<td>0.53</td>
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<tr>
<td>Teaching attitude</td>
<td>33</td>
<td>7.55 0.97</td>
<td>7.70 1.00</td>
<td>0.90</td>
<td>0.38</td>
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<tr>
<td>Experimental Group</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural resource attitude</td>
<td>17</td>
<td>7.49 0.70</td>
<td>7.55 0.67</td>
<td>0.44</td>
<td>0.66</td>
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<tr>
<td>Teaching attitude</td>
<td>17</td>
<td>7.77 0.19</td>
<td>7.84 0.28</td>
<td>0.42</td>
<td>0.68</td>
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<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural resource attitude</td>
<td>16</td>
<td>7.39 0.51</td>
<td>7.22 0.73</td>
<td>1.54</td>
<td>0.14</td>
</tr>
<tr>
<td>Teaching attitude</td>
<td>16</td>
<td>7.33 1.15</td>
<td>7.60 0.86</td>
<td>0.78</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Summary of Findings

Based on the analyses of data presented in this chapter, the following statements summarize the findings:

1. A majority of the student population was white male. Only three percent of the sample were minority students, and thirteen percent were female. Approximately five percent of the students were identified by their teachers as having severe learning disabilities.
2. Fifty-eight percent of the students enrolled in agriculture classes lived on farms, an additional 11 percent lived in rural areas, but not farms, and the remaining 31 percent live in towns and cities.

3. Descriptive analyses of the student, teacher, and class data revealed that random assignment of schools to groups was successful. Only student grade level, semesters of vocational agriculture, semesters of FFA participation, and semesters of natural resources instruction were significantly different between groups.

4. Stepwise regression analyses revealed student and teacher variables which contributed highly to student posttest knowledge scores. Student variables which predicted student posttest scores included: (1) semesters of student FFA membership, (2) semesters of student participation in soils or crop judging teams, and (3) rare FFA involvement (negative contribution). One teacher variable predicted student posttest scores on both the environmental conservation technology knowledge test and the natural resources subscale: the mean positive attitude of the teacher toward teaching natural resources and conservation.

5. Stepwise regression analyses revealed student variables which predicted student pretest and posttest attitude scores. Student variables which predicted pretest attitude scores included: (1) semesters of FFA soil and crops judging team participation, (2) rare FFA involvement (negative contribution), and (3) number of SAE programs. Student variables which predicted posttest attitude scores included: (1) semesters of agriculture instruction, (2) high involvement in FFA, (3) gender being male (negative contribution), (4) grade in school, and (5) semesters of FFA soil and crops judging team participation.

6. Analyses of the criterion-referenced knowledge test and test subscales revealed good item discrimination and item difficulty. Acceptable reliability was revealed on all
posttest knowledge measures. However, the pretest technology subscale revealed a lower than desired reliability. Student attitude inventory and teacher attitude inventory revealed acceptable reliabilities, but again the teacher natural resources attitude pretest subscale produced a lower than desirable reliability.

7. The experimental group scored significantly higher on the environmental conservation technology posttest than the control group after variations in pretest scores were removed. Further investigation revealed significant differences between groups on the technology subscale of the knowledge test. Groups were not significantly different on the natural resources subscale of the knowledge test.

8. The experimental group scored significantly higher on the knowledge posttest than on the pretest. However, there was no significant difference between control group pretest and posttest knowledge scores. Further analysis revealed the experimental group was significantly different between pretest and posttest knowledge scores on both the natural resources and technology subscales. The control group was significantly different between pretest and posttest on the technology subscale, but not the natural resources subscale.

9. There were no differences between experimental and control groups' attitude scores toward natural resources after the effect of the pretest was removed.

10. No significant difference was observed within the experimental and control groups regarding pretest and posttest attitude scores.

11. The percent of natural resources component in the agricultural curriculum was negatively correlated with posttest attitudes of teachers toward natural resources.

12. Teachers in both the control and experimental groups found the level of instruction appropriate for their agriculture students.
13. Teachers reported they needed more time to adequately cover the instructional materials.

14. Teachers reported that fifteen percent of their agriculture curriculum included a natural resources component.

15. Thirty-six percent of the students included a natural resources component in their FFA activities, and almost 16 percent included a natural resources component in their SAE programs.

16. Teachers identified current news and media reports, their own personal concern for the environment, and availability of instructional materials and in-service programs as the major reasons causing them to expand their teaching of natural resources in their programs.

17. Teachers listed soil, water, and wildlife conservation as the three areas they most enjoyed teaching.

18. The environmental conservation technology unit was field-tested in a variety of agriculture courses, including natural resources and conservation, plant science, animal science, agronomy, agribusiness and farm management, and agricultural education.

19. Teachers responded favorably to student reactions to the instructional unit. Teachers reported that the majority of students had a positive attitude, enjoyed the instructional unit, and learned a great deal. A few teachers suggested that biotechnology was emphasized too much and that the unit was too long.

20. Specific recommendations from teachers suggested that the lesson on forestry should be expanded and that small modifications should be made to other lessons. Several teachers identified specific examples of how the instructional materials impacted student interest.
The social reconstructionist concept of curriculum development advocates confronting
the learner with the severe problems facing humankind. Optimistic social reconstructionists
are convinced that education can effect social change, and want a curriculum that challenges
creative thought and looks at alternate ways of accomplishing missions (McNeil, 1985). A
problem of major concern both on a global and national level is the conservation of natural
resources and protection of the environment. Agriculture is a major contributor to soil
erosion and non-point sources of pollution of groundwater. It has been argued that modern,
intensive farming methods cannot be sustained at current production levels. Some suggest a
"revolutionary" approach under the banner of low-input sustainable agriculture rather than
current production systems. A new vision for agricultural production is that the 1990s will
be the decade of the environment (Barrick, 1989).

If there is to be a change in public awareness of and commitment to ecological
balance, there must be movements toward changing public values and positive decision
making by the public concerning conservation issues (Allison & Carrington, 1980). The
need for curriculum addressing environmental conservation has been identified by numerous
studies. It has been said that "The best interests of Americans lie in providing students with a
curriculum that is fixed on the future--on what is possible and potential" (McNeil, 1985,
p. 4).

A continual question asked by educators in agricultural education is how to respond
to both the need for a curriculum addressing natural resources and to the needs of students
who must prepare for the technological careers of tomorrow. More investments in the
educational system are needed to develop scientific minds that produce the knowledge base necessary for technological improvements with minimal adverse impact on the environment. Studies addressing the teaching of science in agricultural education have begun to evolve. Moss (1989) recommended that competencies in agriscience and emerging occupations and technologies should be identified and form the basis for updating vocational agriculture programs. Roegge and Russell (1988) identified how two disciplines, agriculture and biology, may be integrated in a high school agriculture setting. They found that the integrated approach was superior to the traditional approach in producing higher overall achievement and stimulating student interest.

Studies (Sjoberg 1983, 1984) have found that interests and cognitive performance were strongly correlated, and interest led directly or indirectly to increased student effort. Weltner (1980) found a correlation between out-of-school activities concerned with technology and natural sciences and academic achievement. Lancelot (1944) wrote that interest is the inner spring of thought and a person's interest affects her or his education. Interest determines what knowledge will be accepted, acquired, and retained. Lancelot goes on to say that ideals are born of interest, and interest and ideals together are the motivating forces which determine what understandings a person will attain. Intrinsic motivation has been found to correlate with subject matter and student achievement on standard achievement tests. It follows that if instructional materials can appeal to one or more interests of students, then increased motivation and achievement will occur.

Following the reconstructionist concept of curriculum development, the environmental conservation technology instructional unit was developed to address a pressing global and national issue; incorporate innovative scientific technologies to increase student occupational awareness and stimulate learning, and to increase student knowledge of technologies for managing and conserving natural resources. The unit focused on
technologies, including biotechnologies, that have utility in managing and conserving natural resources as a vehicle in stimulating interest and motivating students to learn conservation principles.

   Education, broadly defined, is the process of changing the behavior of people. To this end, volumes of curriculum materials have been developed and disseminated through countless educational programs to assist teachers in this change process. However, many of these instructional materials do not undergo an evaluation to determine if they are accomplishing their objectives (McCormick & Cox, 1988). This study was conducted to evaluate the effectiveness of the environmental conservation technology instructional unit and an accompanying in-service program. The instructional unit was designed for upper level high school ASTM students. Secondary schools with ASTM departments within an 80 mile radius of Iowa State University served as the population for this study. The effectiveness of the unit was measured in terms of student knowledge of environmental conservation technology, student attitudes toward natural resources conservation, teacher attitudes towards natural resources, teacher attitudes towards teaching environmental conservation technology, and teacher responses to the instructional materials.

   A pretest-posttest control group design was used in this study. The experimental group teachers received the instructional unit and an in-service program. The control group teachers were provided with lesson titles and objectives included in the instructional unit and asked to teach the lessons using instructional materials at their disposal.

   Data collected were analyzed to determine if: (1) significant differences existed in selected student, teacher, and class variables between experimental and control groups, (2) determine if selected independent variables significantly contribute to dependent variables, and (3) determine if significant differences existed between groups regarding student knowledge, student attitude, and teacher attitude.
The findings revealed that the instructional unit and in-service program were effective in increasing student knowledge of environmental conservation technology. Both the experimental and control groups increased their knowledge of technology for managing and conserving natural resources. Analyses of pretest and posttest scores within the two groups revealed that the experimental group significantly increased in knowledge of environmental conservation technology. Breakdown of the knowledge test into technology and natural resources subscales revealed that both experimental and control groups significantly increased from pretest to posttest on the technology subscale. However, only the experimental group increased from pretest to posttest on the natural resources subscale. Qualitative data gathered from the teachers on daily reporting forms, showed that students were interested in the technology aspect of the lessons, and that the use of technologies for managing and conserving natural resources stimulated class discussions and thought.

The instructional unit was unsuccessful in significantly changing student's attitude toward natural resources. Significant changes in attitudes were not observed between experimental and control groups, nor were significant changes observed within groups between pretest and posttest scores. Past studies of Iowa secondary vocational agriculture students provided similar findings. Hosseini (1983) and Birkenholz (1982) found a change in cognitive knowledge between experimental and control groups in similar experimental studies; however, neither found significant changes in the affective domain (attitudes) between groups. It is postulated that while students may change in cognitive knowledge within a short period of time, a longer period of time (greater than three weeks) may be necessary to initiate change in the affective domain. In the process of diffusion of information, instructional materials may introduce students to basic concepts and set the stage to help them become environmentally open-minded with further education. The environmental conservation technology instructional unit can provide students with a
knowledge base upon which they can build. Thus, students may become more open to accepting, receiving, and retaining information about conservation of natural resources in the future. Students may also move beyond the awareness phase and actively seek more information about conserving natural resources through technology. For example, qualitative data collected from teachers identified several indicators of student interest: (1) one student wanted to go to the University of Nebraska for more information about fungi which reduces drought stress in soybeans, (2) a class wanted to start a local water testing program, and (3) students who had recently attended a talk by Monsanto representatives on biotechnology, could better understand what had been presented and became excited about the subject.

In an attempt to explain the variations in knowledge and attitude scores, stepwise multiple regressions were performed to identify student, teacher, and class variables which contributed to student outcomes. Variables associated with FFA membership and participation predicted student achievement. The number of semesters students have participated in FFA and number of semesters students have participated in soils and crop judging teams were significant contributors to student achievement. One variable, rare involvement of students in FFA, negatively contributed to knowledge scores. These findings are not surprising. Previous studies have found a relationship between student performance on criterion-referenced tests and active participation in FFA activities (Whent & Leising, 1988; Whent & Williams, 1988; & Kotrlik, Parton, & Lelle, 1986). However, studies have not shown that rare involvement in FFA can be a negative contributor to student achievement.

Stepwise regression between teacher and student post scores resulted in only one teacher variable significantly contributing to student achievement on both the knowledge test and the natural resources subscale of the knowledge test. More specifically, knowing a teacher's attitude toward teaching natural resources can help predict the achievement of his/her students. This finding could be helpful in further dissemination of natural resources
materials. Teachers can be surveyed to identify teachers with less than desired attitudes towards teaching natural resources. These teachers may require more in-service education, unfreezing techniques, resource people, and/or materials to change their attitudes toward teaching natural resources.

In summary, the findings of this study support the literature advocating that subject matter can stimulate student interest and increase achievement. The instructional unit and in-service on its use, were successful in increasing student knowledge of technology that can be used in managing and conserving natural resources.

Conclusions

Based on the findings of this study, the following conclusions concerning introduction of the environmental conservation technology instructional unit into ASTM departments in Iowa were drawn:

1. The high percent of students living on farms or in rural areas provides an excellent audience for instructional materials on conservation of natural resources. It is anticipated that many of these students will share their knowledge of conservation with their parents and/or that they will become the farmers of tomorrow.

2. Only 13 percent of the student population were female. Thus, instruction on environmental conservation is reaching only a limited number of female students through ASTM classes.

3. The environmental conservation technology instructional unit was developed at an appropriate instructional level for most high school ASTM sophomore, junior, and senior students, and can be taught as a complete unit or as supplemental units in a variety of course settings.
4. Semesters of FFA membership and semesters of soils and crop judging team participation significantly contributed to student achievement on the environment conservation technology knowledge test.

5. Student participation in FFA soil and crop judging teams, involvement in FFA, and number of SAE programs contribute positively to pretest attitude scores. Similarly, semesters of agriculture instruction, FFA involvement, gender, grade in school, and semesters of participation in FFA soil and crop judging teams contribute to student posttest attitude scores.

6. Teacher attitude toward teaching natural resources significantly predicted student posttest scores with an associated variance of approximately 20 percent.

7. News media reports about conservation of natural resources, availability of instructional materials, and in-service programs on conservation of natural resources influenced teachers to enhance the natural resources conservation component in their curriculum.

8. The environmental conservation technology unit was successful in improving student knowledge of natural resources and technologies for managing and conserving natural resources.

9. Use of the environmental conservation technology instructional unit significantly increased student knowledge of technology and natural resources.

10. The use of technologies for managing and conserving natural resources as an vehicle to stimulate interest and learning about natural resources was a viable innovation.
Recommendations

The findings of this study identified ASTM student and teacher characteristics, revealed relationships among selected variables, and determined differences between experimental and control groups. Based on these finding, the following recommendations were made.

1. Because of the increasing number of students living in towns or cities enrolled in Iowa agriculture classes, instructional materials about conservation of natural resources should address the needs of both rural and suburban students enrolled in ASTM classes.

2. Based on the positive attitudes females had toward conservation of natural resources, their participation in agriculture programs should be encouraged.

3. Students should be encouraged to join FFA, participate in soils and crop judging teams and have SAE programs.

4. Students should be encouraged to incorporate a natural resources component into their SAE programs.

5. New instructional materials must be concerned with stimulating teacher interest and increasing the teacher's knowledge of the subject area as well as the student's knowledge.

6. The news media, instructional materials, and in-service programs on conservation of natural resources should be used to increase teachers' awareness about conservation.

7. Teaching materials, in-service sessions, and pre-service programs should address the need to instill positive teacher attitudes toward teaching natural resources conservation.
8. Instruction on conservation of natural resources is a global concern and must be addressed in our public education system to ensure knowledgeable producers, consumers, businesspeople, and citizens.

9. New technologies related to agriculture should be included in the ASTM curriculum when feasible to stimulate student interest in learning and awareness of career opportunities.

10. With minor changes, the environmental conservation technology instructional unit should be disseminated to Iowa teachers.

11. Experimental procedures should be used when feasible in instructional materials evaluation prior to general dissemination.

Recommendations for Further Research

1. The effect of FFA participation and semesters of soils and crop judging experience should be investigated further. Investigation is needed to determine the specific areas of FFA participation which are contributing to student achievement.

2. Further study is needed to investigate the causal relationship between teacher attitude toward teaching natural resources and student posttest knowledge success.

3. Factor analyses of the attitude instruments are needed to identify additional variables which may correlate with student and teacher characteristic and situational variables.

4. Follow-up of these students to determine long term effects on environmental conservation technology knowledge and attitudes is suggested.

5. Further study is needed to determine the effect of teacher in-service in contributing to the success of instructional materials emphasizing new or unfamiliar technologies and innovations.
6. Research is needed to explore alternative ways to incorporate natural resources components into student SAE programs.

Additional recommendations for research concerned with evaluation of instructional materials in Iowa public schools were as follows:

1. Due to possibility of severe weather conditions during the winter, it is suggested that instructional materials be tested during the early spring or late fall of the school year.

2. To enhance teacher interest in completing the study and increase their understanding of innovative or complex materials, it is suggested that both the control and experimental groups receive in-service education.

3. It is recommended that researchers select a larger sample than necessary to compensate for participants unable to complete the study.

4. Test instruments developed to test knowledge of a subject area should be reviewed by both experts in the subject area and a test consultant to ensure that items and distractors are phrased correctly.


Dillon, Roy D., & Blezek, Allen G. (1978). Final project evaluation—implementation of the Nebraska core curriculum for vocational agriculture. Lincoln, Nebraska: Department of Agricultural Education, University of Nebraska.


Pins, Kenneth. (1990, February 4)). LISA: Love or leave it behind. *Des Moines Register*, pp. 1J, 2J.


The Leopold Center for Sustainable Agriculture. (1989). Leopold Center for Sustainable Agriculture Pamphlet. The Leopold Center for Sustainable Agriculture, Iowa State University, Ames, Iowa.


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I would like to express my gratitude to the following people for their help, support, guidance, and friendship during my graduate program and especially during the course of this study.

To Dr. David L. Williams, my major professor, for his guidance and patience, and for his continual encouragement and moral and financial support to make my graduate program possible. Dr. Williams has been an excellent professional role model and I have learned much from his example.

Dr. Robert Martin for his excellent editing of my written work, his willingness to offer advice and counseling, and for serving on my committee.

Dr. Wade Miller for his excellent course on educational research, his willingness to offer advice and counseling, and for serving on my committee.

Dr. Tony Netusil for helping me discover the joy of statistics, his willingness to offer statistical advice, and for serving on my committee.

Dr. Mary Huba for being an excellent female role model, providing insights into quantitative evaluation, and serving on my committee.

Dr. William Miller for his courses on SPSSx and multivariate analysis, his willingness to offer statistical advice, and his patience in helping me debug my statistical programs.

The secondary agriculture teachers and students, who made my study possible.

Kristin Cashman for her stimulating conversation, her strong convictions to make the world a better place, her advice and support, and her friendship.

Ruth Wiedemeier for her caring and friendship during good and bad times.
Juergen Meyer for his support and friendship and adding an international influence to my life.

Don King for being a great office-mate and friend.

Janet Heintz for being a supportive neighbor and friend.

The students and staff in the Department of Agricultural Education and Studies whose support was much appreciated.

My father, John Whent, for his encouragement and unflagging faith in me.

And Claude Bullard for her continuous support and being my oldest and dearest friend.

The debt of gratitude which I owe to these and many other people too numerous to mention can never be fully repaid.
APPENDIX A: CORRESPONDENCE

<table>
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<th>Page</th>
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<td>Letter to Potential Experimental Group Teachers</td>
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<td>Letter to Potential Control Group Teachers</td>
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<td>Letter to Potential Experimental Group Principals</td>
<td>126</td>
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<tr>
<td>Letter to Potential Control Group Principals</td>
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<td>Letter and Agenda to Experimental Group Teachers Announcing In-service</td>
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<td>Informational Letter to Control Group Teachers</td>
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<td>Cover Letter to Experimental Group and Directions for Pretesting Materials</td>
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<td>Cover Letter to Control Group and Directions for Pretesting Materials</td>
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<td>Cover Letter to Experimental Group and Directions for Posttest Materials</td>
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<td>Cover Letter to Control Group and Directions for Posttesting Materials</td>
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<td>Cover Letter to Teachers with Posttest Results</td>
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<td>Acknowledgement Letter to Experimental Group Principals</td>
<td>140</td>
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<td>Acknowledgement Letter to Control Group Principals</td>
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Dear

The Agricultural Education Department at Iowa State University is initiating a study to evaluate the effectiveness of a new natural resources instructional unit entitled "Environmental Conservation Technology". This instructional unit emphasizes biotechnology as an interest approach to learning conservation principles. Your school was randomly selected to participate in this study from a select group of Iowa schools offering agricultural education.

We will be trying to determine if the instructional unit improves upon existing natural resources materials in motivating student learning, and improving their awareness and values toward conservation of natural resources.

Specifically, we ask that you meet the following criteria:

1. Teach the environmental conservation technology instructional unit for fifteen days between November 27 and December 15, 1989. Lesson Plans, objectives, worksheets, and transparency masters will be provided.

2. Direct students in completing pretest and posttest evaluations. Keep a daily log of teaching success and problems, and student responses while teaching the instructional unit.

3. Attend an in-service at Iowa State University before November 27 on the use of the instructional materials.
The preservation of natural resources has become a priority in Agricultural Education throughout the nation. We believe that tested natural resources curriculum is vital to accomplishing this priority. Your participation in this effort will ensure that other vocational agriculture teachers have up-to-date tested instructional materials. Our ultimate goal is to produce a tested instructional packet which will be distributed to all Iowa agricultural education teachers. We are sending a separate letter to your principal to explain the purpose of the study and your role if you should choose to participate.

Please be assured that we are not evaluating you or your school. All data will be reported in group summary form. Your individual school scores will be confidential and available to you upon request.

Please use the bottom portion of this letter to give us your response so we may plan the next phase of the project. We have enclosed a self-addressed stamped envelope for your reply. If you have questions, or desire more information, please indicate on the reply form or call us at (515) 294-0901.

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies

Enclosure: Stamped return envelope

(Please fill out and return in enclosed envelope)

---

Yes, I have discussed this project with my principal and would be willing to assist in the instructional unit evaluation. I agree to meet the criteria presented in your letter.

No, I do not wish to participate in this project at this time.

---

(Teacher/s Signature) (Date)

(High School) (School Phone)
October 10, 1989

Dear

The Agricultural Education Department at Iowa State University is initiating a study to evaluate the effectiveness of a new natural resources instructional unit emphasizing biotechnology as an interest approach to learning. Your school was randomly selected to participate in this study from a select group of Iowa schools offering agricultural education.

We will be trying to determine if the instructional unit improves upon existing natural resources materials in motivating student learning, and improving their awareness and values toward conservation of natural resources.

Specifically, we ask that you meet the following criteria:

1. Teach a unit on natural resources between November 27 and December 15, 1989. Unit objectives will be provided.

2. Direct students in completing pretest and posttest evaluations.

The preservation of natural resources has become a priority in Agricultural Education throughout the nation. We believe that tested natural resources curriculum is vital to accomplishing this priority. Your participation in this effort will ensure that other vocational agriculture teachers have up-to-date tested instructional materials. Our ultimate goal is to produce a tested instructional packet which will be distributed to all Iowa agricultural education teachers. We are sending a separate letter to your principal to explain the purpose of the study and your role if you should choose to participate.

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Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies

Enclosure: Stamped return envelope

(Please fill out and return in enclosed envelope)

_____ Yes, I have discussed this project with my principal and would be willing to assist in the instructional unit evaluation. I agree to meet the criteria presented in your letter.

_____ No, I do not wish to participate in this project at this time.

_________________________   ________________________
(Teacher/s Signature)   (Date)

_________________________   ________________________
(High School)   (School Phone)
Dear

The Agricultural Education Department at Iowa State University is initiating a study to evaluate the effectiveness of a new natural resources instructional unit emphasizing biotechnology as an interest approach to learning. Your school was randomly selected to participate in this study from a select group of Iowa schools offering agricultural education.

The preservation of natural resources has become a priority in agricultural education throughout the nation. We believe that tested natural resources curriculum is vital to accomplishing this priority. Our ultimate goal is to produce a tested instructional packet which will be distributed to all Iowa agricultural education teachers. A separate letter has been sent to the agricultural instructor in your school, asking him to participate in this study. The instructor is being asked to teach a three week natural resources instructional unit as part of the regular curriculum, collect pretest and posttest data from agriculture students, and provide formative and summative information for curriculum modification. An inservice will be scheduled for agriculture teachers agreeing to participate in this evaluation.

We believe this study will help, not only the agriculture department in your school, but agriculture programs throughout Iowa as well. Therefore, we request that you encourage your agriculture teacher to participate in this study.

Thank you for your help in this special way.

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies
Dear

The Agricultural Education Department at Iowa State University is initiating a study to evaluate the effectiveness of a new natural resources instructional unit emphasizing biotechnology as an interest approach to learning. Your school was randomly selected to participate in this study from a select group of Iowa schools offering agricultural education.

The preservation of natural resources has become a priority in agricultural education throughout the nation. We believe that tested natural resources curriculum is vital to accomplishing this priority. Our ultimate goal is to produce a tested instructional packet which will be distributed to all Iowa agricultural education teachers. A separate letter has been sent to the agricultural instructor in your school, asking him to participate in this study. The instructor is being asked to teach a three week natural resources instructional unit as part of the regular curriculum and collect pretest and posttest data from agriculture students.

We believe this study will help, not only the agriculture department in your school, but agriculture programs throughout Iowa as well. Therefore, we request that you encourage your agriculture teacher to participate in this study.

Thank you for your help in this special way.

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies
November 1, 1989

Dear

Thank you for agreeing to participate in the evaluation of the natural resources instructional unit emphasizing biotechnology as an interest approach to learning. Plan to teach the unit to one of your upper (10-12 grade) classes between November 27 and December 22, 1989 for 15 days. Please reserve days 1 and 15 for testing.

Because many concepts in biotechnology are new, we have scheduled an inservice and dinner for you and other teachers in the experimental group. The inservice will focus on the use of the instructional materials and procedures for the evaluation. The instructional packet, including teaching plans, transparency masters, student handout masters, and other teaching materials will be given to you at the meeting. We feel this meeting will be a valuable part of the project and urge you to attend.

The inservice will be held at the Agriculture Education and Studies Department at Iowa State University, Room 224, Curtiss Hall at 5:30 pm on Thursday, November 16, 1989. An agenda of the meeting is enclosed. The enclosure also includes a list of other agriculture teachers in the experimental group, who have been invited to this inservice, with whom you may share rides. We look forward to working with you in this effort to improve natural resources technology instruction in ASTM programs. Please call Linda Whent at (515) 294-0901 if you have any questions or concerns.

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies

Enclosure: Inservice meeting agenda and a list of experimental group participants
Inservice Meeting on
Use of the Natural Resources Technology Instructional Unit

November 16, 5:30 PM
Agricultural Education Dept.
225 Curtiss Hall
ISU

1. Welcome and introduction of participants
   Linda Whent

2. Background and purpose of instructional unit evaluation:
   a. partnership with DNR and SCS
      David Williams
   b. reviewing research findings
      David Williams
   c. tested materials for distribution
      Linda Whent

3. Requirements of Participants: Teach the Natural Resources Technology Unit to a 10th, 11th, or 12th grade class between Thanksgiving and Christmas vacations. Attempt to address 100% of the instructional unit and provide feedback on success and problems with the materials.
   Linda Whent

4. Examining the instructional packet
   a. organization
   Linda Whent
   b. content
   Linda Whent
   c. techniques
   Linda Whent

5. Use of the instructional unit.
   a. Lesson 1: Identifying Natural Resources and Their Relationship to the Agricultural Industry
      David Williams
   b. Lesson 3: Defining Biotechnology and its Use in Conserving Natural Resources
      Linda Whent
   c. Lesson 2 and 4 through 7: group discussions
      Participants
   d. Share alternatives for use of materials
      Participants

6. Tissue culture demonstration
   Linda Whent

7. Data Collection
   a. cognitive test scores (pre & post);
   b. student and teacher attitude inventory (pre & post);
   c. teacher reporting form (daily):
      i. teacher and student reactions,
      ii. teacher recommendations for improvement,
      iii. ideas for implementation into the general curriculum.
   Linda Whent
November 1, 1989

Dear

Thank you for agreeing to participate in the study to evaluate the effectiveness of a natural resources instructional unit emphasizing biotechnology as an interest approach to learning.

We are asking that you teach a natural resources unit to an upper (10-12 grades) class of your agriculture students between November 28 and December 21, 1989. An outline of teaching objectives will be sent to you by November 17. We ask that you use these objectives as a guide when you teach your natural resources unit.

Please indicate on the bottom of this page the approximate number of students in the class to which you will be teaching natural resources. We will use this figure to determine the number of pretest materials to send to you.

The pretest materials will be mailed prior to November 27. The posttest materials will arrive before December 21. Directions will be included in each mailing. Please reserve one day at the beginning and one day at the end of your unit for testing.

Please complete the bottom portion of this letter and return it to me. If you have any questions, please indicate on the form or call (515) 294-0901.

Sincerely:

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies

I will teach my natural resources unit to an upper level class with approximately ________ agriculture students enrolled.

__________________________
(Name)

__________________________
(School)

PLEASE RETURN TO:
Linda Whent, Agricultural Education Dept.,
223 Curtiss, Iowa State University, Ames, Iowa 50011
November 20, 1989

Dear Participating Teacher:

Enclosed are the pretest materials for the evaluation of the natural resources technology instructional unit. More specifically, you will find directions for pretesting, student pretest packages, Scantron answering sheets, a personal teacher identification sheet, a teacher natural resources attitude survey and teacher reporting forms. Please follow the direction sheet when administering the pretest and returning materials. Use the reporting forms to record daily comments and reactions concerning the instructional materials.

Thank you again for participating in this study. Your help is vital in evaluating and improving the natural resources technology instructional materials. If you have questions about the pretesting materials or the instructional unit, please call me at (515) 294-0901 (office) or (515) 232-4470 (home).

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

David Williams
Department Head
Agricultural Education & Studies
Directions for Administering Pretest Materials

A. Enclosed you will find:
   1. Attitude inventory and test packets for students,
   2. Attitude inventory for you the teacher,
   3. Scantron answer sheets for you and your students,
   4. Personal Teacher Identification Form,
   5. Teacher Daily Reporting Forms.

B. Give the pretesting materials to students before you start the unit on natural resources. Students will need number two pencils to complete the scantron forms.

C. Ask students to fill out the scantron sheet with their name, sex, grade, and date of birth.

D. Ask the students to fill out the demographic information sheet using the Identification Number portion of the scantron sheet. Walk them through this section by reading each question to them (questions A through J on the demographic sheet), asking them to mark their answers using the appropriate spaces (0-9) of letters A through J on the scantron sheets.

E. Ask the class to answer the Student Natural Resources Attitude Survey questions starting with number 1 on the scantron sheet. Use spaces 1 through 9 on the scantron sheet to mark responses.

F. Ask students to continue on to the Natural Resources Test. Placing the test answers on the scantron sheet starting with number 31 and ending with number 65, marking spaces A through D on the scantron sheets.

G. While the students are taking their pretest, please fill out the Teacher Natural Resources Attitude Survey using a scantron sheet, and complete the Personal Student Identification Form.

H. Please Mail back the following immediately after the pretest:
   a. All the Student NR Attitude Surveys and test packets,
   b. The completed scantron sheets,
   c. The Teacher Natural Resources Attitude Survey,
   d. The Personal Teacher Identification Form.

Thank You for your participation and prompt response. Please mail all pretest materials to: Linda Whent, 223 Curtiss HIL, Iowa State University, Ames IA 50011
November 20, 1989

Dear Participating Teacher:

Thank you again for participating in the evaluation of the natural resources technology instructional unit. Your help is vital in evaluating and improving the instructional materials. The lesson names and objectives are enclosed for your use. Please use the lesson objectives as a guide when you are teaching your natural resources unit. Please use all materials and resources available to you as you teach your unit.

Also enclosed are the pretest materials. More specifically, you will find directions for pretesting, student pretest packages, Scantron answering sheets, a personal teacher identification sheet, and a teacher natural resources attitude survey. Please follow the direction sheet when administering the pretest and returning materials.

If you have questions about the pretesting materials, objectives or the instructional unit, please call me at (515) 294-0901 (office) or (514) 232-4470 (home).

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

David Williams
Department Head
Agricultural Education & Studies
Directions for Administering Pretest Materials

A. Enclosed you will find:
   1. Attitude inventory and test packets for students,
   2. Attitude inventory for you the teacher,
   3. Scantron answer sheets for you and your students,
   4. Personal Teacher Identification Form,

B. Give the pretesting materials to students before you start the unit on natural resources. Students will need number two pencils to complete the scantron forms.

C. Ask students to fill out the scantron sheet with their name, sex, grade, and date of birth.

D. Ask the students to fill out the demographic information sheet using the Identification Number portion of the scantron sheet. Walk them through this section by reading each question to them (questions A through J on the demographic sheet), asking them to mark their answers using the appropriate spaces (0-9) of letters A through J on the scantron sheets.

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G. While the students are taking their pretest, please fill out the Teacher Natural Resources Attitude Survey using a scantron sheet, and complete the Personal Student Identification Form.

H. Please Mail back the following immediately after the pretest:
   a. All the Student NR Attitude Surveys and test packets,
   b. The completed scantron sheets,
   c. The Teacher Natural Resources Attitude Survey,
   d. The Personal Teacher Identification Form.

Thank You for your participation and prompt response. Please mail all pretest materials to: Linda Whent, 223 Curtiss H II, Iowa State University, Ames IA 50011
December 11, 1989

Dear Participating Teacher:

Enclosed are the posttest materials for the evaluation of the natural resources technology instructional unit. More specifically, you will find directions for posttesting, student posttest packages, Scantron answering sheets, and a teacher natural resources attitude post survey. Please follow the direction sheet when administering the posttest and returning materials. The posttest must be administered before Christmas break.

Thank you again for participating in this study. Your help is vital in evaluating and improving the natural resources technology instructional materials. If you have questions about the posttesting materials, please call me at (515) 294-0901 (office) or (515) 232-4470 (home).

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

David Williams
Department Head
Agricultural Education & Studies
Directions for Administering Posttest Materials

A. Enclosed you will find:
   1. Attitude inventory post survey and posttest packets for students,
   2. Attitude inventory post survey for you the teacher,
   3. Scantron answer sheets for you and your students,

B. Give the posttesting materials to students after you compete the instructional unit (Day 15 of instruction). Students will need number two pencils. Complete the posttests before Christmas vacation!

C. Ask students to fill out the scantron sheet with their name, sex, grade, and date of birth.

D. Ask the class to answer the Student Natural Resources Attitude Post Survey questions starting with number 1 on the scantron sheet. Use spaces 1 through 9 on the scantron sheet to mark responses.

E. Ask students to continue on to the Natural Resources Test. Placing the test answers on the scantron sheet starting with number 31 and ending with number 65, marking spaces A through D on the scantron sheets.

F. While the students are taking their posttest, please fill out the Teacher Natural Resources Attitude Post Survey using a scantron sheet. Fill in the answers on the second page.

G. Please Mail back the following immediately after the posttest:
   a. The completed scantron sheets,
   b. The Teacher Natural Resources Attitude Survey,
   c. The daily reporting forms.

Student posttest scores will be mailed to you the first part of January.

Thank You for your participation and prompt response. Please mail posttest materials to: Linda Whent, 223 Curtiss H II, Iowa State University, Ames IA 50011
November 20, 1989

Dear Participating Teacher:

Thank you again for participating in the evaluation of the natural resources technology instructional unit. Your help is vital in evaluating and improving the instructional materials. The lesson names and objectives are enclosed for your use. Please use the lesson objectives as a guide when you are teaching your natural resources unit. Please use all materials and resources available to you as you teach your unit.

Also enclosed are the pretest materials. More specifically, you will find directions for pretesting, student pretest packages, Scantron answering sheets, a personal teacher identification sheet, and a teacher natural resources attitude survey. Please follow the direction sheet when administering the pretest and returning materials.

If you have questions about the pretesting materials, objectives or the instructional unit, please call me at (515) 294-0901 (office) or (514) 232-4470 (home).

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

David Williams
Department Head
Agricultural Education & Studies
Directions for Administering Posttest Materials

A. Enclosed you will find:
   1. Attitude inventory post survey and posttest packets for students,
   2. Attitude inventory post survey for you the teacher,
   3. Scantron answer sheets for you and your students,

B. Give the posttesting materials to students after you complete the instructional unit (Day 15 of instruction). Students will need number two pencils. Complete the posttests before Christmas vacation!

C. Ask students to fill out the scantron sheet with their name, sex, grade, and date of birth.

D. Ask the class to answer the Student Natural Resources Attitude Post Survey questions starting with number 1 on the scantron sheet. Use spaces 1 through 9 on the scantron sheet to mark responses.

E. Ask students to continue on to the Natural Resources Test. Placing the test answers on the scantron sheet starting with number 31 and ending with number 65, marking spaces A through D on the scantron sheets.

F. While the students are taking their posttest, please fill out the Teacher Natural Resources Attitude Post Survey using a scantron sheet. Fill in the answers on the second page.

G. Please Mail back the following immediately after the posttest:
   a. The completed scantron sheets,
   b. The Teacher Natural Resources Attitude Survey,

Student posttest scores will be mailed to you the first part of January.

Thank You for your participation and prompt response. Please mail posttest materials to: Linda Whent, 223 Curtiss II, Iowa State University, Ames IA 50011
January 15, 1990

To: Teacher participants in the natural resources technology study

From: Linda WHenl, Research Assistant

Re: Posttest Results

I have enclosed a computer print-out of individual student posttest scores for your school. All scores are coded and kept totally confidential. I have also enclosed a copy of the test with the correct answers marked for student review. If you would like further information regarding your students’ scores, please call me at (515) 294-0901. Thank you again for participating in this study.
January 18, 1990

Dear

We wish to thank you for your support and inform you of the fine work your agriculture teacher did in helping evaluate the effectiveness of a new natural resources instructional unit emphasizing biotechnology as an interest approach to learning. Your agriculture teacher was randomly selected to participate in this study from a select group of agriculture teachers in Iowa.

The preservation of natural resources has become a priority in agricultural education throughout the nation. We believe that tested natural resources curriculum is essential to accomplishing this priority. Our ultimate goal is to produce a tested instructional packet which will be distributed to all Iowa agricultural education teachers.

The agriculture teacher in your school played a vital role in this evaluation by serving as a teacher for the experimental group. He was asked to teach a three week natural resources instructional unit as part of the regular curriculum, collect pretest and posttest data from agriculture students, and provide formative and summative information for curriculum modification. He also attended an inservice prior to the beginning of the instruction. Without the dedication and assistance of agriculture teachers, evaluations such as this would not be possible.

Thank you again for your support.

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies
January 18, 1990

Dear

We wish to thank you for your support and inform you of the fine work your agriculture teacher did in helping evaluate the effectiveness of a new natural resources instructional unit emphasizing biotechnology as an interest approach to learning. The agriculture instructor from your school was randomly selected to participate in this study from a select group of agriculture teachers in Iowa.

The preservation of natural resources has become a priority in agricultural education throughout the nation. We believe that tested natural resources curriculum is essential to accomplishing this priority. Information from this study will be used to improve the natural resources technology instructional unit. Our ultimate goal is to produce a tested instructional packet which will be distributed to all Iowa agricultural education teachers.

The agriculture teacher in your school played a vital role in this evaluation by serving as a teacher for the control group. He was asked to teach a three week natural resources instructional unit, using lesson titles and objectives as a guideline. He was also asked to collect pretest and posttest data from agriculture students. Without the assistance and dedication of agriculture teachers, studies such as this would not be possible.

Thank you again for your support.

Sincerely,

Linda Whent
Research Assistant
Agricultural Education & Studies

Dr. David Williams
Department Head
Agricultural Education & Studies
APPENDIX B: SCHOOLS AND NUMBER OF STUDENTS BY SCHOOL PARTICIPATING IN THE STUDY
<table>
<thead>
<tr>
<th>Schools</th>
<th>Number of Students</th>
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<tbody>
<tr>
<td>Adair-Casey</td>
<td>8</td>
</tr>
<tr>
<td>Cal Community</td>
<td>5</td>
</tr>
<tr>
<td>Colfax-Mingo</td>
<td>8</td>
</tr>
<tr>
<td>Coon Rapids Community</td>
<td>9</td>
</tr>
<tr>
<td>Eagle Grove</td>
<td>6</td>
</tr>
<tr>
<td>Eldora-New Providence</td>
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<tr>
<td>Glidden-Ralston</td>
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<tr>
<td>Hampton</td>
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<tr>
<td>Hudson</td>
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<td>Humbolt</td>
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<td>Indianola</td>
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<tr>
<td>Jefferson</td>
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<td>Manson</td>
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<td>North Mahaska</td>
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<td>Pella</td>
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<td>United Community</td>
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<td>Webster City</td>
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<td>Westview High School</td>
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<td><strong>Total</strong></td>
<td><strong>266</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Schools</th>
<th>Number of Students</th>
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</thead>
<tbody>
<tr>
<td>Anita</td>
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<tr>
<td>Audubon</td>
<td>10</td>
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<tr>
<td>Bridgewater-Fontanelle</td>
<td>5</td>
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<tr>
<td>Dows</td>
<td>8</td>
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<tr>
<td>Grinnell-Newburg</td>
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<td>Iowa Falls</td>
<td>14</td>
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<tr>
<td>Knoxville</td>
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<tr>
<td>L-D-F</td>
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<tr>
<td>Lytton</td>
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<tr>
<td>Orient-Macksburg</td>
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<tr>
<td>Pleasantville</td>
<td>7</td>
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<td>Pomeroy</td>
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<td>Reinbeck</td>
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<tr>
<td>South Tama</td>
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<td>Southeast Polk</td>
<td>4</td>
</tr>
<tr>
<td>Twin Cedars</td>
<td>5</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>266</strong></td>
</tr>
</tbody>
</table>
# APPENDIX C: INSTRUMENTS FOR DATA COLLECTION

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Page</th>
</tr>
</thead>
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<tr>
<td>Agriculture Student Information Sheet</td>
<td>145</td>
</tr>
<tr>
<td>Agriculture Student Natural Resources Attitude Inventory</td>
<td>146</td>
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<tr>
<td>Agriculture Student Environmental Conservation Technology Pretest</td>
<td>147</td>
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<tr>
<td>Agriculture Student Environmental Conservation Technology Posttest</td>
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<tr>
<td>Teacher Class/Student Situational Form</td>
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<td>Teacher Natural Resources Attitude Inventory</td>
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<td>Teacher Informational Form</td>
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<td>Teacher Daily Instructional Reporting Form</td>
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</tr>
<tr>
<td>Teacher Post Instructional Information Form</td>
<td>159</td>
</tr>
</tbody>
</table>
Agriculture Student Information Sheet

Please write only on the Scantron sheet

Fill in your name, sex, grade and date of birth on the scantron sheet.
**Use the Identification Number section to answer the following questions:

A. How many semesters of agriculture classes have you had? Include courses you are in now. Answer using 0 through 9.

B. In all your high school classes, how many semesters have you been taught natural resources? Use 0 - 9.

C. What is your ethnic background?
   0. White.
   1. Hispanic.
   2. Black.
   3. Asian.
   4. American Indian.

D. Where are you currently living?
   0. on a farm
   1. outside of town or city limits, but not on a farm.
   2. within city limits in a house or apartment.

E. What is your degree of FFA involvement?
   0. not in FFA.
   1. in FFA but never or rarely go to meetings or activities.
   2. in FFA, go to some meetings and activities.
   3. in FFA, attend most meetings and activities.
   4. hold an FFA office, attend all meetings and activities as possible.

F. How many semesters have you been in FFA? Use 0 - 9.

G. What best describes your SAE programs while enrolled in agriculture classes?
   0. never had a SAE program.
   1. have first SAE program this year.
   2. have one program this year and had one program last year.
   3. have more than two SAE programs this year and at least one last year.
   4. have had strong SAE programs for more than two years.

H. In total, how many SAE programs have you had? Use 0 - 9.

I. How many natural resources SAE programs have you had? Use 0 - 9.

J. How many semesters have you been involved with a FFA crops or soils judging team?

You may now start the Natural Resources Attitude Inventory on question 1.
Agriculture Student Natural Resources Attitude Inventory

Please answer questions 1-30 on the Scantron Sheet

Fill in your name, sex, grade and date of birth on the scantron sheet

Directions: Please give your opinion on each statement listed below. If you strongly disagree with the statement, write "1" on the line in front of the item. If you strongly agree with the statement, write "9" on the line. Use any whole number from 1 through 9 (see scale below).

| 1. Soil erosion is a problem in my community. |
| 2. Biotechnology can enhance conservation of natural resources. |
| 3. Natural resources problems will solve themselves. |
| 4. The majority of soil conservation practices are costly. |
| 5. Biotechnology will increase the use of chemicals in agriculture. |
| 6. Use of agricultural chemicals improves wildlife resources. |
| 7. Forest land is plentiful in Iowa. |
| 8. Maintaining water quality is a public concern. |
| 9. Laws are necessary to reduce soil erosion. |
| 10. Highly erodible land should be retired from crop production. |
| 11. Help in planning a conservation system is expensive to farmers. |
| 12. Sustainable agriculture maintains our natural resources for future generations. |
| 13. Conserving natural resources is important. |
| 14. Strict water quality standards are needed in Iowa. |
| 15. Conserving natural resources is beyond my control. |
| 16. Students should learn about conservation of natural resources in school. |
| 17. Agricultural chemicals harm wildlife. |
| 18. Reducing soil erosion is a public concern. |
| 19. Most soil erosion is caused by forces beyond the farmor's control. |
| 20. Soil erosion is easy to recognize. |
| 21. Agricultural chemicals pollute groundwater. |
| 22. Laws are necessary to maintain water quality. |
| 23. Using soil conservation practices helps wildlife. |
| 24. Strict soil conservation standards are necessary. |
| 25. Laws are necessary to protect wildlife. |
| 26. Most farmers manage the application of agricultural chemicals to prevent water pollution. |
| 27. I can do something about conserving natural resources in my community. |
| 28. People want to conserve natural resources. |
| 29. More public education about natural resources and conservation is needed. |
| 30. Natural resources is an interesting subject to learn. |

Thank you for sharing your comments.

You may now start the Natural Resources test on question 31 of the Scantron Sheet.
31. Natural Resources include:
   a. renewable resources.
   b. minerals.
   c. non-renewable resources.
   d. all of the above

32. Which of the following is an example of a non-renewable natural resource?
   a. forest
   b. wildlife
   c. oil
   d. soil.

33. Which of the following natural resources forms a base for agriculture?
   a. soil.
   b. water.
   c. forestry.
   d. all of the above.

34. Conservation of natural resources is necessary to ensure:
   a. natural resources for future generations.
   b. adequate food supplies in the future.
   c. habitats for endangered wildlife species.
   d. all of the above.

35. Technology is defined as:
   a. an applied science or having special knowledge.
   b. a method of achieving a practical purpose.
   c. a means to convert natural resources into material wealth.
   d. all of the above.

36. New technologies:
   a. tend to put people out of work.
   b. increases employment for the unskilled.
   c. require people with technical skills.
   d. increases the number of monotonous jobs.

37. A technology developed to reduce chemical use is:
   a. row cropping
   b. conservation tillage
   c. pest resistant corn plants
   d. low impact tractors

38. New technologies help conserve natural resources by:
   a. reducing the need for agricultural chemicals.
   b. decreasing soil erosion.
   c. producing drought and salt tolerant plants.
   d. all of the above.

39. If steps are not taken to decrease soil erosion in the United States, future generations of farmers may find:
   a. that topsoil is plentiful.
   b. land is less fertile.
   c. topsoil is being replaced.
   d. there is no land left.

40. The term biotechnology includes:
   a. selective breeding of animals.
   b. the transfer of genes from one living organism into another.
   c. selective breeding of plants and animals.
   d. cloning of thousands and thousands of plants.
41. Genetic engineering involves:
   a. production of antibodies by mammals.
   b. the transfer of genes from one living organism into another.
   c. selective breeding of plants and animals
   d. cloning of thousands and thousands of plants.

42. Examples of early biotechnology are:
   a. breeding animals.
   b. getting milk from animals.
   c. making wine and cheese.
   d. planting seeds from corn plants.

43. Tissue culture involves:
   a. the growth of plant cells, tissues or seeds under laboratory conditions.
   b. reproducing genetically identical offspring from a single mother plant.
   c. reproducing plants much faster than can take place in nature.
   d. all of the above.

44. Examples or early biotechnology are:
   a. breeding animals and plants.
   b. making beer, bread, and milk.
   c. making wine, cheese and vinegar.
   d. planting seeds from corn plants.

45. What powers the water cycle?
   a. solar energy.
   b. ocean.
   c. rain.
   d. gravity.

46. Main user of water in the United States is:
   a. industry.
   b. wildlife.
   c. agriculture.
   d. recreation.

47. Improper use of pesticides can:
   a. poison numerous plants and animals.
   b. kill people.
   c. contaminate water supplies.
   d. all of the above.

48. Which of the following is not a cause of water contamination:
   a. sewer leakage.
   b. hydroelectric.
   c. disposal wells.
   d. percolation.

49. Erosion is:
   a. a natural process.
   b. loss of vegetation.
   c. destruction of forest land.
   d. none of the above.

50. Plants that can be grown in salty soil:
   a. will conserve water resources.
   b. will bring more land into use for growing crops.
   c. can benefit agricultural areas with low rainfall.
   d. all of the above.

51. Plants that can be grown in salty soil:
   a. will conserve water resources.
   b. will bring more land into use for growing crops.
   c. can benefit agricultural areas with low rainfall.
   d. all of the above.
52. Accelerated erosion means:
   a. erosion is greater than would occur naturally.
   b. erosion is less than would occur naturally.
   c. the same thing as natural erosion.
   d. none of the above.

53. An example of vegetative control of soil erosion is:
   a. crop rotation.
   b. grass waterways.
   c. strip cropping.
   d. all of the above.

54. Soil erosion that is almost invisible is:
   a. gully erosion.
   b. rill erosion.
   c. sheet erosion.
   d. wind erosion.

55. A biopesticide:
   a. is a chemical used to kill pests.
   b. uses predators to control pests.
   c. uses microorganisms to kill pests.
   d. is the scientific study of chemicals.

56. Nitrogen fixation is done by:
   a. corn plants
   b. earth's crust
   c. bacteria
   d. animals

57. Wildlife is defined as:
   a. birds, fish, and mammals that not domesticated.
   b. animals extinct or endangered.
   c. animals that cannot be kept in captivity.
   d. animals that are raised in zoos.

58. Extinct species are:
   a. animals that exist only in small numbers.
   b. animals that are protected by the government.
   c. animals that no longer exist, they are gone forever.
   d. animals that exist in great numbers.

59. The greatest loss of wildlife is due to:
   a. disease and parasites.
   b. loss of habitat and hunting.
   c. car accidents on highways.
   d. erosion and flooding.

60. Which of the following is not a way to protect wildlife:
   a. restrictions on pesticide application.
   b. clearing of forest land for crops.
   c. hunting and fishing limits.
   d. biological control of insects and weeds.

61. The government agency the regulates pesticide use is:
   a. United States Department of Agriculture.
   b. Environmental Protection Agency.
   d. Supreme Court of the United States.
62. Pesticides are a danger to wildlife because:

a. pesticides spread beyond the target area by wind, rain and water movement.
b. some pesticides do not pass out of the animals when swallowed, but accumulate in the animal's tissues.
c. the pesticide accumulation is passed onto predators higher in the food chain.
d. all of the above.

63. Which of the following is not an important use of forest land?

a. soil and water conservation
b. habitat for wildlife
c. forest products and by-products.
d. insect control

64. The major causes of forest devastation are:

a. recreation and sports.
b. logging and fire.
c. urban and suburban spread.
d. slow growth and lack of replanting.

65. New technologies are helping forests by developing trees which have:

a. greater disease resistance.
b. increased insect resistance.
c. increased tolerance to drought.
d. all of the above.
Agriculture Student Environmental Conservation Technology PostTest

Please answer questions 31-65 on the Scantron Sheet

31. Which of the following is an example of a non-renewable natural resource?
   a. forest
   b. wildlife
   c. oil
   d. soil.

32. The major causes of forest devastation are:
   a. recreation and sports.
   b. logging and fire.
   c. urban and suburban spread
   d. slow growth and lack of replanting.

33. Which of the following natural resources forms a base for agriculture?
   a. soil.
   b. water.
   c. forestry.
   d. all of the above.

34. Examples or early biotechnology are:
   a. breeding animals.
   b. getting milk from animals.
   c. making wine and cheese.
   d. planting seeds from corn plants.

35. Nitrogen fixation is done by
   a. corn plants
   b. earth's crust.
   c. bacteria
   d. animals.

36. New technologies are helping forests by developing trees which have:
   a. greater disease resistance.
   b. increased insect resistance.
   c. increased tolerance to drought.
   d. all of the above.

37. New technologies:
   a. tend to put people out of work.
   b. increases employment for the unskilled.
   c. require people with technical skills.
   d. increases the number of monotonous jobs.

38. A present biotechnology that helps decrease chemical use is:
   a. salt-tolerant crops.
   b. nitrogen fixation in grass.
   c. increase pest resistance in plants.
   d. drought tolerant corn plants.

39. If steps are not taken to decrease soil erosion in the United States, future generations of farmers may find:
   a. that topsoil is plentiful.
   b. land is less fertile.
   c. topsoil is being replaced.
   d. there is no land left.

40. Wildlife is defined as:
   a. birds, fish, and mammals that are not domesticated.
   b. animals extinct or endangered.
   c. animals that cannot be kept in captivity.
   d. animals that are raised in Zoos.
41. A technology developed to reduce chemical use is:
   a. row cropping
   b. conservation tillage
   c. pest resistant corn plants
   d. low impact tractors

42. The term biotechnology includes:
   a. selective breeding of animals
   b. making beer and wine through fermentation.
   c. Using yeast to make bread.
   d. all of the above.

43. Plants that can be grown in salty soil:
   a. will conserve water resources.
   b. will bring more land into use for growing crops.
   c. can benefit agricultural areas with low rainfall.
   d. all of the above.

44. Tissue culture involves:
   a. the growth of plant cells, tissues or seeds under laboratory conditions.
   b. reproducing genetically identical offspring from a single mother plant.
   c. reproducing plants much faster than can take place in nature.
   d. all of the above.

45. New technologies help conserve natural resources by:
   a. reducing the need for agricultural chemicals.
   b. decreasing soil erosion.
   c. producing drought and salt tolerant plants.
   d. all of the above.

46. Present biotechnologies to help agriculture include:
   a. nitrogen fixation in corn plants.
   b. drought resistance in corn plants.
   c. robotic sensing of soil moisture.
   d. tractors that work by remote control.

47. Genetic engineering involves:
   a. production of antibodies by mammals.
   b. the transfer of genes from one living organism into another.
   c. selective breeding of plants and animals.
   d. cloning of thousands and thousands of plants.

48. Which of the following is not a cause of water contamination:
   a. sewer leakage.
   b. hydroelectric.
   c. disposal wells.
   d. percolation.

49. Natural Resources include:
   a. renewable resources.
   b. minerals.
   c. non-renewable resources.
   d. all of the above.

50. Pesticides are a danger to wildlife because:
   a. pesticides spread beyond the target area by wind, rain and water movement.
   b. some pesticides do not pass out of the animals when swallowed, but accumulate in the animal's tissues.
   c. the pesticide accumulation is passed onto predators higher in the food chain.
   d. all of the above.
51. Biopesticide:
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   b. uses predators to control pests.
   c. uses microorganisms to kill pests.
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52. Erosion is:
   a. a natural process.
   b. loss of vegetation.
   c. destruction of forest land.
   d. none of the above.

53. Accelerated erosion means:
   a. erosion is greater than would occur naturally.
   b. erosion is less than would occur naturally.
   c. the same thing as natural erosion.
   d. none of the above.

54. What powers the water cycle?
   a. solar energy.
   b. ocean.
   c. rain.
   d. gravity.

55. The greatest loss of wildlife is due to:
   a. disease and parasites.
   b. loss of habitat and hunting.
   c. car accidents on highways.
   d. erosion and flooding.

56. Which of the following is not a way to protect wildlife.
   a. restrictions on pesticide application.
   b. clearing of forest land for crops.
   c. hunting limits.
   d. biological control of insects and weeds.

57. Main user of water in the United States is:
   a. industry.
   b. wildlife
   c. agriculture.
   d. recreation.

58. An example of vegetative control of soil erosion is:
   a. crop rotation.
   b. grass waterways.
   c. strip cropping.
   d. all of the above.

59. Extinct species are:
   a. animals that exist only in small numbers.
   b. animals that are protected by the government.
   c. animals that no longer exist, they are gone forever.
   d. animals that exist in great numbers.

60. The government agency that regulates pesticide use is:
   a. United States Department of Agriculture.
   b. Environmental Protection Agency.
   d. Supreme Court of the United States.

61. Soil erosion that is almost invisible is:
   a. gully erosion.
   b. rill erosion.
   c. sheet erosion.
   d. wind erosion.
62. Conservation of natural resources is necessary to ensure:

a. natural resources for future generations.
b. adequate food supplies in the future.
c. habitats for endangered wildlife species.
d. all of the above.

63. Improper use of pesticides can:

a. poison numerous plants and animals.
b. kill people.
c. contaminate water supplies.
d. all of the above.

64. Technology is defined as:

a. an applied science or having special knowledge.
b. a method of achieving a practical purpose.
c. a means to convert natural resources into material wealth.
d. all of the above.

65. Which of the following is not an important use of forest land.

a. soil and water conservation
b. habitat for wildlife
c. forest products and by-products.
d. insect control
Please fill-out and return with other materials

Personal Teacher Identification Form

Name of Class that is being tested

Grade of most students in the class

Time of the day the class is taught

Length of the class period

Please write the names of students whom you feel have a severe handicap or for some reason would do poorly on the test, (example: can't read).

__________________________  ________________________

__________________________  ________________________

__________________________  ________________________

__________________________  ________________________

__________________________  ________________________
Agriculture Teacher Natural Resources Attitude Inventory

Please answer questions 1 - 35 on Scantron Sheet

Directions: Please give your opinion on each statement listed below. If you strongly disagree with the statement, write "1" on the line in front of the item. If you strongly agree with the statement, write "9" on the line. Use any whole number from 1 through 9 (see scale below).

1. Soil erosion is a problem in my community.
2. Biotechnology can enhance conservation of natural resources.
3. Natural resources problems will solve themselves.
4. The majority of soil conservation practices are costly.
5. Biotechnology will increase the use of chemicals in agriculture.
6. Use of agricultural chemicals improves wildlife resources.
7. Forest land is plentiful in Iowa.
8. Maintaining water quality is a public concern.
9. Laws are necessary to reduce soil erosion.
10. Highly erodible land should be retired from crop production.
11. Help in planning a conservation system is expensive to farmers.
12. Sustainable agriculture maintains our natural resources for future generations.
13. Conserving natural resources is important.
14. Strict water quality standards are needed in Iowa.
15. Conserving natural resources is beyond my control.
16. Students should learn about conservation of natural resources in school.
17. Agricultural chemicals harm wildlife.
18. Reducing soil erosion is a public concern.
19. Most soil erosion is caused by forces beyond the farmer's control.
20. Soil erosion is easy to recognize.
21. Agricultural chemicals pollute groundwater.
22. Laws are necessary to maintain water quality.
23. Using soil conservation practices helps wildlife.
24. Strict soil conservation standards are necessary.
25. Laws are necessary to protect wildlife.
26. Most farmers manage the application of agricultural chemicals to prevent water pollution.
27. I can do something about conserving natural resources in my community.
28. People want to conserve natural resources.
29. More public education about natural resources and conservation is needed.
30. Natural resources is an interesting subject to teach.
31. I find most students are interested in studying natural resources.
32. Natural resources supports the agricultural industry.
33. Infusing new technology makes teaching of natural resources more interesting.
34. Infusing new technology motivates students to study natural resources.
35. Teaching a natural resources unit is of great importance to me.

End of Scantron Use.
Directions: Please provide the following information about your agriculture program and yourself by filling in the blank or checking the appropriate response.

36. How many years have you been teaching agriculture? ________.

37. How would you describe your knowledge of conservation and natural resources?

( ) None ( ) Slight ( ) Average ( ) Above average ( ) High

38. Approximately what percentage of your agriculture curriculum is devoted to natural resources (soil, water, wildlife, forestry etc.)? ________

39. Approximately what percentage of all your agriculture students include a natural resources component in their FFA activities (soil judging, speech on conservation, etc.)? ________

40. Approximately what percentage of all your agriculture students include a natural resources component in their SAE programs (conservation tillage for corn, managing wildlife habitats, planting windbreaks, etc.)? ________

41. Please list experiences, materials, etc. which have caused you to consider expanding the teaching of natural resources in your agricultural program?

42. What subject area(s) in natural resources/conservation do you most enjoy teaching?

Thank you for your comments
<table>
<thead>
<tr>
<th>Day Taught</th>
<th>Lesson Time to Complete</th>
<th>What worked or didn't work</th>
<th>Suggested improvements and changes or other comments</th>
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</table>
Directions: Please provide the following information about your agriculture program and yourself by filling in the blank or checking the appropriate response.

36. Please describe how the students reacted to the unit.

37. How would you describe your knowledge of conservation and natural resources?
   ( ) None  ( ) Slight  ( ) Average  ( ) Above average  ( ) High

38. How many class periods did you spend teaching the natural resources unit?

39. Did you have enough time to cover all the learning objectives?
   Yes__________  No______________

   If you answered no above, how much time do you believe you would need to cover the learning objectives?

40. Indicate the level of class that received the instruction:

   _____ Freshmen  _____ Junior
   _____ Sophomore  _____ Senior
   _____ Combination of Soph., Junior, Senior.

41. Was the level of instruction appropriate for the students' level of learning?
   Yes__________  No______________

   If you answered no, please indicate how the instructional unit should be revised.

Thank you for your comments
APPENDIX D: LESSON TITLES AND OBJECTIVES PROVIDED TO CONTROL GROUP TEACHERS
Dear Participating Teacher:

Listed below are lesson titles and objectives for a natural resources technology instructional unit. Please use these as a guide when you teach your natural resources unit to a class of 10th, 11th, or 12th year agriculture students. We ask that you use all resources currently available to you in teaching this unit.

Unit: Conservation of Natural Resources Through Technology

Lesson 1: Identifying Natural Resources and Their Relationship to the Agricultural Industry.

OBJECTIVES

1. Define and categorize natural resources.
2. Explain what makes something a natural resource.
3. Draw the relationships between natural resources and the agricultural industry.
4. Describe the role of natural resources on the long-term viability of agriculture.

Lesson 2: Recognizing New Technologies and Their Use in Conserving Natural Resources.

OBJECTIVES:

1. Define technology.
2. Compare the three major areas of technology used in agriculture.
3. Name and classify technologies that can be used to help conserve natural resources.
4. Describe how new technologies help conserve natural resources.

Lesson 3: Defining Biotechnology and its use in Conserving Natural Resources

OBJECTIVES

1. Define biotechnology.
2. Compare the three major areas of biotechnology.
3. Compare past, present and possible future biotechnologies.
4. Understand basic principles in genetic engineering.
5. Understand steps in the process of tissue culture.
6. Identify use of biotechnologies to conserve natural resources.
Lesson 4: Conserving Soil Using Biotechnology

OBJECTIVES

1. Define accelerated soil erosion and discuss why soil erosion control is important.
2. Name and describe the major types of soil erosion.
3. Identify vegetation methods used to control soil erosion.
4. Compare and contrast pesticide, biological control, and biopesticide.
5. Describe how biotechnologies conserve or improve the soil.

Lesson 5: Conserving Water Resources Using Biotechnology

OBJECTIVES

1. Identify the components of the hydrologic cycle.
2. Discuss the main water users.
3. Identify common causes of water contamination.
4. Identify how biotechnology is helping conserve water resources.

Lesson 6: Conserving Forest Resources Using Biotechnology

OBJECTIVES

1. Explain why forest resources are important to our country.
2. List problems facing our forests.
3. Identify forest conservation techniques that include biotechnology.
4. Describe the principle steps in micropropagation of trees.
5. Compare and contrast the use of chemical pesticides and biopesticides on forests.

Lesson 7: Conserving Wildlife Using Biotechnology

OBJECTIVES

1. Identify wildlife conservation problems.
2. Define wildlife and differentiate between extinct and endangered species.
3. Describe the three processes of pesticide accumulation in animals.
4. Compare and contrast legislative issues in pesticide regulation.
5. Identify biotechnologies which can help conserve and improve wildlife.
APPENDIX E: USE OF HUMAN SUBJECTS CLEARANCE
DATE: September 9, 1987
TO: Dr. George Karas
    Associate Dean
    Graduate College
FROM: David L. Williams
    Professor and Head
    Agricultural Education Department
RE: Human Subjects Approval for Research Project Entitled
    "Natural Resources and Conservation Programs in
    Agriculture", submitted 8/17/87

I understand the Human Subjects Committee had two
questions about the referenced research project.

First, let me say that the Agricultural Education
Department at Iowa State University works closely
with the agriculture teachers in the 265 Iowa high
schools offering vocational agriculture. We supply
these teachers with technical update and the latest
in new developments on a regular basis through Iowa
State University Extension programs. At times, we
ask the teachers and their students to provide
feedback as part of the regular instructional
program. This is especially true when new areas are
being explored as is the case with the referenced
research project.

In our cover letter, we ask the teachers to clear
this activity with their school administration if
they deem necessary. We assume that if teachers
participate in the activity, they are granting
permission for us to use their school facilities for
this research. They are not required to participate.
(see highlighted portion of attached letter.) We
state in the materials that student participation is
also voluntary. (See highlighted portion of the
enclosed sheet.)

I hope this clarifies the questions asked by the
committee.

Thank you.
INFORMATION ON THE USE OF HUMAN SUBJECTS IN RESEARCH
TOWA STATE UNIVERSITY

(Please follow the accompanying instructions for completing this form.)

1. Title of project (please type): Natural Resources and Conservation Programs in Agriculture

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are properly protected. Additions to or changes in procedures affecting the subjects after the project has been approved will be submitted to the committee for review.

   David L. Williams 8/17/87
   Typed Named of Principal Investigator Date Signature of Principal Investigator

   201 Curtiss Hall 294-0241
   Campus Address Campus Telephone

3. Signatures of others (if any) Date Relationship to Principal Investigator

4. ATTACH an additional page(s) (A) describing your proposed research and (B) the subjects to be used, (C) indicating any risks or discomforts to the subjects, and (D) covering any topics checked below. CHECK all boxes applicable.

   [ ] Medical clearance necessary before subjects can participate
   [ ] Samples (blood, tissue, etc.) from subjects
   [ ] Administration of substances (foods, drugs, etc.) to subjects
   [ ] Physical exercise or conditioning for subjects
   [ ] Deception of subjects
   [ ] Subjects under 14 years of age and(or) Subjects 14-17 years of age
   [X] Subjects in institutions (Iowa High Schools and Iowa Area Schools)
   [ ] Research must be approved by another institution or agency

5. ATTACH an example of the material to be used to obtain informed consent and CHECK which type will be used. (See attached)

   [ ] Signed informed consent will be obtained.
   [X] Modified informed consent will be obtained.

6. Anticipated date on which subjects will be first contacted: Month Day Year
   Anticipated date for last contact with subjects:
   Month Day Year

7. If applicable: Anticipated date on which audio or visual tapes will be erased and(or) identifiers will be removed from completed survey instruments:
   Month Day Year

8. Signature of Head or Chairperson Date Department or Administrative Unit

9. Decision of the University Committee on the Use of Human Subjects in Research:
   [ ] Project Approved [ ] Project not approved [ ] No action required

   George G. Karas