The Effect of Instructional Videos and Simulation-Gaming Activities in the Environmental Science Curriculum on Knowledge and Attitudes.

Lyle Mark Soniat
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The effect of instructional videos and simulation-gaming activities in the environmental science curriculum on knowledge and attitudes

Soniat, Lyle Mark, Ph.D.
The Louisiana State University and Agricultural and Mechanical Col., 1992
THE EFFECT OF INSTRUCTIONAL VIDEOS AND SIMULATION-GAMING ACTIVITIES IN THE ENVIRONMENTAL SCIENCE CURRICULUM ON KNOWLEDGE AND ATTITUDES

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The Department of Administrative and Foundational Services

by

Lyle Mark Soniat
B.S., Louisiana State University, 1975
M.S., Louisiana State University, 1977
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ABSTRACT

As a result of science reform efforts in the United States numerous shortcomings of the predominant curricula have been identified. The following study evaluates a modular, environmental science curriculum entitled Wild Louisiana, which attempts to address these shortcomings. Wild Louisiana is Science-Technology-Society (STS) oriented and infuses regionally based instructional videos and simulation-gaming activities into the secondary science curriculum. The videos and activities depict the confluence of regional biological, technical, and social phenomena to illustrate universal environmental concepts. The multimedia, modular approach is intended to address the varied learning styles of different students.

Following random selection, teachers were randomly assigned to one of four conditions of study. Group A teachers lectured from their assigned textbooks, supplemented with the regionally based background information that was provided; Group B teachers used the background information and the simulation-gaming activities for infusion into their classes; Group C teachers used the background information together with the instructional videos; and Group D teachers used the background information, infusing both the activities and videos into their classes.

Over 600 secondary science students, representing 11 parishes in Louisiana, took part in the 16-week study. After the treatment, students were evaluated on their environmental knowledge and attitudes using analysis of covariance. Students were also grouped by locus of control to determine whether there were any aptitude-treatment interaction effects caused by their learner styles. The instruments that were used included the Louisiana Environmental Knowledge Test to measure students' environmental knowledge, the New Environmental Paradigm Scale to measure students' environmental
attitudes, and the Nowicki-Strickland Locus of Control Scale to measure students' locus of control orientation.

The results of the study suggest that STS-oriented infusion materials can be more effective in increasing students' environmental knowledge. In addition, the results indicate that certain types of instructional materials may be more effective when students' aptitudes are considered. Students in the videos-only group and the activities-with-videos group had significantly higher knowledge scores than the lecture group. Internally oriented students in the activities group had significantly higher knowledge scores than similar students in the lecture group.
CHAPTER I

Introduction

The impact of science and technology upon society, be it an environmental impact study, the energy problem, or other timely occurring issues, indicates a need for social studies and science educators alike to develop guidelines for teaching about science-related social issues.

Position Statement,
National Council for the Social Studies

Currently, the state of science education in America is in a tremendously problematic phase. Criticism of our methodology, philosophy, the very core of what we do and what purposes we are trying to achieve, is the norm rather than the exception. This call for reform comes from all directions, especially from such groups as the American Association for the Advancement of Science (1982), the National Science Teachers Association (NSTA) (1982), and the National Science Board Commission (1983). These groups are demanding a totally new curricular approach if we are to transform the students of today into the informed citizens of tomorrow.

What we need, according to the NSTA (1982), is a science education curriculum that supports a kind of science that is useful for all, not just future scientists.

Some educators (Yager, 1984; Hurd, 1985) claim that only a small percentage of high school graduates are scientifically and technologically literate. They state that few graduates understand the interrelationships of science and technology in a social context; fewer still have the scientific knowledge or process skills to judge knowledge claims and make responsible decisions about public issues. If these shortcomings continue, the American
Association for the Advancement of Science (1982, p. 2) warns, "the gap between the public's understanding of science and technology and the requirements of citizenship in a participating democracy will continue to widen."

In response to these problems, a national panel of experts convened under the auspices of Project Synthesis, sponsored by the National Science Foundation (Harms and Yager, 1981). These experts drafted a cluster of four goals to serve as organizers for curriculum development efforts. The four areas include:

1. **Personal Needs.** Science education should prepare students to use science to improve their lives and to cope with an increasingly technological world.

2. **Societal Issues.** Science education should produce informed citizens prepared to deal responsibly with science-related societal issues.

3. **Career Education/Awareness.** Science education should make all students aware of the nature and scope of a wide variety of science and technology-related careers open to students of varying aptitudes and interests.

4. **Academic Preparation.** Science education should allow students who are likely to pursue science academically as well as professionally to acquire the academic knowledge appropriate for their needs (p. 7).

The calls and reasons for reform have come from diverse areas; therefore, strategies for action are not all in agreement. This call for a change in the focus of science education has spawned a major curriculum reform effort developed by the Social Science Education Consortium (SSEC). The SSEC is a group of science educators headquartered at the University of
Colorado, Boulder, bound together by a common interest in educational research and development of curriculum materials that reflect a synthesis of social, technological and science issues (Hickman, Patrick, and Bybee, 1987).

For example, Science/Technology/Society (STS): A Framework for Curriculum Reform in Secondary School Science and Social Studies was developed through a grant from the National Science Foundation (Hickman, et al., 1987). STS advocates believe that the success of individuals and their society is tied to their decisions on issues related to social uses of science and technology. Hickman et al. (1987) also feel that the confluence of the science-technology-society theme can be an effective organizer for science education.

Some traditionalists, however, hold to a more conservative definition of science education—that is, science as a process of educating students in the quest or search for knowledge, rather than the knowledge itself. For example, Good and Kromhout (1983, p. 649) state, "These social-problem-organized courses remain, thus, only courses about the science-society interface and fail to reduce the crisis in science education ......that the organization of science courses by social issues opens science education to manipulation and perversion by social activists into a vehicle for reinforcing one-sided or narrow perceptions of social, political, intellectual, and religious issues."

These critics of the holistic or STS approach feel, at best, that the interaction of science and society may be worth studying; however, it shouldn't be confused with science education. And, at worst, the use of societal issues as organizers for science education may open the door for "dangerous" extremists. "The major concern of science education researchers should be identifying factors which help people learn science; science as defined by scientists, not by sociologically and politically oriented observers" (Good, Herron, Lawson, and Renner, 1985, p. 140).
STS advocate Yager (1985, p. 143) counters by saying that,

"Defining science education as a discipline concerned with the interface of science and society does not suggest that knowing how humans learn science is not important. In fact, it may give more meaning and reason for asking fundamental questions about the development of thought, cognition, and learning."

The difference between these two schools of thought, on analysis, may be the manner in which they each view pure and applied science education. Good et al. (1985) seem to ignore data (NAEP, 1979; NSF, 1979; NSTA, 1982) that reveal the failure of traditional science teaching, which emphasizes preparation for passage to the next course of science and thereby fails to prepare the majority of students. In contrast, STS advocates echo reform goals, calling for science literacy for all students (Brunkhorst and Yager, 1986).

Other educators in the sciences and social studies have also pushed for emphasis on a holistic or science-technology-society framework in the core curriculum of secondary schools, but these recommendations have not emerged in the form of widespread curriculum development (Hickman, et al., 1987). There is a discrepancy between "what ought to be," according to major national reports recommending educational policy in secondary schools, and "what is," as documented by various assessments of student achievement, teaching procedures, and curriculum materials (Piel, 1982; Patrick and Remy, 1985). According to the National Science Foundation (1979), a major problem of science education is that it merely prepares students for the next science course, which is usually more specific in content. This approach is geared to the 1.5 percent of high school graduates who finish college with a science or engineering degree. The needs of the other 98.5 percent are left largely unmet.
In recent times, American public schools have assumed a responsibility to encourage individual social mobility and to help assure the social and economic progress of the nation (Kliebard, 1986). The schools must shoulder the assumption that they should foster an understanding of society and its component parts. Adler (1982) in *The Paideia Proposal: An Educational Manifesto* points out that formal schooling is only a part of education in a democratic society. Adler's manifesto recognizes the need for all students to have a high-quality education that encourages positive values and develops basic knowledge and skills. Thus equipped, they are enabled to assume roles in society as responsible citizens and productive individuals. The reform in science education must relate science and technology to human affairs and the social process. "To achieve these purposes will require the teaching of science in a social context supported by a curriculum that has scientific, technological, and social relevance (Hurd, 1985, p. 98)." This mandate presents a challenge for educators to develop pedagogically sound curricula that synthesize a holistic instructional approach of several disciplines and methodologies.

In spite of the recommendations of prominent national science teachers' organizations, foundations, and commissions, few STS-oriented curricula have been developed on a local level. Collette and Chiappetta (1989, p. 21) state that, "even though the rationale and need to include STS in the science curriculum is obvious, the extent to which STS should be included and emphasized has not been established. New methods and strategies must be developed to teach science in an STS context." But few local programs have emerged that embrace a holistic approach of inquiry and hands-on activities (Penick and Meinhard-Pellens, 1984). New curricula should reflect
the shift in emphasis toward the interaction of local social issues, science, and technology.

Louisiana typifies the national norm. While the Department of Education in Louisiana has an adopted Environmental Science Curriculum, Bulletin 1792 (1987), state education policy allows some latitude to local education authorities to select textbooks from a list of approved texts. Currently four different textbooks are being used in environmental science classes statewide (Moran, Morgan and Wiersma, 1980; Turk, 1985; Nebel, 1987; and Chiras, 1989). An inspection of these texts revealed a uniform lack of indigenous examples used to illustrate environmental concepts. For instance, to illustrate an example of the concept "biome," the textbooks use savanna or rainforest or desert to make their point, rather than an example indigenous to Louisiana. Look up "endangered" and one finds leopards, snaildarters, and gorillas, rather than the Kemp's ridley sea turtle, the brown pelican, or the Louisiana black bear. The concept of "erosion" turns up discussions of the Grand Canyon or glaciers, instead of coastal wetlands. The researcher is not suggesting that the examples discussed in the texts are not important, or that environmental phenomena indigenous to Louisiana should be studied in isolation from worldwide environmental constructs, but that the environmental phenomena that do exist in Louisiana can better be used to illustrate universal environmental concepts to its citizenry.

Nowhere is the need for local emphasis in science education, especially that pertaining to the management and conservation of coastal wildlife and natural resources, more urgent than in the state of Louisiana. Louisiana's economy is strongly tied to the resources yielded by its coastal and marine environment. Besides oil and natural gas, Louisiana produces over 25 percent of the nation's fur harvest and an annual fisheries catch of nearly two
billion pounds. Extensive maritime commerce and recreational hunting and fishing also make important contributions to the coastal economy, employing thousands of Louisiana citizens.

If Louisiana is to manage, use, and conserve its rich coastal resources wisely, its educational system must produce citizens who understand certain concepts: that coastal wetlands are fragile; that a healthy functioning whole depends on complex relationships among many natural processes and species; and that careless exploitation and lack of balanced management will lead to a severe reduction in coastal resources—the finfish, shellfish, and wildlife on which many livelihoods depend. This kind of education must begin in youth. Unfortunately, there is a shortage of suitable instructional materials about Louisiana available to teachers (Fowler, 1988). Furthermore, a recent statewide survey of science teachers by McCoy, Wandersee, and Good (1991) indicates that "overall, Louisiana's science teachers are slightly below average in information awareness" according to their pre-set scale that was based on their professional membership and amount of professional reading.

In an attempt to fill this gap, a multi-media series of instructional units was designed that integrate a variety of methodologies and media in the science-technology-society mold. Entitled Wild Louisiana, the approach takes advantage of video technology to visually present regionally oriented STS paradigms. Hands-on activities in the form of games, simulations, and role-playing present universal environmental concepts in a regional context. A modular approach was used to facilitate the infusion into the existing curriculum. In linking new materials to the existing statewide curriculum, it was felt that teachers and school administrators would more readily accept them. The combination of instructional approaches was designed to address the various learning styles of individual students.
Statement of the Problem

The purpose of this study was to see whether the use of media and simulation-gaming activities, with an infusion approach to instruction, influences student achievement and attitudes in environmental science. The first objective was to determine whether the infusion method was most effective when used with simulation-gaming activities, or with videos, or with a combination of the two techniques. The second objective was to determine if a particular instructional method was most appropriate for certain learner styles as identified by the student's locus of control.

Rationale

According to Volk, Hungerford, and Tomera (1984), in a national survey of environmental educators, the respondents believed that there was a substantial need for new curricula, especially at the secondary level. In addition, they felt that environmental education goals were not being met with existing curricula largely because these existing materials describe examples and situations that are foreign to the students' realm of experience. Some educators feel that regionally based curricular materials are effective. Boulanger (1981) reports that studies have shown that instructional programs which focus on greater realism and concreteness result in increasing students' cognitive levels. This is supported by Hostettler (1983) and by Foote (1981) who believe that the use of real world examples and situations can be more readily understood if the impact of those examples and situations can be internalized through regional or personal experience. Gagne, Briggs, and Wager (1988) clarify this theme by stating that this approach is only
meaningful to students if they understand the broader applications of the example used in the lesson.

A combination of media was selected as a carrier of information, thereby providing students with different learning styles an opportunity to learn. Salomon (1979) notes that various forms of media stimulate different sets of mental skills, and thereby cater to different learners. He suggests that it is the students' perceptions, along with the formal attributes of media, that are causally connected to the effort they invest in learning. Since students with different cognitive styles can learn from a variety of media, it is important to determine the individual's orientation to learning. Foremost learning theorists Gagne et al. (1988, p. 114) state that,

Learner characteristics that affect the learning of new instructional material assume several kinds of organization in human memory. The learned capabilities of intellectual skills, cognitive strategies, verbal information, attitudes, and motor skills have direct effects on the learning of new instances of these kinds of capabilities. The learners may differ in the amount of prior learning they have experienced, have different learned capabilities, different schemas, and different abilities and traits.

While a lecture may be sufficient for raising achievement levels of one part of a class, other students may require a different instructional approach. A recent study by Nadel (1988) on instructional television has indicated several intervening variables which may have an impact on individual student's attitudes and learning. Student preferences for learning modes and learning styles, academic self-confidence, sources of motivation, and locus of control were among variables that Nadel identified. In other words, the learning process is affected by the individual differences among students. Another complication is that different materials have different effects on the learning process. Clark (1983, p. 455) states, "Presumably, differences in
the qualities attributed to different media may influence learning-related behaviors of students. Higher ability students seem to like methods and media that they perceive as more structured and directive because they think they will have to invest less effort to achieve success. Lower ability students typically seem to like less structured and more discovery-oriented methods and media." He suggests that students incorrectly choose the method of presentation to suit their individual learning styles.

One of the earlier criticisms of television's potential as an instructional tool had to do with the pervasive nature of the medium; that over-familiarity with the medium bred passive viewers. Still, many other factors also inhibit the attention span of the viewer/learner. In an attempt to focus the students' attention, a method was sought to require their active viewing by fulfilling some task, yet without that task's interfering with the content presented in the program. The result was a variation of Novak's (1980) instructional device that he describes as "concept mapping."

In the concept maps developed as part of the Wild Louisiana Video Guide, the flow of concepts mirrors the flow of concepts in each video program. Broad conceptual areas are broken down to increasingly simpler, but related, concepts and serve as concept outlines for the information presented in the video. The concept maps function as advance organizers as described in Novak (1980, p. 284). "Advance organizers are a kind of cognitive bridge: they serve to link some relevant concept or proposition in the learner's cognitive structure to the new concepts or propositions we want to teach."

For Chu and Schramm (1967), the question about the instructional effectiveness of television was no longer whether students learn from TV, but rather (1) what learning situations most appropriately called for the use of
TV, and (2) how it can be used effectively. Fleming and Levie (1978) felt that program efforts should be preceded by planning, with focus on the learners and the objectives to be realized. In addition, Perrin (1976) reported that television is most effective when combined with other learning experiences, especially when the separate elements are designed to work together. He felt that the potential for learning is significantly increased over traditional instruction when television serves as an integral component with other methods and media techniques to comprise a total learning system.

The hypotheses of this study were as follows:

**Research Hypotheses**

1. Students enrolled in an environmental science course supplemented with regionally based STS-oriented videos will achieve higher cognitive scores as compared with students enrolled in courses with a textbook or traditional approach.

2. Students enrolled in an environmental science course supplemented with regionally based STS-oriented videos will achieve higher affective scores as compared with students enrolled in a course with a textbook or traditional approach.

3. Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities will achieve higher cognitive scores as compared with students enrolled in courses with a textbook or traditional approach.

4. Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities will achieve higher affective scores as compared with
students enrolled in a course with a textbook or traditional approach.

5. Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities and videos will achieve higher cognitive scores than students who are: (1) supplemented with video only, (2) supplemented with simulation-gaming activities only, or (3) enrolled in a course with a traditional approach.

6. Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities and videos will achieve higher affective scores than students who are (1) supplemented with video only, (2) supplemented with simulation-gaming activities only, or (3) enrolled in a course with a textbook or traditional approach.

7. There will be a treatment by locus of control interaction effect for knowledge.

8. There will be a treatment by locus of control interaction effect for attitude.

Significance of the Study

Today's students face serious responsibilities concerning the future management of Louisiana's coastal and marine environment. In fact, management decisions made at all levels of government over the next two decades will determine the future survival and productivity of Louisiana's coastal wetlands. Therefore, it is crucial for today's students to know that their present attitudes about the coastal and marine environment will
determine the fate of coastal areas in the future, and that they are ultimately responsible for decisions concerning the use of coastal and marine resources.

In addition, rapid technological and scientific advancements have increased dramatically in recent years. The rapid progress has brought with it new challenges and controversies not easily addressed. The high technology of modern times is more science based than the technology of previous centuries, and modern science is more of an applied technology (Hurd, 1985). If a goal of science education is to produce informed students who will be our future citizens and leaders, then they must be provided an opportunity to think about relevant issues so that they may deal with them intelligently.

New methods and strategies must be developed to teach science in an STS context. This study compares the utility of an approach that integrates science, technology and social issues into the traditional core curriculum with the utility of the traditional curriculum alone. The combination of a regionally based, mixed-media package of simulations, videos, and print materials was intended to meet the variety of learning styles of students with appropriate instructional strategies.

**Definition of Terms**

For the purpose of this study the following definitions apply:

**Activities** - hypothetical microcosms that model real world paradigms, constructed as role playing, games, and simulations that require students' active participation in a sensory-motor exercise.

**Concept Maps** - instructional devices used to prepare students for watching the video programs and encourage their active viewing. Broad concepts are presented first in a flow chart format, followed by more detailed or related concepts connected together with linking words.
The conceptual flow charts help students understand the relationship and hierarchy of related concepts. The concept maps function as advance organizers by alerting students to the conceptual flow of the video. This presentation creates a framework for subsequent learning (Novak and Gowin, 1984). Examples are provided in Appendix C.

**Environmental Education** - the process of developing knowledge, understanding, attitudes, and responsibility with regard to man's relationship to his sociocultural and biophysical surroundings (Barr, 1980).

**Regionally Based Materials** - supplemental educational curricular materials that are framed around local geographical, social, and environmental constructs.

**Textbook Approach** - an instructional technique that follows the format recommended in the particular textbook. Textbook information is presented in a lecture as the primary source of information. No films, videos, or activities are used.

**Limitations**

Measuring the utility of materials that are intended for a diverse group of teachers, each with his or her own style of teaching, presents a number of challenges to the integrity of any study. Numerous situations could detract from the uniformity and the consistency desirable in an experiment. This became apparent to the researcher in the pilot that preceded this study. In the pilot, although the selection of environmental science teachers was random, many of them did not have science backgrounds. This is not an uncommon situation considering the shortage of science teachers; however, it could affect the validity of the data. The variance in certifications held by environmental
science teachers indicates that those teachers' breadth and depth of knowledge of environmental science was not consistent. It was apparent that some strategies were required to ensure continuity, uniformity, and consistency in the treatment within groups of classes. The present study has been designed to minimize these problems. While teachers were still randomly selected, a science certification selection criterion for teachers was established to ensure a sound experimental design and to provide a fair evaluation of the materials. This still allows for the variance in the certification among science teachers in the school system, yet provides a practical level of consistency among teachers. It also allows the experimental design to provide a truer picture of the usefulness of the materials and the instructional approach used.

In addition, an evaluation of the piloting process and implementation revealed other factors that could affect the study's validity. Interviews conducted with the pilot teachers indicated that many of them spent varying amounts of time and emphasis on parts of the curriculum, while others skipped segments entirely. Still others did not "teach" the video programs, but merely showed them.

To correct for the varying amounts of time and emphasis teachers spent on the materials, Wild Unit Plans (WUPs) were developed to ensure consistency of instruction among teacher groups. The WUPs describe when the different Wild Louisiana segments should be introduced into the regular curriculum and prescribe a recommended amount of time that should be spent teaching each concept. The WUPs offered many advantages to the teachers using Wild Louisiana; thus, the unit plans were made a regular component of the materials. In addition, regionalized background information regarding relevant environmental issues precedes each module.
to further provide teachers with a consistent knowledge base of local environmental issues.

In its report to the Secretary of Education, the National Task Force on Education Technology (1985) presented a number of goals to transform education in America. One goal was to increase the equity of opportunity, access, and quality of the various educational technologies available to teachers. In the pilot of the Wild Louisiana materials, it was apparent that there was a broad interpretation by teachers of the best way to utilize video as an instructional tool. This divergence in the instructional approach by teachers affected the validity of the data and showed the researcher that the teachers needed a more explicit approach to infusing instructional videos into the lessons.

As a result, an instructional approach was used to develop the video guides that not only presented the new information, but also established how the student was intended to learn such knowledge. Previewing, viewing, and post-viewing strategies were developed to extend the utility of the videos. These instructional techniques synthesize Gagne's nine events of instruction (Gagne, Wager, and Rojas, 1981) into three strategies. The previewing strategy is intended to gain students' attention, alert them to what they will see and hear, and to tell them what they are expected to learn. This component of instruction also serves to stimulate the retrieval of long-term memory to short-term or working memory (Gagne, 1985). This helps students relate new knowledge to prior knowledge. This step includes Gagne's first three events of instruction by gaining the students' attention, informing them of the lesson objective, and stimulating their recall of prior learning. The viewing strategy is intended to alert viewers to the organization of the video and to make them active learners. This approach employs the use of concept
mapping, which also serves the purpose of organizing for students the relationship of concepts by clarifying their connection and relative importance. It also signals to the teacher which students have not grasped the new information. The viewing strategy includes Gagne’s next two events of instruction, that of presenting stimuli with distinctive features and guiding the students learning. The final four learning events identified by Gagne are subsumed into the post-viewing strategy. They are "eliciting performance, providing informative feedback, assessing performance and enhancing retention and learning transfer" (p. 59). The post-viewing strategy clarifies the concepts presented by the video, reviews pertinent constructs, and enhances the development of thinking skills by emphasizing the application of real problems to learning (Pizzini, Abell, and Shepardson, 1988).

Further analysis of the instructional environment prompted additional mitigation strategies. Currently, environmental science teachers in Louisiana may use any of four different textbooks. The textbooks are selected by the local parish school board from a recommended list of textbooks compiled by the Louisiana Department of Education (Glisson, 1989). However, the state also provides an Environmental Science Curriculum Guide (1987) which establishes statewide curricular standards. The Louisiana Department of Education (1987) adopted the environmental science curriculum in the 1987-88 academic year after piloting the curriculum in selected schools the previous year. Environmental science is now taught in many parishes in Louisiana in the eleventh grade and is offered as an alternative to chemistry as a third science, according to Bulletin 741, the Louisiana School Administrators’ Handbook developed by the Louisiana Department of Education (1988). To minimize any effect caused by the use of different texts, all teachers in the study were directed to cover certain
environmental concepts as presented in the state-adopted curriculum. A copy of the outline of these concepts is provided in the Appendix (A). This insures that all groups of teachers will cover the same environmental concepts during the 16-week period of study. Each of these modifications was developed as an attempt to strengthen the treatment and minimize any loss in validity or generality.
CHAPTER II
Review of Literature

Science education is unique in that it emphasizes firsthand experiences. Rather than study about things, we study the things themselves. Sometimes, however, firsthand experiences are impractical or impossible to bring into the classroom.

Robert Sigda
President
National Science Teachers’ Association
1983, p. 27.

Sigda (1983) advocates the use of visual media to teach science, primarily as a means to enhance information about inaccessible places, species, or phenomena, and as a concession to convenience. But the potential of visual media is much greater, as the literature suggests, as it is uniquely capable of addressing the demands of science education reform. This chapter organizes a review of literature into four relevant areas: science, instructional television, games, simulations, activities, and the impact of learner characteristics.

Science Curriculum

The call for reform. Sociologists Catton and Dunlap (1978) describe a shift in American concern regarding the environment, due in part to the increased awareness of man’s role in a growing number of environmental problems. In the past, viewpoints that are variously described as the Dominant Social Paradigm (DSP) (Giller and Lasley, 1985) and the Human Exceptionalism Paradigm (HEP) (Catton and Dunlap, 1978) supported an anthropocentric worldview, whereby humans were seen as separate from and
above the rest of nature. Nature was man's to control and use according to his needs. This perspective, that human progress was limited only by advances in science and technology, gave way to concern about the negative effects of that growth on the environment. Man was no longer viewed as above and distinct from nature but rather as a dependent part of nature. This shift has given rise to what Dunlap and Van Liere (1978) have called the New Environmental Paradigm (NEP) which holds that man is intertwined with nature, and that what he does to nature, he does to himself.

This shift in worldview spawned increased concern about the environment, particularly in the 1970s, generally regarded as the decade of increased environmental awareness throughout the United States (Trent, 1983). The realization that American consumers, with 6 percent of the world's population, use up to 50 percent of the world's natural resources and produce 40 percent of the world's nonhuman waste forced educators to call for a reform in science education (Stapp, 1974).

"Numerous educational leaders and associations agree that the study of science and technology in a social context should be included as part of the core curriculum—subjects required of all students as part of general education for citizenship" (Hickman, Patrick, and Bybee, 1987, p. 5). The calls for reform in science education were not only based on the shifting worldview of man's oneness with nature, but also reflected a dissatisfaction with the goals of science education. Brunkhorst and Yager (1986) argue that the science curriculum in essence is elitist; that courses merely prepare students for the next course of science. This justification serves the 1.5 percent of high school graduates who end up as scientists or engineers, but fails the needs of the other 98.5 percent, imbuing many students with negative feelings toward
Thus, the basic science courses meet the needs of a small minority of students.

Two national studies support this assessment. The National Assessment of Educational Progress (NAEP, 1979) and the National Public Affairs Study (Miller, Suchner and Voelker, 1980) report low levels of knowledge about persistent science-related social problems. Respondents showed little knowledge of how science is used to improve the quality of human life or its relationship to advances in science and technology.

A major research effort by the National Science Foundation, Project Synthesis (Harms, et al., 1981), identified four goal clusters for the reform of science education: personal needs, societal issues, career education and awareness, and academic preparation (p. 7). The project researchers, in a review of American schools, noted that existing programs, as a group, ignored the first three goals, focusing entirely on academic preparation. Basic social problems, even those related to science and society, were not included as a part of instruction. Scientists were never portrayed as ordinary humans, and science careers were only mentioned in context of a famous personality. The perception of science was the information found in textbooks, rather than a way of knowing about the world (Brunkhorst and Yager, 1986).

Science-Technology-Society. The philosophical crisis in science education has been clearly linked to social change (Hurd, 1985). This condition is the result of the failure of both the educational and scientific community to regard the connectedness of science, technology, and society. Adler (1982) reports that many calls for reform stress that science is an important part of a general education. Some call for humanistic ties and others include economic development, productivity, and life in the
workplace. All agree that science education should include social and personal themes.

The symbiotic relationship between science and technology has grown as the disciplines have increasingly complemented each other. Hurd (1985) notes that modern technology is more science-based than before, and modern science is more of an applied technology. Discoveries in both fields enable new developments to occur correspondingly.

This sentiment forms the basis for the rationale of *Science-Technology-Society: A Framework for Curricular Reform in Secondary School Science and Social Studies* (Hickman et al., 1987), which takes the position that teachers must assume a more active role in reform.

Teachers must rethink the role they play in the development of STS education, particularly in reflecting the constant shifts in values, the need for an increased knowledge base, and the implementation of processes that convey knowledge while including students in active, participatory learning (p. 1).

This viewpoint suggests that teachers will have to be trained to include an STS orientation in their classrooms, and, as the literature in the next two sections indicates, teacher training can have a positive impact on student learning. Training should provide teachers with a relevant knowledge of social issues and how to make the best use of the materials pedagogically. Brinckerhoff (1985) states that students must be taught to use their science base of knowledge in viewing social problems. "STS is not just an additional topic to be added to the curriculum; it requires pedagogical methods that encourage student participation" (p. 222).

**Methods of instruction.** While there is widespread support for the STS concept, few full-year courses of precollege materials exist (Patrick and Remy,
The majority of the literature refers to modular or infusion approaches to instruction rather than whole courses of STS. Some educators (Brinckerhoff, 1985; Carlson, 1985; Jarcho, 1985) cite some advantages to a modular approach. For example, infusing STS into a regular science class enables students to experience local issues but still be given a background in the related science principles. Carlson, on the other hand, (1985) cites one problem with a modular approach as its potential to take time away from content that should be covered in the regular class. This stresses the importance of linking the learning objectives in the modules to the learning objectives in the curriculum. Carlson also notes that "the ideal course would include a mixture of strategies, thereby encouraging a successful experience for each student" (p. 200). In support of an infusion approach, Brinckerhoff (1985) suggests that combining STS and basic science materials can enhance classroom instruction. He recommends that an infusion approach should follow these guidelines:

1. The STS issues should be related to the material already contained in the conventional science course.
2. Social issues should be chosen that relate to a student's immediate experience or are likely to appeal to his or her imagination.
3. The issues should provoke the intellectual and emotional participation of the student and should lead to a choice or decision (p. 224).

These science-related social issues often involve making decisions from a base of values, providing tough or conflicting choices as the only options. Environmental issues often involve value conflicts in which there is no clear right or wrong choice. For example, communities often have to choose between clean air and water or jobs and production. Making decisions
in a conflict between economic and ecological values is difficult because arguments seldom follow facts and logic, but stem from value judgments and emotionalism instead (Patrick and Remy, 1982). Paul (1984, p. 5) suggests that science instruction should include problem-solving skills. He states,

> There is a fundamental difference between the kinds of problems one faces in technical domains and those in the logically messy 'real world.' Solutions to technical problems are typically determined by a consistent system of ideas and procedures. In contrast, the problems of everyday life are rarely settled in a rational manner.

But even though structured conflict has potential in the classroom, teachers generally fail to utilize controversy and conflict as an instructional mechanism. Johnson and Johnson (1979) did a metanalysis of available research and found that most classrooms avoided the use of controversy, and that teachers lacked skill in conflict management. However, they noted several advantages to incorporating controversy, including its use as a motivator for new information and developing problem-solving and decision-making. Hart (1983) cautions that conflict and controversy must be properly managed for maximum learning to occur. This suggests that STS materials, while fashioning the conflict contextually within the curriculum, should be explicit in providing discussion and extension activities to positively channel and maximize learning. Winning arguments may not be as productive as trying to resolve the controversy.

**Effective science instruction.** In reviewing the literature, several studies were located that have bearing on the nature of the treatment materials and some factors that may influence their effect. For example, the work of Wise and Okey (1983) proved to be most useful in analyzing the related research on science achievement. They examined a large number of
studies that investigated science teaching techniques to determine the circumstances under which a particular method was shown to be effective. This study supports the way in which the curricular materials were presented to students and also the benefits of active involvement.

The authors categorized the various studies into 12 different teaching methods and determined the effect size for each technique. This was cross-tabulated with the various features of the studies (e.g., class size, grade level, content) to determine the conditions in which teaching strategies had their influence. As a result of this analysis, effective science classes made students aware of the instructional objectives, provided them feedback on their progress, and gave them an opportunity to physically interact with instructional materials and engage in varied kinds of activities. Discussion was guided by preplanned questions.

Conversely, the traditional classroom was unlike the composite effective classroom that emerged from the study. Typical classrooms were not objectives oriented, with formative tests rarely given. Questioning by the teacher was usually fact oriented and not usually preplanned. There were few opportunities for students to interact with materials.

The broad view provided by this type of study presents a useful analysis of which elements of instruction had a large (and small) effect on science achievement. Wise and Okey speculate about the desirability of subsequent research that would emphasize combining effective elements and minimize those proven to be less effective. "It is interesting to imagine how several strategies, none of which has an overwhelming impact, might influence achievement if used in concert" (p. 435).

Gabel and Sherwood (1983) have found that a combination approach that uses both visual and verbal methods is superior to a strictly verbal
approach in teaching problem-solving in high school science classes. They found in the comparison of the two methods of instruction that the combination approach resulted in significantly higher learning of scientific concepts. This supports the use of a visual component in increasing learning in science.

Other educators recommended different approaches to make science education more meaningful. Hostettler (1983) believes that the use of real-world examples can help students understand science concepts, especially when the examples are personally relevant. This belief is supported by Philips (1988) who studied regionally based activities compared with a textbook approach to instruction in environmental science. Philips found the regionally based activities approach to be a superior method in raising students' environmental knowledge and influencing attitudes.

In his study, Lutts (1985) recommends that teachers must go beyond the books, facts, and general principles in developing environmental awareness and concern among students. He believes that it is essential for students to be familiar with the place where they live. Students must learn what makes their home a unique place before they can appreciate what constitutes "home." These studies support the use of materials that the students can relate to in increasing knowledge and attitudes.

However, in a number of the studies reviewed, changing students' environmental attitudes was not frequently achieved. Kinsey and Wheatley (1984) studied the effects of an environmental science course on university students. They found that the older students' attitudes were not significantly affected, but that the course provided informational support for preexisting attitudes. The researchers felt that the older students' age and education level may have affected their findings.
Sia, Hungerford, and Tomera (1985) explored different behavioral variables as predictors of responsible environmental behavior. Using a validated behavior instrument, they statistically determined that a number of key variables were significant predictors of environmental behavior. They were: (1) level of environmental sensitivity, (2) knowledge of environmental action strategies, (3) skill in using environmental action strategies, (4) sex, (5) individual locus of control, (6) group locus of control, and (7) attitude toward pollution. The first three behavior predictors were found to be the most consistent for all respondents and were recommended for consideration in curriculum development and instructional practice. Sia et al. stated that environmental education research and curricular materials are largely directed toward the awareness and analysis of environmental problems, while environmental problem-solving skills and citizen participation are neglected or perceived as something that is achieved by awareness education.

They contend that responsible environmental problem-solving behavior is not given due consideration because of a lack of information in regard to understanding, predicting, and changing those behaviors. In their study, Sia et al. sought to test a theoretical framework incorporating a number of variables previously identified in the literature. The researchers defined "environmental action" variables as behaviors of the respondents that fell within five categories: consumerism, physical intervention (ecomanagement), persuasion, legal action, and political action. They believed that their results

Provide a clear mandate for environmental education curriculum developers to address citizen participation in environmental problem solving. This statement is made, in part, because both knowledge of and skill in using environmental action strategies were shown by the findings to be strong predictors of responsible environmental behavior (p. 38).
This suggests that students require more than just instruction in basic science concepts. This implies that students also need to have knowledge of and practice in problem-solving strategies. These types of strategies, such as evaluating the trade-offs of different forms of land use, determining a reasonable balance between preservation and conservation issues and recognizing bias, are similar to those presented in the *Wild Louisiana* curriculum materials.

According to Richardson and Johnson (1980), better informed teachers who have a greater environmental awareness are more capable of producing environmental awareness in their students. In a study of teachers' attitudes toward energy and related subjects, they found that what is taught and how it is presented are directly related to what the teacher knows and feels. This suggests that in states like Louisiana, where the certification and expertise of environmental science teachers are diverse, students' learning levels could vary substantially. It also suggests that when developing curricular materials, it is critical that teachers be provided with some background support materials.

Mayer and Fortner (1987) found that short intensive workshops were a more effective method of getting teachers to use supplemental curricular materials. Also, they found that providing teachers with regionally based materials alone is not enough to encourage teachers to use free materials. Simply giving materials to teachers resulted in no usage. The researchers recommended that detailed curricular materials are most effective when teachers are trained in short, intensive workshops. This study offers support for the training format used in introducing the *Wild Louisiana* curricular materials to the teachers involved in this study.
Instructional Television (ITV)

Research on the ability of television to teach has been documented over the past 30 years. Cambre (1987, p. 30) notes that,

It has been established, unequivocally and irrevocably, that a well-designed and produced television program can and does teach. This is especially verifiable when the potentials of the medium are exploited and content visualization is maximized. It is most especially true in the hands of a skilled teacher.

Conversely, it is less effective when it is not presented with a (skilled) teacher. In much of the research on the effectiveness of ITV done prior to 1975, one critical factor that most studies agreed upon was that the presence of a mentor, either a teacher in class or a parent at home, increased the learning potential for viewers (Newman, 1981).

The benefit of the presence of a mentor as a factor in increasing learning is perhaps characteristic of the nature of television. It is a passive medium. One concludes that for learning to increase from viewing ITV programming, it should be more directed and planned, rather than incidental. This has relevance for the present study in that the presentation of the videos in Wild Louisiana is framed within an explicit instructional strategy that directs learning. The following section reviews some of the relevant studies that consider some factors of effective ITV programs and methods of presenting them.

In a synthesis of research, Newman (1981) identified a number of characteristics of effective instructional programs. She notes that, "ITV programs produce significant gains in student achievement when they repeat the key concepts a variety of ways, entertain as well as inform, and provide
opportunities for students to participate in a learning activity" (p. 4). This has bearing on the use of captioning key ideas in the video programs as well as the use of the concept maps in the previewing strategy.

When the learner was considered, Newman noted that students show gains in achievement from viewing ITV when teachers "prepare students to receive information presented by the program, provide reinforcing discussion and activities following viewing, and provide corrective feedback to students, based on what students reveal they have understood" (p. 4). This also relates to the use of the viewing strategy used to enlist the learner's active viewing and the postviewing strategies used in the videos to promote reinforcement and extension.

In a qualitative analysis of several science ITV programs, Watts and Bentley (1987) pose the question, "What makes good science education television?" In an extensive series of interviews with both science teachers and students, the researchers found that "good science education television is not vastly different from good television. That is, it can contain visual images that are stimulating, memorable, fun, 'attention grabbing', and commensurate with the level of sophistication they receive during evening viewing" (p. 214). Further analysis of their subjects' responses revealed two further points, that science programs should be tailored to the needs of learners, and that science should be portrayed differently. Science should "be seen to be personally, socially, culturally, and technologically relevant" (p. 214). Further critique centers around how ITV is used in the classroom and reflects somewhat on the way programs are produced. The authors state that few teachers or students regard ITV as a serious medium by which science can be learned. "At best, a video program is treated as support material for other classroom activities; it is very seldom allowed to stand on
its own as a learning experience. Showing a video is frequently used as a break in routine, often simply as an entertaining interlude" (p. 208). They say the reason for this is that the information base and the visual images presented are considered to be "ephemeral," that the effects on the learner are transitory and soon forgotten. They felt that for the video to be effectively used as a teaching device, it must be reinforced with written material and with some type of active participation from students. This is supported by Perrin (1976) who asserted that most educators and TV producers would agree that television is most effective when combined with other learning experiences. "Learning is significantly better than traditional instruction when television serves as an integral component with other methods, techniques, and media to comprise a total learning system." This has bearing on the present study because the methods employed in the Wild Louisiana materials, that of visual, auditory, and enactive stimulation, synthesizes ITV with other forms of instruction.

Kozma (1986) provides a practical synthesis of instructional psychology implications in adapting the design of ITV to address students' learning needs. He links television production methods to components of the cognitive or information-processing model of learning, primarily short-term and long-term memory. He reports that information in long-term memory may be stored semantically as well as pictorially. "If the same information is stored both verbally and pictorially, it is more likely to be retrieved" (p. 13). Based on this general model of learning, Kozma presents a number of production considerations using the capabilities of the medium to support learning. For example, pacing of the program should be balanced by the learners' ability to extract what they need for learning. Production features, such as sound effects or music, may be used to cue the learners to key concepts
by stimulating their attention. Salomon (1979) expands this premise, stating that media production elements, such as the camera's focusing on a key detail, can support cognitive processing by supplanting it. Kozma terms this "modeling" and says that "viewers not only learned more about the details that were highlighted, but they internalized the focusing ability" (p. 16). These references not only relate to the highlighting of key concepts in the *Wild Louisiana* videos and other production features, but also the pre-viewing and post-viewing instructional strategies in the video guide. The study by Watts et al. provides some guidelines as to how good science instructional television should be produced, but some more fundamental concerns about the ability of the medium to teach should be addressed. The following studies refer to findings about both the elements within instructional television and how it has been used in combination with other instructional strategies.

As early as 1967, Chu and Schramm were proclaiming that there was no longer any doubt that children and adults learn a great amount from instructional television (ITV). Instructional television is a visual medium combining audio, text, and graphics, with its primary strengths being a realistic depiction of events and dramatic power. The major purposes of instructional television are to impart knowledge and to influence opinions. This is in contrast to commercial TV, whose primary purpose is to entertain (Brown, Lewis and Harcleroad, 1977). Although some researchers question the ability of televised media to influence learning achievement (Clark, 1983), the literature suggests some agreement that television (and film) is at least as effective a carrier of information as a live presentation (Comstock and Fisher, 1975). Others state that when the content of a program is properly presented, television's potential to aid learning is enhanced (Cates, 1989).
Television has a number of properties that can make it an effective instructional device. Gueulette (1988) documented several positive features of ITV: introducing new materials or ideas; summarizing or reviewing previously learned materials; giving visual support to ideas or concepts; enriching or expanding the viewers' world; exploring feelings of subjects and viewers; clarifying special points; and reinforcing key concepts.

Some ways that ITV has been used effectively in education include its use as a prelesson, a presentation, a post-lesson, and enrichment (Cates, 1989). Prelessons are useful to introduce concepts to be discussed and help prepare the viewer in recognizing key concepts that will be presented. Ausubel's theory, (1978) that linking new information to what has already been learned is a critical factor in learning the new information, supports the usefulness of prelessons.

The multiple resources that can be synthesized into a video program can make television a powerful presentation medium, especially when the content is difficult to represent or illustrate. For example, various design elements such as the use of charts, closeups, zooms or camera movement, animation, and captions in the presentation can enhance the content. Wakshlag, Reitz and Zillman (1982) looked at the effect of another element—pacing—on the effectiveness of ITV. They found that the rate of presentation of visual and auditory elements can affect attention levels and learning. Fast action and audio tempo may increase viewership, but not necessarily sustain attention or increase learning. Programs paced more slowly may be necessary to accommodate the cognitive level of a particular audience (Bliss, Goater, Jones and Bates, 1983). Recognizing the learning needs of the target audience is an important part of the design process (Gagne, Briggs, and Wager, 1988). Salomon (1979) indicates that cognitive processing can be activated by the
cuing of instructional messages and thus is an important design consideration. Other important design elements were studied by Anderson and Levin (1976). They demonstrated a relationship between production variables—such as music, pacing of visuals, and sound effects—and attention and comprehension. Saloman (1979) asserts that formal elements of television production facilitates cognitive processes. Pans, zooms, slow-motion, and freeze-frames, for example, can focus on detail in complex visuals and model mental visual operations. Highlighting conceptually rich segments with formal production elements has been shown to increase learning (Fleming and Levie, 1978).

Other production elements that have been investigated include the use of imbedded words, or captions, superimposed on the television screen. A release by the National Captioning Institute (1983), reports that its commissioned studies have shown that captions are beneficial not only to hearing impaired audiences, but also to hearing audiences. In a number of studies of various hearing audiences, the Institute reports improvements in vocabulary development, word recognition, and retention in instructional television programs that used captions.

Presenting key words or concepts on the screen in context with the audio portion of the program may provide students with additional opportunities to visualize constructs. In support of this, Dwyer and De Melo (1983) have concluded that words and pictures are not processed in the same way and are not equal in terms of facilitating student achievement. They report that visualization can be mentally processed simultaneously on several levels, and that the effectiveness of visualization is central to the learning process. And, by manipulating and combining the elements of television, the learner is presented with increased opportunities to visualize.
Cambre's review (1987) of instructional television's influence on education also supports this and contends that the medium's effectiveness depends largely on how well the program is put together. "It has been established, unequivocably and irrevocably, that a well-designed and produced television program can and does teach. This is especially verifiable when the potentials of the medium are exploited and content visualization is maximized" (p. 30).

Formal production elements, or television effects, are what Clark (1983) would call "methods." He also contends that the effects of instructional television presentations are due to the methods, rather than to the media per se. This theme is central to Clark's criticism of early television research that focused on the medium rather than the formal attributes and the content of television. Winn (1987, p. 46) suggests that researchers should focus their attention on "the instructional methods that users of television might employ with students, "the settings in which instruction takes place," and "the cognitive process it engages through the use of symbols."

Previous hindrances to effective ITV utilization, such as lack of equipment, quality programming, and target audience needs have largely been overcome (Reider, 1985). The question remained as how to take advantage of what ITV could offer. Hilliard and Field (1976) felt that the true potential of instructional television lies in its effective utilization. Following this lead, Wohl and Tidhar (1988) suggested that because of television's widespread use and acceptance throughout society as part of our daily routine, a viewer's psychological state was passively involved rather than active. They felt that effective utilization of ITV must involve stimulating the viewer/learner's vigilance. "Unless children are specifically instructed to
treat a television stimulus differently than usual, they invest little effort in it and extract little inferential knowledge from it" (p. 12).

Stimulating the viewer's vigilance, or gaining his attention, is a crucial step in effective ITV utilization and becomes integral with the viewing experience (Hunter, 1984; Gagne, 1985). This preparatory step includes telling the viewer what to expect in the segment, as well as key points to watch and listen for. By doing so, the viewer/learner's prior knowledge can be stimulated into working memory (Novak, 1980) and serve to facilitate the learning of new information. This concept of "meaningful learning" is described by Novak (1980) as Ausubel's most important single idea. "Meaningful learning occurs when new knowledge is consciously linked by the learner to existing concepts or propositions the learner already knows" (p. 282).

One of the advantages provided by instructional television that is generally agreed upon by educators (Chu and Schramm, 1967; Comstock, 1978; Houston-Stein and Wright, 1979; Clark, 1983) is that the content of the medium can effectively present new concepts that can supplement and enrich regular classroom instruction. But in order for the concepts to be meaningful to the learner, there must follow an inactive stage (Bruner, 1962; Gagne, 1985). Using new concepts in a symbolic fashion can aid the learner in acquiring meaning (Womack, 1989). Gagne (1985) tells us that long-term retention will be much more likely if students are able to do more than passively receive information, and are able to touch, taste, smell, or, in some fashion, experience new concepts.
Games and Simulations

I hear, and I forget
I see, and I remember.
I do, and I understand.

Chinese Proverb

Situated cognition. Recent arguments in cognitive theory by Brown, Collins, and Duguid (1989, p. 32) support the position that "knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used." Other theorists (Rogoff and Lave, 1984) concur, stating that the activity in which knowledge is developed and utilized is not ancillary or separate from learning and cognition, but is an integral part of what is learned.

Hearing new concepts in a didactic lecture alone may be more expedient for the teacher, but may not provide the type of instruction necessary for students with varying learning styles (Womak, 1989; Bloom, 1976). Hearing alone is often not enough of a stimulus for learning to occur. Womak (1989) notes that exposition should proceed demonstration, and then be followed up by giving students an opportunity to show that they have grasped the meaning.

Concomitantly, Perkins (1986) sees conceptual knowledge as in some ways similar to a set of tools. He states that tools and knowledge share many significant features; that both are fully understood only through use. He states that using them entails both changing the user's perspective and adopting the belief system of the culture in which they are used. Brown et al. (1989, p. 36) support this analogy, stating that "the perceptions resulting from actions are a central feature in both learning and activity. What a person perceives contributes to how they act and learn." This is also supported by
Collins, Brown, and Newman (in Brown et al., 1989) who describe situated learning in terms of a "cognitive apprenticeship." "Cognitive apprenticeship methods try to enculturate students into authentic practices through activity and social interaction in a way similar to that evident in craft apprenticeship" (p. 37). Cognitive apprenticeship methods, such as simulations and role playing, support learning in specific content areas by allowing students to acquire, develop, and use knowledge in real world applications.

Many educational simulations and games are designed based on the premise that learning involves not only acquiring new knowledge, but also a change in behavior (Cunningham, 1984). As Dewey (1963) has pointed out, learning is more than simply the storage of information; it also involves the ability to use information.

Game structure. Chartier (1973) feels that the simulation-gaming experience is more productive for students when a learning "set" is determined by establishing why they are doing the activity, what is expected of them and what they can be expected to learn. However, individuals vary in what they learn from simulations and games. For some students, simulation-gaming can become more like an artistic experience than a conventionally defined learning experience (Bredemeier and Greenblat, 1981).

What a student learns from these types of instructional devices can depend upon other factors besides what the student brings to the occasion, such as prior knowledge and attitudes. How the instructor presents and controls the development of the experience can also have an impact on the student's learning outcomes.

For example, Livingston (1970), studying different groups of students using the same simulation, found a significant difference in the attitude change of students with different instructors. Other procedural variables in
the administration of games and simulations can also affect students' learning. Livingston and Kidder (1973) note that teacher-led discussions after the gaming experience are critical for maximum increases in student achievement. This suggests that, to increase the potential for learning to occur when designing games or simulations, developing pregame and post-game strategies should not be considered separately from the game. Pregame background information can provide students a common base of knowledge as well as stimulate a richer game experience. Post-game discussion can stimulate critical thinking and reinforce learning objectives and generalizations to real-world experiences (Spelvin, 1979).

Internally, recommend Smith (1972) and Greenblat (1980), the structure of games or simulations should approximate reality as closely as possible. This is important, especially if generalization to similar real-world paradigms is a desired outcome. Knowledge about a topic is ordinarily a necessary condition for thinking critically in the topic (Glaser, 1984). According to Ennis (1989) most cognitive psychologists agree that background knowledge is required for thinking in a given domain and that transfer of critical thinking abilities to other domains is unlikely unless there is practice on transfer. The issue of "transfer" for the purposes of this study, however, is not relevant. The general thinking skills and the content in the curricular materials employed exist within a domain. "One of the key points of the concept of indexicality is that it indicates that knowledge, and not just learning, is situated. A corollary of this is that learning methods that are embedded in authentic situations are not merely useful; they are essential" (Brown et al., 1989, p. 37).

**Effects of games, simulations and activities.** Proponents of games and simulations claim that one advantage of this instructional technique over
conventional instruction is the ability to experientially convey facts and concepts. In a metanalysis, Greenblat (1973) suggested that games may be more effective in teaching principles, procedures, and concepts than in teaching facts. Greenblat points out, however, that many of the studies supporting this assertion were qualitative. Other quantitative studies showed that retention was a significant factor of games and simulation studies. This is supported by Pierfy (1977) who also looked at 11 studies that measured retention. Eight of those studies found retention to be significantly better, while three had no difference. Of those 11 studies Pierfy also found eight studies with a significant difference when comparing attitudes and conventional instruction, with three of the studies showing no significant difference. Interestingly, some of the same games utilized were represented in both the significant and nonsignificant groups. This supports earlier references about the variability of procedure and individuals in learner outcomes. Other researchers report the effective use of games and simulations in developing attitudes toward science education (Reid, 1979), declines in political cynicism (Shade and Paine, 1975), political attitudes (Livingston and Kidder, 1973), and attitudes about racism and sexism (Chapman, 1974).

Wolfe (1981) criticizes the methodology of many of these earlier studies of simulations and games as failing to follow the criteria for experimental design. This raises a concern about the validity of the results of many of these studies. Research in simulation and games should use an experimental design that offers safeguards against problems of internal validity. Butler, Markulis, and Strang (1988) identify three characteristics that were indicators of a strong experimental design based upon a review of research literature. These include: (1) whether the researcher used randomization or not, (2)
whether the researcher used control groups or not, and (3) whether the researcher controlled the treatment variables or not.

Gentry and Burns (1981) call for the development of simulations or games that operationalize learning using Bloom's taxonomy of cognitive outcomes. This may help researchers to standardize and clarify the domain and level of learning goals being investigated, as well as the expected outcomes.

The Impact of Learner Characteristics

Educational research has identified a large number of factors that influence learning. Many of the newer models (Bruner, 1966; Bloom, 1976; Glaser, 1976) acknowledge individual learner variables in contrast with older models that focus on instructional variables (Wang, Haertel, and Walberg, 1990). Those models that key on the learner recognize the importance of student ability, and include such concepts as aptitude, attitude, prior knowledge, verbal IQ, pupil background, motivation, and self-concept. The following studies relate to some of the individual learner characteristics that students bring to the instructional environment and any effect they may have on learning.

The research literature in gaming and simulations suggests that inconsistent findings are due in part to the varying effects that a game has on different players (Greenblat, 1980). Research by Fletcher (1971) and Remus (1977) has found that individual characteristics such as attitude, cognitive style, and academic ability can affect game performance and outcomes. Students who exhibited greater gains seemed to prefer listening and experiencing methods of instruction and working in groups. Students
showing lesser gains had a preference for independent work such as reading and writing.

Seginer's (1980) study looked at the effect of SES, verbal/logical cognitive abilities, and self-esteem on game ability and on academic ability. While the correlation between game ability and academic ability was barely significant at the .05 level, a more important finding may be that high game performance was less dependent on SES than was academic performance. Seginer suggests that games or simulations may reduce advantages in the classroom associated with high SES students.

In a study of the relationship between learner preference and student achievement and attitudes in an ITV course, Nadel (1988) found distinct learner preferences that varied with age, but not by gender. Nadel's instrument was designed to measure differences in learning modes, academic self-confidence and sources of academic motivation. Based on their responses, students were categorized into one of six learner preference types: the enthusiastic learner, the grade-conscious learner, the collaborative learner, the confident learner, the reticent learner, and the structured learner. These categories were then correlated with attitude scores toward ITV and achievement scores in the televised course. Her findings indicate that, "although older students may be self-motivated, eager to learn and take an active part in the learning process, they may feel insecure in the classroom and may need more structured learning situations such as specific directions from the instructor about how to proceed on certain tasks (p. 9). Nadel also found that those students who scored high on the structured learner type, that is, students preferring teacher directed versus student directed lessons, responded more positively to visual programming. She states that those students who perform better, when provided a high level of structure and
organization, appreciate the use of visual or instructional aids. Snow (1977) supports this saying that learners with less developed cognitive skills are more likely to benefit from highly structured presentations that support their cognitive processes. This relates to the present study, in that students with an external locus of control, who are recognized as performing better with teacher directed situations, can be expected to do better in the videos group than the activities only group.

The literature indicates that locus of control influences learning. This construct was originally described by Rotter (1966) when he suggested that people vary in the degree in which reinforcement is felt to be related to luck, fate, or significant others. Rotter proposed that internally oriented individuals feel that reinforcement is tied to their own behavior, while externally oriented individuals feel that reinforcement is dependent upon external factors not in their control.

In a study with high school science students, Sherris and Kahle (1984) reported that subjects with an internal locus of control achieved more than those with an external locus of control. They reported that internally oriented students were found to perform better in learner directed situations, whereas externally oriented students were found to perform better in teacher directed situations. This study has bearing on the Wild Louisiana curricular materials, with the activities geared as student directed events and the videos oriented as teacher directed materials.

In a review of literature on locus of control research, Lefcourt (1982) chronicles the evidence from various research studies that supports the assumed relationship between locus of control and cognitive activity. He states,
Whether the focus has been on attention, deliberation, inquisitiveness, or utilization of information, internals have more often been found to be active and alert individuals than have externals. Sometimes the differences between internals and externals have varied with the ostensible qualities of the task or have occurred only in combination with other measures. Nevertheless, an internal locus of control seems to be a sine qua non of being able to steer oneself more clearly and appropriately through the vagaries and confusions of different situations (p. 72).

This bears relevance in regard to the self-directed nature of the Wild Louisiana gaming activities. In this case, internals could be expected to perform better than externals.

However, in another study, Lefcourt (1967) found that externals performed as well as internals in achievement tasks when explicit reference was made to the meaning of the task in which they were engaged. The conclusion can be made that externals when provided explicit, teacher-directed information about the significance of the task, can perform better than their counterparts who are not provided this information. In this case, the videos treatment is more explicit in teacher-directed format than the activities treatment.

In a related study, Wolk and DuCette (1974) reported that internals did consistently better than externals on both intentional and incidental learning measures. They concluded that internals were more perceptually sensitive. Based on this data, one could infer that internal students' performance would be higher than external students in the activities group. This is because the varying prior experience of both students and teachers is likely to have a greater influence on the activities group than the videos group. The activities group would therefore present more opportunities for incidental learning to occur which would favor internal students.
In Summary

Many groups calling for the reform of science education see it as not meeting the need for producing scientifically literate individuals (Pizzini et al., 1988). As a response, the Science-Technology-Society approach (Hickman et al., 1987) has been debated and defended as a science education framework for all students. While the call for change has been widespread, the question of an STS instructional approach that addresses various learning styles has not been answered. Aikenhead (1985, p. 139) writes, "A science curriculum that fosters a socially responsible citizenry is not achieved simply by attaching an STS chapter or module to an already burdened syllabus. Instead, schools should require curricula that accurately represent real science and the practice of scientific activities within their social contexts."

Agreement with this mandate is one thing; achieving it is another. The STS theme calls for instruction in a broad range of areas not easily incorporated into a cohesive design. Advocates call for a curriculum that includes science content that is related to social-technical paradigms to produce scientifically literate and socially responsible citizens (Hickman et al., 1987). Hurd (1985, p. 94) writes, "there has been little normative research that seeks to relate either social changes or changes in the culture of science to science education. As a result, science education has drifted outside the social stream and failed to respond to shifts in scientific endeavor. We find that most STS instructional materials are being shoehorned into obsolete curriculum structures and taught by traditional methods that achieve at best outmoded objectives."

The literature suggests that games and simulations are at least as effective as traditional methods of instruction at presenting information and
concepts, and more effective at teaching in an affective domain and achieving retention for some types of learners (Bredemeier et al., 1981). Greenblat (1973), in a review of literature, claims that simulation-gaming has been shown to be more effective in teaching principles, procedures and concepts than in teaching facts. Other researchers speculate about the effectiveness of simulation-gaming in removing learning blocks, helping students prepare for examinations, and establishing links between different concepts (Hearn, 1980; Rosen, 1981; Tiene, 1981).

Early television research has focused on the medium of television in comparison with other instructional methods (Chu et al., 1967). Much of this research sought to provide support for the notion that television was a superior method of instruction. The results of many of these types of studies were less than impressive (Cohen, Eliling and Kulik, 1981). The failure of most of this research stems from not distinguishing between "the medium" and "learning from the medium" (Clark, 1983, p. 445). This does not suggest that this medium cannot be an effective carrier of information or be used pedagogically; only that we may not have yet tapped its full potential (Kozma, 1986).

The basis of the new arguments was that television should be used to do what teachers could not do in their classrooms. Wilbur Schramm (1977) states that ITV is often at its best when it does not instruct, that the job of television is to take students out of the classroom, and to convey the human aspects of situations rather than factual information. The literature suggests that ITV can be effectively used, especially when the potentials of the medium are exploited in the hands of a skilled teacher.
Population and Selection of Sample

The sampling procedure followed a multistage cluster random design. The experimentally accessible population consisted of 38 parishes (counties) in the southern half of Louisiana that were assigned numbers sequentially. Sixteen parishes were randomly selected from the 38 numbers that were placed in a hat.

The target population consists of all eleventh grade environmental science classes taught throughout Louisiana. With few exceptions, environmental science is taught in most parishes at the eleventh grade. Because the random selection of teachers provided a good cross section of urban and rural, and large and small schools, the accessible population should be representative of the target population.

All certified environmental science teachers were identified in the 16 parishes selected from a list of Louisiana environmental science teachers provided by the Louisiana Department of Education. Teachers were selected randomly and then contacted to determine eligibility. Eligible teachers were defined as: (1) certified to teach science, (2) teaching at least two environmental science courses in the coming year, (3) able to attend a full-day training session on a Saturday, and (4) willing to participate. Because five parishes had no eligible teachers, a decision was made to select teachers from the other eleven parishes in the sample, as long as two teachers from the same school were not in the study. Sixteen teachers who met these requirements were identified and randomly assigned to each of the three treatment groups and the control group. Since each teacher may teach two or
more classes, they were instructed to teach the materials to their second and last environmental science classes.

**Sample Description.** The teachers who were selected varied according to the amount of experience and education that they had. Table 1 displays the information about the teachers and the schools in which they teach. The average years of teaching experience by group follows: in the comparison condition (A), teachers averaged 15 years of teaching experience; teachers in the activities-only condition (B) averaged 19.75 years; teachers in the video-only condition (C) averaged 14.75 years; and teachers in the activities-with-videos condition (D) averaged 10.25 years.

Ten percent of the students were 15 years of age, 42 percent were 16 years of age, 34 percent were 17 years of age, and 14 percent were 18 years of age or older. The students' age, race, and frequency by group are also shown in Table 2. Slightly more male students were represented in the study than females. Approximately 49 percent of the sample was female.

**Research Design**

Four groups of four teachers, each teaching two environmental science classes with approximately 20 students per class, were selected randomly for the study. By drawing numbers, teachers were assigned randomly to a treatment condition, with four teachers in each of the three treatment conditions and four teachers in the comparison condition. Group A teachers, the comparison condition, used the *Wild Louisiana* background information and their assigned textbook to teach environmental concepts in a lecture presentation. A copy of the background information is presented in Appendix E. Teachers in this group were requested to not use any other activities, games or video programs during the study period. An outline
<table>
<thead>
<tr>
<th>Group</th>
<th>Teacher</th>
<th>Sex</th>
<th>Years teaching</th>
<th>School size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison (A)*</td>
<td>#1</td>
<td>F</td>
<td>12</td>
<td>1545</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>F</td>
<td>19</td>
<td>1153</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>M</td>
<td>14</td>
<td>1252</td>
</tr>
<tr>
<td>Activities (B)</td>
<td>4</td>
<td>F</td>
<td>26</td>
<td>979</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>M</td>
<td>20</td>
<td>468</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>F</td>
<td>19</td>
<td>929</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>M</td>
<td>14</td>
<td>522</td>
</tr>
<tr>
<td>Videos (C)</td>
<td>8</td>
<td>M</td>
<td>5</td>
<td>833</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>F</td>
<td>7</td>
<td>1390</td>
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<tr>
<td></td>
<td>10</td>
<td>F</td>
<td>20</td>
<td>898</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>M</td>
<td>27</td>
<td>1628</td>
</tr>
<tr>
<td>Activities With Videos (D)</td>
<td>12</td>
<td>F</td>
<td>19</td>
<td>2195</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>F</td>
<td>13</td>
<td>2614</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>F</td>
<td>3</td>
<td>1758</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>F</td>
<td>6</td>
<td>579</td>
</tr>
</tbody>
</table>

*Note: One teacher in this group unavoidably left the study before completion, therefore those students were dropped from the study.
Table 2

**Student Demographics by Group**

<table>
<thead>
<tr>
<th>Group</th>
<th>School</th>
<th>n</th>
<th>Age</th>
<th>Sex</th>
<th>Race</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>M/SD</td>
<td>Male/</td>
<td>% Black/white/other</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>female</td>
<td></td>
</tr>
<tr>
<td>Comparison (A)</td>
<td>1</td>
<td>39</td>
<td>16.9/.77</td>
<td>24/15</td>
<td>12/88/0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>38</td>
<td>17.0/.91</td>
<td>24/14</td>
<td>50/50/0</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>47</td>
<td>16.9/.91</td>
<td>26/21</td>
<td>31/69/0</td>
</tr>
<tr>
<td>Activities (B)</td>
<td>4</td>
<td>37</td>
<td>16.1/1.06</td>
<td>19/18</td>
<td>26/74/0</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>36</td>
<td>16.9/.96</td>
<td>16/20</td>
<td>62/38/0</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>40</td>
<td>16.9/.96</td>
<td>19/21</td>
<td>20/80/0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>49</td>
<td>16.4/.89</td>
<td>28/21</td>
<td>33/67/0</td>
</tr>
<tr>
<td>Videos (C)</td>
<td>8</td>
<td>39</td>
<td>16.6/.85</td>
<td>18/21</td>
<td>32/68/0</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>42</td>
<td>16.7/.83</td>
<td>22/20</td>
<td>11/89/0</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>41</td>
<td>16.7/1.01</td>
<td>20/21</td>
<td>60/40/0</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>33</td>
<td>17.2/.90</td>
<td>18/15</td>
<td>29/71/0</td>
</tr>
<tr>
<td>Activities with</td>
<td>12</td>
<td>43</td>
<td>16.8/.93</td>
<td>19/24</td>
<td>22/65/13</td>
</tr>
<tr>
<td>Videos (D)</td>
<td>13</td>
<td>43</td>
<td>16.4/.81</td>
<td>21/22</td>
<td>46/45/9</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>39</td>
<td>17.0/.90</td>
<td>20/19</td>
<td>35/65/0</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>38</td>
<td>16.7/.84</td>
<td>15/23</td>
<td>20/80/0</td>
</tr>
</tbody>
</table>

**Note:** M refers to mean scores; SD to standard deviation; n to frequency.
based on the Louisiana environmental science curriculum guide was provided to all teachers so that they would cover the same material during the 16-week period of study. A copy of the outline is provided in Appendix A.

The three treatment conditions were then organized. Group B teachers integrated the *Wild Louisiana* background information and activities into their classes, and were requested not to present any video programs during the period of study. A copy of the activities is presented in Appendix D. Group C teachers integrated the background information and the videos into their classes, and were requested not to employ any games, simulations, or other activities in their classes during the period of study. A copy of the video guide is presented in Appendix C. Group D teachers taught the background information, conducted the activities, and presented the video programs to their classes. They were requested not to use any other outside activities or videos, and refer only to their assigned textbook during the period of study.

The experimental and comparison teachers were randomly selected, randomly assigned, and treated similarly in all regards except for the level of treatment they employed in their classes.

**Variables**

The primary independent variable was the method of instruction which consisted of infusing the *Wild Louisiana* curricular materials into the designated classes of environmental science at three levels. Three groups of environmental science classes were treated and compared and a fourth group of environmental science classes with no treatment served as a comparison group. Within the three treatment conditions, the first group of four teachers infused both the activities and videos into their classes, while the second group of four teachers infused only the activities. The third group of four
teachers infused only the videos. The fourth group of four teachers, the comparison group, taught the environmental concepts outlined from the state curriculum guide by using their assigned textbooks and the background material provided in a lecture format.

The second independent variable was the students' locus of control. Students were classified according to their particular orientation, either internal or external.

The dependent variables consisted of the students' knowledge of and attitudes toward the environment. Demographic information including age, sex, membership in environmental organizations, school size, and the number of science courses taken was also collected.

Instrumentation

**Louisiana Environmental Knowledge Test (LEKT)**. The four groups were given the Louisiana Environmental Knowledge Test (LEKT) to determine if there was a significant difference between means of environmental achievement of the four groups. The LEKT (Barr, 1980) was developed from a review of pertinent literature that yielded 134 general objectives. Thirty-five faculty and staff members from various science departments at Louisiana State University were enlisted to serve on a panel to evaluate and rate the 134 objectives according to what they felt was most important for high school students to know about the environment. According to the panel's responses, 43 of the 134 objectives were selected as the basis for this instrument. In a pilot study of tenth-grade students, Barr (1980) determined the reliability for the LEKT using the rationale equivalence reliability formula by Kuder and Richardson. The estimated reliability value
was calculated at .96. The instrument was also tested for readability and was determined to have an acceptable level for eleventh-grade students.

In addition, Philips (1988) conducted a replicative study, also at the secondary level, using 78 eleventh- and twelfth-grade students in Louisiana. Using the Kuder-Richardson 21 formula, the reliability coefficient was calculated at .85. Philips also found the LEKT to be valid for his study by employing a panel of curricular specialists and science educators. Four of the reviewers were secondary science teachers in Louisiana public schools, and the fifth was a scientist with the Louisiana Sea Grant College Program. The panel determined that the LEKT was an appropriate instrument for measuring cognitive levels of secondary students. However, all questions in the instrument were not directly related to the curricular materials being used.

Content validity for this study was determined by a group of five educators familiar with the *Wild Louisiana* materials. Four of the reviewers were secondary science teachers in Louisiana public schools, and the fifth was a scientist with the LSU Sea Grant College Program. The panel was provided with a copy of the LEKT and was then asked its opinion to determine (1) if the LEKT was an appropriate instrument to be used in measuring *Wild Louisiana* materials, (2) which items in the instrument did not relate to the materials, and (3) which items applied to specific *Wild Louisiana* modules.

All five educators agreed that the LEKT was appropriate for the environmental concepts covered by the *Wild Louisiana* materials and represented a valid evaluation tool. While they believed that all of the modules were represented by questions on the LEKT, not all questions were related to concepts in *Wild Louisiana*. As a result of this review, a subset of 12 items was selected from the original 43 items and determined to be valid.
items for measuring students' environmental knowledge. However, the entire test was administered to retain the statistical integrity of the instrument. A copy of the LEKT is provided in the Appendix (F).

**New Environmental Paradigm Scale (NEPS).** One goal of the *Wild Louisiana* materials was to utilize regionally based scenarios to raise students' knowledge levels and change their attitudes about environmental issues. Therefore, it was appropriate to select an instrument that examined an individual's position on environmental issues. There exists a wide variety of attitudinal measures of related science areas in the literature. Instruments that measure scientific attitude include "The Scientific Curiosity Inventory" (Campbell, 1972), "The Environmental Phenomena Attitude Scale" (Maddock, 1975), and "A Test on Scientific Attitudes" (Kozlow and Nay, 1976). Other science attitudinal scales measure science career preferences, attitudes about teaching science, attitudes to specific science subjects, and science interests and activities (Munby, 1983).

Dunlap and Van Liere (1978), authors of the instrument that was used, hypothesized that society is abandoning the Dominant Social Paradigm (DSP), and moving toward the New Environmental Paradigm (NEP). The DSP represents an anthropocentric worldview, that man is above and in control of his environment, whereas the NEP presents a more ecologically integrative view of man, which holds that man is a part of nature.

The two researchers developed the NEP scale which includes 12 Likert-type items related to environmental issues. It was administered to determine if there was a significant variance between means of affective scores based on the treatment condition. Each test item presents the respondent with four choices of responses: Strongly Agree, Mildly Agree, Mildly Disagree, and Strongly Disagree. Four of the items are phrased such that disagreement
reflects acceptance of the NEP, while eight are phrased so that agreement designates acceptance. This type of Likert, four-choice scale encourages respondents to choose whether they agree or disagree (rather than choose no opinion) and to consider each item. Kerlinger (1986) holds that a summated rating scale is the most useful in attitudinal and other behavioral research. He feels that this type of instrument allows for the intensity of attitude expression, resulting in greater variance. He does caution, however, that certain personality types are prone to select extreme responses, while others are more conservative.

Dunlap and Van Liere determined the reliability and validity of the NEP scale by using members from the general population and members of a statewide environmental organization. Cronbach's alpha produced a .81 reading of reliability for the general population sample and a .76 reading for the environmental group sample. A high correlation with scores on other instruments that measure similar attitudes established concurrent validity.

To determine the usefulness of the NEP scale with a high school audience, Philips (1988) applied Cronbach's alpha and determined the reliability of the instrument to be .77 for the group. The alpha coefficient for this group is consistent with those of other studies. A copy of the instrument is included in Appendix F.

Nowicki-Strickland Locus of Control Scale (LOCS). Individuals have been categorized as having either an internal or external locus of control (Rotter, 1954). This orientation refers to the extent that individuals conceptualize relationships between actions and outcomes. Internal locus of control, or internality, describes a condition in which individuals feel that they control their own destinies and that they are responsible in large part for their own successes or failures. External locus of control, or externality,
describes a condition in which individuals feel less in control of their lives; that other forces, such as luck, circumstance, or other individuals guide the outcome of their own experience (MacDonald, 1973).

Nowicki and Strickland (1973, p. 148) report that,

There is ample reason to believe that this variable is of significant influence on children's behavior. For instance, Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, and York (1966), in a study of almost half a million youngsters across the United States, found that a belief in destiny was a major determinant in school achievement. They concluded that this pupil attitude factor had a stronger relationship to achievement than all other school factors together.

Also, Nowicki and Strickland (1973) saw a need to develop a reliable instrument to study the effects of a student's generalized locus of control orientation. Beginning with 102 items, made readable at the fifth-grade level but appropriate for older students, the researchers refined the items to a subscale of 21 items. Estimates of internal consistency for grades 9, 10, and 11 were $r = .74$, with test-retest reliability, sampled at a six-week interval, measured at .71 for the tenth grade. Construct validity was determined by correlations with the Intellectual Achievement Responsibility Scale, Bailer-Cromwell Scale, and the Rotter Scale. A copy of the instrument is included in Appendix F.

Curriculum Materials

Environmental science curriculum. The researcher has developed a multimedia series of educational videos, activities, and background information to supplement and enhance the state-adopted Louisiana environmental science curriculum. The purpose of the project is to increase students' knowledge and influence their attitudes by raising their level of
awareness of environmental concepts through a Science-Technology-Society approach. This is addressed by the development and implementation of a series of enhancement activities, background information, and videos, which integrate science with social issues that are prevalent in the Gulf of Mexico region. *Wild Louisiana* was developed to provide educators with supplemental classroom materials in environmental science that used regional paradigms to illustrate universal environmental concepts. The modules, which include activities and videos, were developed by the researcher together with a team of science educators; the modules are focused on three topics that are relevant to the Gulf of Mexico region: conservation, fisheries, and resource management.

**Module format.** Each of the three modules in *Wild Louisiana* contains the following organization of materials: a Wild Unit Plan (WUPs) to help teachers integrate the materials into their classrooms (Appendix B); background material synthesizing research findings that includes information relevant to the social paradigm such as trends, problems, morphology, and a glossary of relevant terms (Appendix E); a video guide that contains previewing, viewing and post-viewing instructional strategies (Appendix C); a video program that illustrates various environmental concepts in the context of regional issues; and classroom activities that may be simulations, games, or role-playing assignments that require the students' active participation (Appendix D).

**Background information** (Appendix E). Included with each module is general background information related to that particular theme. This includes data relevant to the regional issue, for example, local social issues, species morphology, local geological processes, natural influences, consequences, a discussion of solutions, current scientific research related to
the issue, and a related glossary. The background information serves as an introduction to the issue and enrichment for both the teacher and the students. It contains the same issues that are covered in the video programs and the activities.

The simulation-gaming activities (Appendix D). Each module contains two activities that are structured as games, simulations, and role playing, or as an assignment that requires students to synthesize research and develop a product. Each activity details the purpose, the learning objectives, the concepts, the reference to the state curriculum guide, the reference to the Louisiana Education Assessment Program Exit Test, directions, background information, lesson plans for the teacher, and several evaluation questions and extension activities. In many instances, the materials are provided as masters for the teachers to duplicate and hand out to their students. An envelope of reference materials consisting of relevant pamphlets, brochures, and news clippings is also provided as an additional resource.

The activities allow students to be actively involved in their own learning. Students assume the roles and attitudes outlined in hypothetical situations and personality profiles of characters in regionally based issues. By acting out their defined roles and interacting with each other in context of the activity, students are able to experience relevant perspectives. The pace and direction of the activity may be controlled by the teacher who then focuses on the relevant environmental concepts and relates them to the activity. Evaluation questions were designed to help students extend what they learned to other situations. Critical thinking questions require students to predict, analyze, and synthesize the presented environmental concepts and apply them to other situations. A sample of a complete activity is provided in the Appendix D.
The videos (Appendix C). In addition to the background material and the activities, a video program for each module was produced and included in the curricular materials. Video guides offer previewing, viewing, and post-viewing instructional strategies for the teacher to stimulate and extend the students' learning. Step-by-step instructions guide the teacher through each of three strategies and list why each step is pedagogically important.

The previewing strategy presents important vocabulary words necessary for student understanding. Learning outcomes highlight the key concepts and let the students know what they are expected to learn. Previewing questions activate the students' prior knowledge and help bring concepts stored in long-term memory to working memory.

Viewing strategies take shape in the form of concept maps. An example of the concept maps is provided in Appendix C. Concepts are mapped into an outline form that mirrors the presentation of concepts in the videos. This prepares the students for viewing, and by predicting the missing concepts, encourages active viewing. As the video progresses, the students follow the flow of concepts in the concept maps and check their predictions.

Two different versions of the concept maps are provided for class use, each with a small number of concept boxes left blank. Before viewing the video, the teacher goes over the concept map, explaining the flow, the linking words, and the relationship to the upcoming video. Students then select words (provided in a list at the bottom) that they think are contextually appropriate, and write them into the blank. Students must predict which concept is correct from the meaning they have derived from the conceptual flow of the map and from the adjacent concepts. Then, while watching the video program, the students can check off their answers as the program
covers the particular concept, or make note if their answers vary from the concept presented in the video.

The post-viewing strategy is designed to allow the student to extend the knowledge learned in the videos into different contexts. Questions and statements require higher order thinking skills by asking students to predict, compare and analyze what they learned from the video. After the video program is finished, the teacher reviews the correct answers to both forms of the maps. This clears up any misconceptions that the students may have and alerts the teacher to which students need further instruction. Because of the pacing of the video, the number of stimuli, and the various story line presentations, viewers may have difficulty in understanding the message and the relationship of key concepts. This device, which attempts to visually describe the structure of the content as well as the interrelationships of various elements, may serve to activate the student's "vigilance" and to aid learning (Wohl and Tidhar, 1988).

After viewing the video, students are then grouped into pairs, each pair having both concept maps A and B, and are instructed to link the concept maps with as many lines as they feel are needed. The A form and the B form should be placed side-by-side. Students are then instructed to work together drawing connecting lines between concepts that they feel are related, based on information presented in the video program, their previous knowledge, and in class discussion. They then add linking words between the boxed concepts, similar to the linking words already on the existing concept maps. This clarifies meaning and helps them defend their choices in class. A completed concept map combining both A and B forms is presented in the materials to the teacher. This cooperative learning allows the students to visualize the interrelationships of a broader group of related concepts. An example is
provided in Appendix C. This strategy, employing the idea of "active" learning, involves the learners in actively constructing their own understanding and making sense of what is taking place around them (Driver, Guesne and Tiberghien, 1985; West and Pines, 1985).

The video guide then presents post-viewing questions and a series of multiple choice questions as a strategy for review and reinforcement. The post-viewing questions allow the students to extend the knowledge they learned in the videos into different contexts by the use of critical thinking. The multiple choice questions, while providing an opportunity to practice, require the learner to recall or recognize information as presented during the video. This type of question may improve the learning of factual information, but may limit the application of knowledge to related areas (Clark, 1983). Critical thinking questions, however, require the learner to reformulate information previously learned with new information (Andre, 1979).

The video guide follows the instructional design events described by Gagne et al. (1988, p. 12), which include "stimulating recall of prerequisite learning, informing the learner of the objective, presenting the stimulus material, providing learning guidance, eliciting the performance, giving feedback, assessing the performance and enhancing transfer and retention."

The videos provide additional background and enrichment, offering a contextualized capsule of the STS theme relative to the topic of each module. Each video was kept under 20 minutes to allow adequate time for use in a classroom environment. Key vocabulary words are captioned and when heard are also seen in context, in order to increase word recognition and vocabulary development. A sample of the video guide, including the concept maps, is presented in Appendix C.
**Wild Unit Plans - WUPs.** A preliminary evaluation of the materials with environmental science teachers in the 1989-90 school year revealed a need to show teachers an explicit method for integrating *Wild Louisiana* materials into their classrooms (Soniat, 1990). In addition, interviews with teachers from the same evaluation showed a need to extend the utility of the video programs by linking them pedagogically with the rest of the materials.

As a result, Wild Unit Plans (WUPs) were developed to consolidate a methodological approach toward integrating and using the materials in a recommended formula. The WUPs detail goals and objectives, cross-referencing them with the state-adopted curriculum, and offer explicit teaching strategies for a 50-minute class period. A sample of the WUPs is presented in Appendix B.

**Procedures**

**Teacher training.** All 16 teachers were trained in the use of the *Wild Louisiana* background materials and the test instruments. (However, one teacher did not complete the school year and unavoidably left the school. Those students scores were omitted from the study.) Additional training in the use of the materials was provided based on the group to which the teacher was randomly assigned. Dates were established for pretesting and for posttesting so that all groups would be tested at the same time. During the 16-week study period, all teachers were instructed to teach the content that was outlined from the state-adopted environmental science curriculum guide, Bulletin 1792. The outline ensures that the teachers in all groups cover the same concepts. Places where each module should be introduced to the students are bracketed within the outline. A copy of this outline is provided in Appendix A.
Teachers were then assigned randomly into four groups according to treatment by pulling names from a hat. The four comparison teachers (Group A) were instructed to teach the content provided in the curriculum outline (Appendix A), using only their textbooks and the *Wild Louisiana* background materials. No other supplemental materials (activities, films, or videos) were provided or to be used during the 16-week period of study. After the training in presenting the background materials, they were then dismissed from the workshop.

Each of the remaining teachers were then separated by condition (Group B, activities; Group C, videos; and Group D, activities with videos) and provided additional instruction on teaching the background information, the activities, or the videos, depending on the group in which they were placed. They were also provided the Wild Unit Plans or the Videos Guides as appropriate to their group. Teachers in groups using activities were instructed to conduct the following activities: "Where's the Big Mouth?" in the *Vanishing Wetlands* module; "Food for Thought" and "To Fish or Not to Fish" in the *Redfish: A Culinary Controversy* module; and "Would You Eat A Wild Thing?" and "Oh Alligator" in the *Cata Data* module.

The actual training involved introducing each group of teachers to the *Wild Louisiana* materials they would be using. Teachers using the videos went over the background information and the video guide in detail, covering the previewing, viewing, and post-viewing instructional strategies. Teachers using the activities were trained in using the background information and in conducting the activities.

**Classroom procedures.** All teachers were instructed to pretest at the beginning of the school year during the first week of the period of study. They were then instructed to integrate the materials related to their group
over the next 16 weeks according to the curriculum outline presented in Appendix A. When they were not using the activities or the videos, they were instructed to teach concepts from the curriculum outline using their assigned textbook. All teachers were then instructed to administer the posttests (the LEKT and the NEPS) during the sixteenth week of class and to also give the Nowicki-Strickland Locus of Control Scale to their students. A copy of the directions provided to all teachers for administering the instruments is presented in Appendix F.

All teachers were contacted by phone at least four times during the 16 weeks of the study to determine if there were any problems in implementing the materials. In addition, each teacher was visited one time during a class period when using the materials. Observations were made regarding the students' reactions to the materials and the teacher's facility in using the materials. Exit interviews were also conducted by phone after the 16-week period of study to gather the teachers' impressions about the materials.
CHAPTER IV

Results

Introduction

The purpose of this study was to determine whether the use of media and simulation-gaming activities were more effective in influencing students when presented using an infusion approach, rather than the traditional or lecture method of instruction. In addition, a secondary purpose was to determine which method of instruction was most appropriate for certain learner styles when students were classified according to their locus of control. The two dependent variables investigated were students' knowledge and attitude. The primary independent variable was the method of instruction that was used in presenting each of the four conditions or treatments. The materials of instruction were the supplemental environmental education materials, entitled Wild Louisiana, that were developed by the investigator.

This study was designed to test eight hypotheses that pertain to the effectiveness of those supplemental materials. Three treatment groups and a comparison condition used different components of the materials to determine which method of infusion was most effective. The statistical design used in the study employed a one-way analysis of covariance (ANCOVA).

Two instruments were used to measure students' knowledge and attitude, and an additional instrument was used to determine their locus of control. Copies of the instruments, the Louisiana Environmental Knowledge Test (LEKT), the New Environmental Paradigm Scale (NEPS), the Nowicki-Strickland Locus of Control Scale (LOCS), and optically scanned answer...
sheets, were provided to each of the teachers in the study. Copies of all instruments can be found in Appendix E. Upon completion of the pretest and posttest, the students' responses were mailed back to the researcher. The answer sheets were organized according to group, optically graded, and then transferred onto a computer disk for analysis by the Statistical Analysis System (SAS, 1985). The results were analyzed using ANCOVA to control for initial differences between groups.

This chapter begins with a demographic description of the sample, provides information relevant to the initial comparability of the treatment groups, and then presents statistical information regarding each of the eight hypotheses presented in Chapter I.

**Sample Demographics**

The sample population used in this study consisted of 660 students. A total of 32 classes in 16 schools located in 11 different parishes participated in the study. Of the 660 students, 39 were dropped from the study because the original instructor left the school and did not complete the testing. Nine more were dropped because they were absent on the day of either the pretest or the posttest. In addition, eight other students were dropped because an examination of their test sheets revealed that they had selected answers at random. These 56 students represent a mortality rate of 8.4 percent. This left 15 teachers, comprising 30 classes with a total of 604 students that completed the study. A breakdown of teacher and school demographics is presented in Table 1 in Chapter III.

The classes were randomly assigned to experimental conditions. Of those completing the study, 124, or 21 percent, were in the comparison condition; 162, or 27 percent, were in the activities treatment group; 155, or 25
percent, were in the videos treatment group, and 163, or 27 percent, were in the activities-with-videos treatment group. The instructor who left the school had students assigned to the comparison condition.

Approximately 46 percent of the subjects attended schools with fewer than 1000 students. While 27 percent attended schools with populations between 1000 and 1499 students, 26 percent attended schools with populations greater than 1500 students. A complete breakdown of student demographics are presented in Table 2 (in Chapter 3).

Nearly 32% of the students had previously taken two or fewer other secondary science courses. Approximately 38 percent of the students had previously taken at least three other science courses. Thirty percent of the students reported having taken as many as four other science classes. The data are presented in Table 3.

Club affiliation was reported, with 43.5 percent of the students having no membership in relevant outdoor or environmental groups. Over 28 percent of the students reported membership in at least one group, with almost 19 percent responding as having membership in at least two groups. Frequencies and percentages for club membership by group are listed in Table 4.

Initial Comparability of the Groups

An analysis of variance (ANOVA) was performed on the pretest scores of the four groups of students to determine if there were any initial differences between the groups. Despite the teachers random selection from a sampling frame and random assignment to group, there was a significant difference between two of the four groups on pretest scores for knowledge
Table 3

Number of Students Having Taken Science Courses by Group

<table>
<thead>
<tr>
<th>Group</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison (A)</td>
<td>4</td>
<td>7</td>
<td>22</td>
<td>40</td>
<td>44</td>
<td>6</td>
</tr>
<tr>
<td>Activities (B)</td>
<td>0</td>
<td>11</td>
<td>52</td>
<td>61</td>
<td>29</td>
<td>9</td>
</tr>
<tr>
<td>Videos (C)</td>
<td>4</td>
<td>7</td>
<td>32</td>
<td>76</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>Activities With Videos (D)</td>
<td>9</td>
<td>12</td>
<td>30</td>
<td>53</td>
<td>48</td>
<td>10</td>
</tr>
<tr>
<td>Total Number</td>
<td>17</td>
<td>37</td>
<td>136</td>
<td>230</td>
<td>154</td>
<td>28</td>
</tr>
<tr>
<td>Percentage of Total</td>
<td>3</td>
<td>6</td>
<td>23</td>
<td>38</td>
<td>25</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: The science courses taken included: Physical Science, Biology, Biology II, Chemistry, Earth Science, and Physics.

\[ F (3,600) = 3.60, p < .05 \]. No significant difference was found to exist on group pretest scores for attitude for any of the groups.

The results of this ANOVA are presented in Table 5. A pair-wise comparison using Tukey's T-test confirmed that the significant difference for knowledge was between the videos treatment, Group C, and the activities with videos treatment, Group D. Because an initial difference was found based on the knowledge scores, there was concern that the groups might differ on other measures as well. In order to control for this initial difference in pretest scores, analyses of covariance were performed to test some hypotheses. These ANCOVAs adjusted the posttest knowledge and attitude scores on the basis of the respective pretest scores on these measures.
Table 4

**Student Membership in Clubs by Group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Clubs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Comparison (A)</td>
<td>41</td>
</tr>
<tr>
<td>Activities (B)</td>
<td>52</td>
</tr>
<tr>
<td>Videos (C)</td>
<td>77</td>
</tr>
<tr>
<td>Activities With Videos (D)</td>
<td>93</td>
</tr>
<tr>
<td>Total Number</td>
<td>263</td>
</tr>
<tr>
<td>Percentage of Total</td>
<td>43.5</td>
</tr>
</tbody>
</table>

*Note: The membership in clubs included: Boy Scouts, Girl Scouts, 4-H, FFA, and Science Club.*

Table 5

**ANOVA for Pretest Knowledge Scores**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>54.775</td>
<td>3</td>
<td>18.258</td>
<td>3.60*</td>
</tr>
<tr>
<td>Error</td>
<td>3042.448</td>
<td>600</td>
<td>5.071</td>
<td></td>
</tr>
</tbody>
</table>

*Note: n = 604.

*p < .05.*
Tests of Hypotheses

Effect of instruction on knowledge. Hypotheses 1, 3, and 5 concerned the effects of the treatment on the students' knowledge as measured by the LEKT. The LEKT was administered as a pretest to all groups during the first week of class, prior to any presentation of the materials, and was given as a posttest during the sixteenth week of instruction, the end of the period of study. Of the 43 questions on the LEKT, 12 were found to have content validity by a panel of experts for the purposes of this study. These were items 4, 5, 14, 15, 24, 25, 30, 32, 33, 34, 36, and 38 on the LEKT, which can be found in Appendix E. On this scale, students could score a maximum of 12, with a minimum score of 0.

The three treatment groups (B, C, D) scored higher than the comparison condition (A), with the video-only treatment (C) posting the highest score on the adjusted mean posttest scores. Table 6 presents the pretest and the adjusted posttest mean knowledge scores by group. An

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Comparison (A)</td>
<td>6.084</td>
<td>0.607</td>
</tr>
<tr>
<td>Activities (B)</td>
<td>6.417</td>
<td>0.539</td>
</tr>
<tr>
<td>Videos (C)</td>
<td>6.607</td>
<td>0.480</td>
</tr>
<tr>
<td>Activities With</td>
<td>5.845</td>
<td>0.393</td>
</tr>
<tr>
<td>Videos (D)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANCOVA was computed to test the effect of treatment on knowledge. As indicated by Table 7, the effect of the treatment with all four groups was significant \[ F (3,588) = 5.78, p < .001. \]

The first hypothesis was formulated to compare the effect on knowledge, as measured by the LEKT, of the videos-only condition (C) as opposed to the comparison condition (A). A restatement of the hypothesis follows:

Hypothesis 1: Students enrolled in an environmental science course supplemented with regionally based STS-oriented videos will achieve higher cognitive scores compared to students enrolled in courses with a textbook or traditional approach.

Using the PDIFF statement with the LSMEANS statement provided probability values for all possible combinations of groups, enabling the identification of which groups differed significantly. As indicated by Table 8, the least-squares means for the videos-only condition was significantly higher

Table 7

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>MS</th>
<th>( F )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>64.741</td>
<td>3</td>
<td>21.580</td>
<td>5.78*</td>
</tr>
<tr>
<td>Covariate</td>
<td>729.397</td>
<td>12</td>
<td>60.783</td>
<td>16.28**</td>
</tr>
<tr>
<td>Error</td>
<td>2195.077</td>
<td>588</td>
<td>3.733</td>
<td></td>
</tr>
</tbody>
</table>

Note: \( n = 604. \)

*\( p < .001. \)

**\( p < .0001. \)
when compared to that of the comparison condition ($p < .01$). Hypothesis 1 was therefore accepted.

Table 8

**Least Squares Means Comparison Matrix for the LEKT Across All Four Groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>LS $\bar{X}$</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison (A)</td>
<td>7.082</td>
<td>—</td>
<td>0.082</td>
<td>0.002**</td>
<td>0.008**</td>
</tr>
<tr>
<td>Activities (B)</td>
<td>7.487</td>
<td>0.082</td>
<td>—</td>
<td>0.033*</td>
<td>0.082</td>
</tr>
<tr>
<td>Videos (C)</td>
<td>7.957</td>
<td>0.002**</td>
<td>0.033*</td>
<td>—</td>
<td>0.682</td>
</tr>
<tr>
<td>Activities With Videos (D)</td>
<td>7.866</td>
<td>0.008**</td>
<td>0.082</td>
<td>0.682</td>
<td>—</td>
</tr>
</tbody>
</table>

*Note:* The numbers in this matrix are the probability levels associated with the comparison between pairs of groups.

* $p < .05$

** $p < .01$

The third hypothesis was formulated to compare the effect on knowledge of the activities-only condition (B) with that of the traditional approach (A), as measured by the LEKT. A restatement of the hypothesis follows:

**Hypothesis 3:** Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities will achieve higher cognitive scores compared to students enrolled in courses with a textbook or traditional approach.
As shown in Table 8, the pair-wise comparison indicated that the difference between the activities-only condition (B) and the comparison condition (A) (p = .08) only approached significance. Therefore, hypothesis 3 was rejected.

The fifth hypothesis was formulated to compare the effect on knowledge of the activities-with-videos condition (D) with the effects on (1) the comparison condition (A), (2) the activities-only condition (B), and (3) the videos-only condition (C). A restatement of the hypothesis follows:

Hypothesis 5: Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities and videos will achieve higher cognitive scores than students who are: (1) supplemented with video only, (2) supplemented with simulation-gaming activities only, or (3) enrolled in a course with a traditional approach.

The fifth hypothesis was tested using an ANCOVA to determine whether differences between adjusted group means as measured by the LEKT were significant. As indicated in Table 8, it was determined by the pair-wise comparison that the mean of the activities-with-videos condition (D) when compared with the mean of the videos-only condition (C) was not significantly different (p = .68). When the activities-with-videos condition (D) was compared with the activities-only condition (B), the difference only approached significance (p = .08). However, when the mean of the activities-with-videos condition (D) was compared with that of the traditional group (A), a significant difference was found (p < .01). Based on this data, hypothesis 5, parts one and two, were rejected. Part three of hypothesis 5, comparing the difference between the activities-with-videos condition and the comparison condition, was found to be highly significant, and therefore it was accepted.
As a group, males generally scored higher than females on the posttest LEKT, getting a mean score for knowledge of 8.10. Although females' posttest mean score was lower (7.84), they showed a higher gain over the pretest scores of 1.83, in comparison with males, whose increase averaged 1.49.

Effect of instruction on attitude. Hypotheses 2, 4, and 6 investigated the effects of the treatment on students' attitude as measured by the NEPS. The NEPS was given before and after the 16-week treatment period to all groups of students and was administered immediately after the LEKT pretest and posttest. The NEPS consisted of 12 questions with a four-part Likert format. Each of the 12 questions had a range from one to four points, for a maximum score of 48, and a minimum score of 12.

As indicated in Table 9, students in the activities-with-videos condition (D) registered slightly higher mean posttest scores than the other groups,

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest M</th>
<th>Pretest SD</th>
<th>Posttest M</th>
<th>Posttest SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison (A)</td>
<td>36.61</td>
<td>1.22</td>
<td>36.01</td>
<td>0.93</td>
</tr>
<tr>
<td>Activities (B)</td>
<td>36.04</td>
<td>2.99</td>
<td>35.15</td>
<td>3.47</td>
</tr>
<tr>
<td>Videos (C)</td>
<td>36.18</td>
<td>0.60</td>
<td>36.43</td>
<td>0.61</td>
</tr>
<tr>
<td>Activities With Videos (D)</td>
<td>36.01</td>
<td>1.25</td>
<td>36.46</td>
<td>1.58</td>
</tr>
</tbody>
</table>
and students in the activities-only condition (B) scored slightly lower. The variance in students' attitudinal responses between groups on the posttest was not as consistent as the variance in those responses on the knowledge instrument. While the post-treatment attitude variance was greatest in the activities-only condition (B), it did not differ greatly from the attitude variance in the pre-treatment measurement (SD = 2.99).

An ANCOVA was performed on the attitude posttest scores because of the initial differences between the groups (Table 10). The covariate was students' scores on the attitude pretest. As the data in Table 10 shows, the ANCOVA indicated no significant difference based on treatment across all groups for attitude. Hypotheses 2, 4, and 6 were formulated to consider various treatment effects on students attitudes in comparison with the lecture condition of instruction. No significant treatment effect was found, therefore no pair-wise comparisons were necessary.

Table 10

**ANCOVA for the NEPS Comparing All Four Groups**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>134.913</td>
<td>3</td>
<td>44.971</td>
<td>2.01</td>
</tr>
<tr>
<td>Covariate</td>
<td>4002.653</td>
<td>25</td>
<td>160.106</td>
<td>7.17*</td>
</tr>
<tr>
<td>Error</td>
<td>10342.482</td>
<td>463</td>
<td>22.338</td>
<td></td>
</tr>
</tbody>
</table>

*Note:* Due to missing values, only 492 observations were used.

*p < .0001.
The second hypothesis was formulated to compare the effect on attitudes of the videos-only condition (C) in contrast with that of the comparison group (A), as measured by the NEPS. A restatement of the hypothesis follows:

Hypothesis 2: Students enrolled in an environmental science course supplemented with regionally based STS-oriented videos will achieve higher affective scores compared to students enrolled in a course with a textbook or traditional approach.

The fourth hypothesis was formulated to compare the effect on attitudes of the activities-only condition (B) with the effect on the traditional group (A), as measured by the NEPS. A restatement of the hypothesis follows:

Hypothesis 4: Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities will achieve higher affective scores compared to students enrolled in a course with a textbook or a traditional approach.

The sixth hypothesis was formulated to compare the effect on attitudes of the activities-with-videos condition (D) and (1) the activities-only condition (B), (2) the videos-only condition (C), and (3) the comparison condition (A), as measured by the NEPS. A restatement of the hypothesis follows:

Hypothesis 6: Students enrolled in an environmental science course supplemented with regionally based STS-oriented simulation-gaming activities and videos will achieve higher affective scores than students who are (1) supplemented with video only, (2) supplemented with simulation-gaming activities only, or (3) enrolled in a course with a textbook or traditional approach.
The treatment effect for all groups \( F(3, 463) = 2.01, p = n.2. \) indicated that there was no significant difference, therefore hypotheses 2, 4 and 6 were rejected.

Overall, male and female posttest mean scores for attitude were similar. Males posted a slightly lower mean score of 36.33 than females, who scored 36.59. There was essentially no difference in attitude when students were grouped according to gender.

**Influence of locus of control on instructional effectiveness.** To determine if students' locus of control influenced their knowledge or attitudes, only students who were highly oriented, either internally or externally were considered. Those scoring one standard deviation above the mean score were labelled externals; those scoring one standard deviation below were named internals. Internally oriented students numbered 96, while externally oriented students numbered 95. These two groups comprised about 32 percent of the total group.

After identifying students by their locus of control, an ANCOVA was performed comparing all highly oriented students' scores, both internal and external, for knowledge (Table 11). Although the interaction effect (locus x group) was not significant \( (p < .10) \), it approached significance, therefore a pair-wise comparison using Tukey's T-Test was performed to determine which pairs of conditions differed significantly on knowledge. In the ANCOVA for attitude, no significant treatment effect was found \( (p = .56) \), therefore it was not necessary to perform any pair-wise comparisons.

**Effect of instruction on knowledge and attitudes for externally oriented students.** Hypotheses 7 and 8 considered the effects of the four conditions on the internal and external students' knowledge and attitudes, respectively.
Table 11

**ANCOVA for the LEKT Comparing Internal and External Students in All Four Groups**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>42.010</td>
<td>3</td>
<td>14.003</td>
<td>3.78*</td>
</tr>
<tr>
<td>Locus</td>
<td>8.868</td>
<td>1</td>
<td>8.868</td>
<td>2.39</td>
</tr>
<tr>
<td>Locus X Group</td>
<td>23.489</td>
<td>3</td>
<td>7.830</td>
<td>2.11</td>
</tr>
<tr>
<td>Covariate</td>
<td>202.351</td>
<td>11</td>
<td>18.396</td>
<td>4.96**</td>
</tr>
<tr>
<td>Error</td>
<td>637.570</td>
<td>172</td>
<td>3.707</td>
<td></td>
</tr>
</tbody>
</table>

*Note: n = 191.*

*p < .05.

**p < .0001.

Figure 1 presents the internal and external knowledge scores that are considered by hypothesis 7.

Hypothesis 7 was formulated to determine if there was an aptitude-treatment interaction between locus of control and the students' knowledge based on the four conditions of instruction. A restatement of hypothesis 7 follows:

**Hypothesis 7:** There will be a treatment by locus of control interaction effect for knowledge.

The ANCOVA model compared all highly internal and external students' knowledge scores by condition, locus of control, and locus of control by condition. As the data in Table 11 indicates, there was a significant
Figure 1. Adjusted mean knowledge scores by locus of control and group.
treatment effect [$F (3,172) = 3.78; \ p < .05$]. Because the aptitude treatment interaction approached significance ($p = .10$), it was believed that the pair-wise comparisons would provide further information regarding the relationship between locus of control and the method of instruction. Tukey's T-Test provided the comparison presented in the matrix in Table 12.

To simplify the presentation of the results, only similar orientations will be presented, i.e., internals vs. internals or externals vs. externals, from condition to condition. Dissimilar orientations, i.e., internals vs. externals, will be presented only within the same conditions, because comparing dissimilar orientations across conditions is of limited utility.

Across conditions, as indicated in Table 12, there were no external-external treatment interactions that approached significance. However, there were three internal-internal treatment interactions for knowledge that were significant. The internal students in the activities-only condition (B) scored higher means than the internal students in the comparison condition (A) ($p < .001$), and also higher means than the internal students in the activities-with-videos (D) condition ($p < .01$). In addition, the internal students in the videos-only condition (C) scored higher means than the internal students in the comparison condition (A) ($p < .05$).

Within conditions, there was only one aptitude-treatment interaction comparison that was significant. In the activities-only group, internal students scored much higher means than the external students ($p < .01$). This difference is clearly shown in Figure 1. Apparently, the activities condition was significantly more effective in addressing internally oriented students' preferred learning style. This is in sharp contrast with the externally oriented students who scored essentially the same as external students in the comparison condition.
Table 12

**Least Squares Means Comparison Matrix on the LEKT by Group and Locus of Control**

<table>
<thead>
<tr>
<th>Group</th>
<th>LOC</th>
<th>LS X</th>
<th>AI</th>
<th>AE</th>
<th>BI</th>
<th>BE</th>
<th>CI</th>
<th>CE</th>
<th>DI</th>
<th>DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison (A) Internal</td>
<td>6.859</td>
<td>0.561</td>
<td>0.001**</td>
<td>0.366</td>
<td>0.026*</td>
<td>0.025*</td>
<td>0.153</td>
<td>0.664</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison (A) External</td>
<td>7.227</td>
<td>0.561</td>
<td>0.005**</td>
<td>0.796</td>
<td>0.111</td>
<td>0.107</td>
<td>0.444</td>
<td>0.851</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities (B) Internal</td>
<td>8.969</td>
<td>0.001**</td>
<td>0.005**</td>
<td>0.005**</td>
<td>0.194</td>
<td>0.178</td>
<td>0.022*</td>
<td>0.002**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities (B) External</td>
<td>7.381</td>
<td>0.366</td>
<td>0.796</td>
<td>0.005**</td>
<td>0.147</td>
<td>0.143</td>
<td>0.577</td>
<td>0.628</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Videos (C) Internal</td>
<td>8.218</td>
<td>0.026*</td>
<td>0.111</td>
<td>0.194</td>
<td>0.147</td>
<td>0.980</td>
<td>0.341</td>
<td>0.057</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Videos (C) External</td>
<td>8.203</td>
<td>0.025*</td>
<td>0.107</td>
<td>0.178</td>
<td>0.143</td>
<td>0.980</td>
<td>0.347</td>
<td>0.057</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities With Videos (D) Internal</td>
<td>7.682</td>
<td>0.153</td>
<td>0.444</td>
<td>0.022*</td>
<td>0.577</td>
<td>0.341</td>
<td>0.347</td>
<td>0.290</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities With Videos (D) External</td>
<td>7.113</td>
<td>0.664</td>
<td>0.851</td>
<td>0.002**</td>
<td>0.628</td>
<td>0.057</td>
<td>0.057</td>
<td>0.290</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The numbers in this matrix are the probability levels associated with the comparison between pairs of groups.

* $p < .05$.

** $p < .01$. 

8
Hypothesis 8 was formulated to consider if there was an aptitude-treatment interaction between locus of control and the students' attitudes based on the four conditions of instruction. A restatement of hypothesis 8 follows:

Hypothesis 8: There will be a treatment by locus of control interaction effect for attitude.

The ANCOVA model compared all highly internal and external students' attitude scores by condition, locus of control, and locus of control by condition. As the ANCOVA provided no significant interactions, hypothesis 8 was rejected.

Post hoc analysis. Other information about the students that may have influenced the outcome was gathered. This included such information as the number of other science classes that students may have taken, their membership in environmentally oriented clubs, the students' gender, and their age. These variables were correlated with their knowledge and attitude scores using the Pearson product correlation statistic. It was found that for the students' age, sex, and membership in clubs there were no significant correlations between these factors and knowledge or attitudes. However, when considering the number of other science related subjects, low, but significant, correlations were found for both knowledge ($r = .14; p < .001$), and attitude ($r = .18; p < .001$).
Overview

The various critiques of science education have suggested that current science curricula are only relevant to the small percentage of prospective scientists within the student population. Calls for reform hold that the curricula should be made more meaningful in order to meet the needs of all students. These same critics note, unfortunately, that the call for reform has not resulted in widespread curriculum development or revision, nor do appropriate precollege materials currently exist (Patrick and Remy, 1982). Others (Collette and Chiapetta, 1989) have stated that few STS-oriented curricula have been developed on a local level that embrace a holistic approach of inquiry and hands-on activities. Additional questions persist regarding the nature of such curricula—should they be developed as whole courses—should they be infused into existing curricula—and would either method be more effective than the traditional, or lecture, method?

The purpose of this study was to determine whether the use of STS-oriented media and simulation-gaming activities, using an infusion approach to instruction, was an effective method of influencing secondary students' achievement and attitudes in environmental science. The research on television, notwithstanding its critics, has shown that a well-designed and produced television program can and does teach. Cambre (1987, p. 30) states that, "This is especially verifiable when the potentials of the medium are exploited and content visualization is maximized. It is most especially true in the hands of a skilled teacher." The research on games, simulations and
other activities is based on the cognitive theory that, "knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used" (Brown, Collins and Duguid, 1989, p. 32). The literature upholds situated learning, or "cognitive apprenticeship" methods, such as simulations and role playing, in supporting learning in specific content areas by allowing students to acquire, develop, and use knowledge in real world applications.

The first objective of this study was to determine whether the infusion method was most effective when used with simulation-gaming activities alone, or with videos alone, or when used with a combination of the two approaches. The second objective was to determine whether a particular instructional method was more appropriate for students with certain learner styles as identified by the student's locus of control.

To determine which method was best at increasing students' environmental knowledge and changing their attitudes about the environment, a multistage cluster random design was used to select teachers for the study. Sixteen teachers, each of whom taught two environmental science classes, were selected for the study. The teachers, representing 11 parishes, were randomly assigned to one of four conditions. Group A teachers served as a comparison condition and used a lecture method of instruction to infuse regionally based information into their regular courses of instruction. Group B teachers infused simulation-gaming activities into their regular lesson plans, while Group C teachers infused videos into theirs. Group D teachers infused both the simulation-gaming activities and videos into their regular classes. All teachers followed the concept outline (Appendix A) that was prepared from the Louisiana Department of Education Environmental Science Curriculum Guide, Bulletin 1792 (1987).
The regionally based information, simulation-gaming activities, and videos, entitled *Wild Louisiana* (Soniat, 1990), were part of a series of supplemental environmental science curricular materials that use regional biological and social phenomena to illustrate universal environmental concepts. Teachers in each of the four conditions were trained in the use of the materials they would be using, as well as in testing procedures and timelines for the 16-week study. Other than the materials provided and their assigned textbook, all teachers were requested not to use any outside resources, such as videos, films, or simulation-games.

Students in all four conditions were pretested, then treated over a period of 16 weeks, and then finally retested to determine differences in their environmental knowledge and attitudes. The LEKT and the NEPS were the two instruments used to measure the dependent variables: students' environmental knowledge and attitudes.

Students were further identified by their locus of control with the LOCS to determine whether a particular treatment affected individuals with particular orientations. Analysis of covariance was the statistical procedure used to analyze the data. In this chapter, the findings will be discussed, the limitations of the study will be presented, the implications for practice will be discussed, and recommendations for further study will be suggested.

**Discussion of Findings**

**Videos-only findings for knowledge.** Several hypotheses were designed to test the effectiveness of the independent variable, which consisted of the four conditions used to present the *Wild Louisiana* curricular materials. The first hypothesis focused on knowledge and compared the videos-only condition with the comparison condition. Students in the
videos-only condition scored significantly higher on the test of knowledge than students in the comparison condition. This supports the premise that some element or combination of elements in the video presentation influenced those students' knowledge gain. These elements could include the captioning of key ideas in context, the method of presenting "local color" or regional flavor, and the use of the previewing, viewing, and post-viewing instructional strategies included in the video guide.

The literature provides support for each of these possibilities. The captioning of key ideas is supported by Kozma (1986) who contends that information stored both pictorially and verbally is more likely to be retrieved. Presenting science concepts in a regional context offers students a chance to learn meaningfully. This is supported by Lutts (1985), Phillips (1988) and by Hostettler (1983) who felt that the use of real-world examples can help students understand science concepts, especially if the examples are personally relevant.

An additional finding, not specifically addressed by a hypothesis, adds to the regional dimension. Students in the videos-only condition also scored significantly higher than students in the activities-only condition. The videos contained more explicit and easily ascertained regional information than did the activities. While the information in the activities was also regionally oriented, it was not presented in as explicit a fashion as that of the videos. It was more impressionistic and took longer for students to synthesize meaning from the data presented and the interaction of the simulation. Furthermore, the visual images being of the region, may have stimulated or activated the students long-term memory, enabling them to link the new information to their prior knowledge. This is a prerequisite for meaningful learning to occur. Novak (1981, p. 13) notes that, "meaningful
learning (as distinct from rote learning) requires that new knowledge to be learned is anchored (assimilated or subsumed) into concepts we already know." With the teacher directed approach, the students were able to absorb the regional flavor more easily in the videos. While the activities also exhibited regional characteristics, the students' ability to assimilate the stated learning objectives in the activities depended more on the individual student and on classroom dynamics than did the videos. Learning was more student-directed in the activities, while the video condition presented a more teacher-directed approach.

Exit interviews with the teachers in the video condition during the first year these materials were piloted and interviews with the teachers described in this study provide additional evidence that the instructional strategies presented in the video guide were also responsible for students' knowledge gains. Interviews with teachers in the pilot year indicated that they merely showed the video programs with no consistent plan for presenting the videos or leading follow-up discussions with students. Much of the prelesson and postlesson instruction depended upon the individual teacher's background and training. To minimize the variation in the teachers' backgrounds and to provide a more directed plan of instruction, three instructional strategies within the video guide were developed and provided to teachers for this study.

Training the teachers in the video condition with a uniform, directed approach to viewing is supported by Newman (1981) and Cambre (1987) who note that the presence of a mentor while viewing enhances learning only if the potential of the medium is fully exploited and the visualization of content is maximized. Comments from the teachers who used the videos
indicated that they felt the video guides increased the teaching potential of the materials.

**Activities-only findings for knowledge.** While students in this condition averaged slightly higher mean scores, no significant difference for knowledge was found to exist when scores were compared with the lecture method. Several possibilities exist to help explain this result.

First of all, the activities condition may be only equally as effective a method of increasing students' knowledge as the lecture method of instruction, since the students' scores were the same or slightly higher than those of students in the lecture condition. Exit interviews with the teachers help to uncover some other possibilities.

Secondly, teachers using the activities reported varying degrees of success with their students. While all four teachers in this condition reported that they had used hands-on, teacher-directed activities and experiments, none had previously used student-directed simulation-games in their science classes. Four of the six activities in *Wild Louisiana* are simulations that are more student-directed in nature than teacher-directed. The first occasion for the teachers to use the simulations was under the experimental conditions.

Later conversations with these teachers revealed that subsequent opportunities to use the activities with other classes gave them more experience in directing the dynamics and outcomes of the simulations. For example, one teacher reported that he felt more adept at controlling the activity, knowing when to step in as a mediator, or in matching roles with students' personality types, after he had several opportunities to manage the simulations with different students.

How a simulation is managed and who manages it appears to make a difference. Shirts (1976) noted that instructors' attitudes toward simulation-
gaming and toward students, as well as their knowledge and skill in running the simulations, can affect the students' gaming experience. Cambre's findings (1987), regarding a skills mentor's presence influencing learning, also apply here. Mentor influence in guiding a student's learning is also supported by Livingston's research (1970) when he reported varying results with different teachers using the same activities, holding other variables constant. Other research by Livingston and Kidder (1973) found that teacher-led discussions after simulations were critical for increasing student achievement.

Apparently, being a skilled mentor also includes proficiency in managing controversy. Some activity teachers also reported that initially the controversial issues inherent in the simulation activities turned class discussion into uncontrolled arguments. They reported that many of the students and their families were directly affected by the issues in the simulations, and that some students had strong, preconceived opinions. These teachers reported that as they gained experience in using the activities with later classes, they were able to avoid disrupting conflicts and channel the controversy constructively by employing critical thinking strategies. If not enough time was allowed for students to engage in those critical thinking skills typically involved in postgame discussions (such as the synthesis of events and facts, forming analogies, and abstract thinking), there may have been an influence on the students' ability to synthesize similar content. As teachers gained experience, an effect on the students' environmental knowledge and attitudes may have resulted.

The literature suggests that this experience is not unprecedented. DeCecco and Richards (1974) state that teachers in the past often chose to inhibit discussion that might lead to disagreement. Others suggest that the
problem is more widespread. Paul (1984) suggested that there is a critical need to train teachers in teaching problem solving.

There is a fundamental difference between the kinds of problems one faces in technical domains and those in the logically messy 'real world'. Solutions to technical problems are typically determined by one self-consistent, close-textured system of ideas and procedures. In contrast, the problems of everyday life are rarely settled in a rational manner . . . To this point the schools, to the extent they have addressed problem solving, have focused their efforts on technical problems and technical reason and procedure, and have either illicitly reduced real-world problems to them or have tacitly inculcated into students the prefabricated "apodictic answers" of the dominant social majority or some favored minority (pp. 5-6).

Johnson and Johnson (1985, p. 229) note that, "A cooperative context is essential for the successful use of controversy. If students engaged in an argument see themselves as competing, they lose sight of the objective or arriving at the best answer. Instead of trying to resolve the controversy, they try to win the argument." Effectively handling controversy can benefit students' critical thinking skills by exploring different solutions before deciding which option is most appropriate. "This procedure of divergence before convergence is central to scientific thinking and is an essential ingredient of structured controversy" (p. 229).

The literature also indicates that, as teachers become more familiar with using simulations, the potential exists for increasing students' learning (Hickman, 1985). While the teachers who used the activities in this study were familiar with nature, components, and procedures of the activities, constructive ways of handling controversy were not a part of their training session. While the teachers eventually gained some experience in this area, the interviews with the teachers, as well as the literature, suggest that the
results for the activity condition might have varied had explicit training been provided in structuring controversy positively. The lesson here may also be that merely presenting students with differing opinions does not guarantee that productive discussions will ensue.

**Activities-with-videos findings for knowledge.** Students in the activities-with-videos condition scored significantly higher than the traditional, or lecture, method of instruction, but curiously averaged slightly lower mean scores than students in the videos-only condition. The significantly higher scores for the combined condition could be explained partially with the same argument presented for the videos-only condition, that is, the personally relevant, regional context, the captioning, or the explicit approach of the video guide. But this does not address the fact that mean scores in the activities-with-videos condition were similar to the videos-only condition.

One assumes that students in the combined condition should achieve at least at the same level as students in the videos-only condition, considering that all were exposed to the video instruction. In fact, the prediction was that student receiving both activities and videos would benefit from the additional coverage and discussion of related environmental concepts, and would likely post higher scores. The assumption was that the combined method of infusion would reach a greater number of students with individual learning styles. Additionally, by presenting information to students in several ways, it was felt that they would more likely be able to retrieve that information when needed. In support of this, Hooper (1990, p. 75) states that, "Students store more information in a memorable, readily usable fashion—dubbed 'meaningful learning'—if they get it by several routes and in an integrated form."
The argument could be made that the difference between the posttest means of the activities-with-videos condition ($X = 7.87$) and the videos-only condition ($X = 7.96$) could be considered inconsequential. However, when interviewing the teachers in the activities-with-videos condition, another factor that may have influenced the outcome emerged.

Teachers in the activities-with-videos condition indicated that in order to cover all the materials according to the content outline that was provided (Appendix A), time devoted to post-activity or post-video discussion was generally kept to a minimum. This is in contrast with the length of class discussions in the activities-only condition, whose teachers reported that discussions generally lasted the entire class period. While the total amount of class time that was spent conducting the activity was essentially the same for all conditions, the amount of time synthesizing, discussing, and bringing closure to the lesson in the activities-with-videos condition may have varied. As previously noted, the activity debriefing is widely regarded as critical for maximum learning to occur (Livingston and Kidder, 1973). This is the area where generalizations and symbolic meaning are synthesized from the students' game experiences. Spelvin (1979) emphasizes the teacher's role in helping students organize their thoughts and generalizing their experiences to real life.

The difference in the time of discussion probably would have been enough to influence the outcome. But the crowded schedule may have also influenced the quality of the discussions. Swift and Gooding (1983) note in studies conducted by the staff of the Classroom Interaction Research Laboratory that teachers find it difficult to engage in guided discussions with their students, and that discussions change into drill or lectures, as teachers strive to cover the material. They found that high school science teachers had
difficulty in guiding discussions effectively. All of this suggests that for
teachers to effectively use simulations, there should be a more
comprehensive teacher training regimen than was offered, time for the
teachers to gain experience in managing the activities, and a longer period of
implementation for the study.

**Findings across all conditions for attitude.** No significant difference
was found among conditions with regard to students' attitudes. Mean scores
for all conditions were essentially the same for both pretest and posttest,
regardless of condition. This possibility was not completely unexpected, and
is generally consistent with the literature.

In Munby's metanalysis of 10 years of science attitudinal studies (1983,
p. i), he reports that, "In general it is found that the field attitude
measurement in science education is not one in which one may have
confidence because the instrumentation is weak on many counts." He reports
that the problem goes far beyond the customary criteria of reliability and
validity, and relates more to the conceptual confusion relating to the nature
of attitudes in general. This is supported by Trowbridge (1972, p. 64) in his
review of approximately 400 attitudinal studies when he states, "A serious
weakness of attitude studies is the lack of adequate instruments for
measurement and vagueness about the meaning of attitude." Novak (1973,
p. 35) comments on the sparsity of an adequate theoretical base and states,

*We lack a theoretical framework for the definition and eludcation of attitudes and attitude growth. Important as affective dimensions of school learning may be, we are not likely to make substantial progress in understanding attitude measurement and designing instructional practices for positive affective growth on the basis of research unless and until some better theoretical framework or paradigm is elucidated to guide our work.*
The obvious question then becomes, "Why conduct science attitudinal research?" The answer is related to the numerous problems identified earlier with science education nationally and is reflected by the increased number of attitudinal learning objectives in new science curricula (Hurd, 1970). In addition, Munby (1983, p. 9) argues, notwithstanding the status quo of science attitudinal instruments, "any evaluation of science curricula ought to attend to affective as well as cognitive outcomes."

In the case of the present study, students in all four conditions scored essentially the same mean attitudinal scores. Interviews with teachers using the materials, however, indicated that the activity students seemed more eager and enthusiastic, with class discussions that were more animated than usual. They commented positively about reserved, normally nonparticipatory students who became actively involved in the *Wild Louisiana* activities.

Teachers using the videos reported increased participation from their students, with one teacher describing it as "unusual interest" among his students. He said that previous class discussions on the topics of "wetland loss" or "resource management" had never elicited those types of responses. When asked further, this teacher responded that when his students saw how these issues affected them personally, it made more of an impact on them than just telling them.

This suggests that the materials may have had some additional effect not addressed by the NEPS. And while these behavioral affects were not addressed in this study, it suggests that an additional approach or instrument may clarify the multiple effects of different conditions of infusion. The apparent difference between the test scores and the impressionistic evidence presents a sharp contrast, and according to Jackson (1979, p. 134), may be the
result of two explanations. "The problem may lie in faulty conceptual linkage between the experiences of the games and the measures used. In addition, students liking the experience may not necessarily mean they learned anything from it."

Because of the size and geographic separation of the sample, it was not physically possible to do an in-depth qualitative analysis for this study. However, a qualitative approach may provide additional insight regarding students' attitudes and other variables and the effects of the activities, and may prove to be fertile ground for future research.

**Locus of control findings.** No significant difference was found to exist among students with external locus of control in either knowledge or attitudes when students were grouped by condition. However, it was found that internal students in certain conditions differed significantly in knowledge scores when compared with both internal students in other conditions and external students in the same condition. Internal students in the activities-only condition (B) and the videos-only condition (C) both scored significantly higher than internal students in the comparison condition (A). Internal students in the activities-only condition (B) also scored significantly higher than the internal students in the activities-with-videos condition (D).

Because the videos were more teacher-directed and the activities more student-directed, the prediction, based on the literature cited earlier, was that externally oriented students would score higher means in the activities-with-videos condition. The rationale was that the videos would appeal to the preferred learning style of externals, and the activities would further serve to reinforce concepts previously presented in the videos, as well as present the concepts in an alternative way. While the external students in the videos-only condition registered the highest posttest means for all external students,
the difference was not statistically significant, when compared with the other conditions. In addition, the external students in the activities-with-videos scored no better than external students in the lecture condition.

This result suggests several possible explanations. One explanation is that learning from videos or simulations may have been new to these students, that they may have been unfamiliar with having to learn from instructional video programs or games, or that they were slower to adapt than their internal classmates to a new method of instruction. Lefcourt (1982) supports this, stating that external students were slower to adapt to new learning situations and less adept at applying themselves. In addition, the lack of closure and, or abbreviated class discussions previously discussed may have influenced the outcome.

In addition, there is the rationale that the attitude instrument used was not as appropriate as some other instrument could have been for measuring the noted positive behavioral affects on the students. An additional instrument or further impressionistic observations may have clarified the effects of the conditions on different students and teachers.

Another possibility for the variance in the internal/external scores to paraphrase Bredemier and Greenblat (1981), is that different people will learn different things by different means. They conclude that, "A major difficulty in simulation-gaming outcome assessment has been the failure of most researchers to take account of the fact that some students learn from games while others do not, and therefore treat individual differences in outcomes as error variance" (p. 315).

The students predictably followed the findings of previous studies (Daniels and Stevens, 1976; Horak and Slobodzian, 1980) regarding locus of control. The external students performed slightly higher in the teacher
directed conditions, such as the lecture method and the videos conditions, while internal students performed significantly higher in the student directed conditions, such as the activities condition. External and internal mean knowledge scores differed slightly from each other in most conditions of instruction, but as shown in Figure 1, converged in the videos-only condition (C).

This suggests that the condition of instruction most favored by externally oriented students was likely not one of the four methods used in this study. This becomes more probable when considering the results of the internally oriented students. If all students had registered similar, yet nonsignificant scores, the presumption could be that none of the conditions was measurably superior. This was not the case. External and internal students' scores differed in most conditions of instruction for knowledge.

Internal students in the activities-only condition (B) scored significantly higher knowledge scores on the test than external students in the same condition. In addition, those internal students in the videos-only condition (C) also scored significantly higher means than internal comparison condition (A) students. Sherris and Kahle (1984, 93) found similar results in their study concluding that, "Students with an internal locus of control orientation may always achieve at a higher level than externally-oriented students, in part because they may be more likely to apply specific skills when working to succeed in a school subject." Clearly, the results of this study indicate that the various conditions used in this study affect students with different locus of control orientations in different ways.

The one exception to this was in the videos-only condition in which both internal and external students' mean scores were close enough to be
considered essentially the same. Apparently this condition was the most appropriate of those used when considering all types of students.

Besides the difference between internal and external scores by condition, a finding that is most curious is the score of the internally oriented students in the lecture method. These students scored the lowest of all conditions, even lower than the external students in the same condition. Generally, the internal students scored the same or higher knowledge means than external students throughout the study. Furthermore, the literature indicates that internally oriented students can be expected to develop higher achievement than externally oriented students (Lefcourt, 1982; Sherris and Kahle, 1984; and Nadel, 1988). In this instance, both the external and internal students in the videos-only condition scored significantly higher than the internal students in the lecture method. The most interesting finding may not be that internal students did significantly better than many of the external students, but that internal students in the lecture method scored the lowest of all groups of students. The evidence here suggests that the lecture method may be the least effective method to teach the most capable students.

**Limitations**

Problems in sampling. Louisiana graduation requirements may have influenced the ability to generalize the results of this study to the general student population. High school graduation requirements in Louisiana presently require all students to successfully complete three units of science, one of which must be Biology I. Students may elect to take Biology I, Chemistry I, Biology II, Chemistry II, Environmental Science, or Physics to fulfill this requirement. Students planning to enter any college generally take at least Biology I, Chemistry and Physics, and these subjects are also required
to enter Louisiana State University (1991). Students not planning to enter college and taking Environmental Science are, in general, taking it as their third science, and are taking it as an alternative to Chemistry II or Physics. In interviews with several science teachers, it was the consensus that Environmental Science was less rigorous than Chemistry II or Physics. Students enrolled in Environmental Science were also perceived by these teachers to be not as academically strong as students completing Chemistry and Physics.

An intense search turned up no other reference regarding this issue, and any suppositions must take into account that the data are based solely on the consensus of the teacher interviews. While there are students who probably have taken both Environmental Science and Physics, the interviews suggest that students taking Environmental Science generally are not on a college track. Therefore, it would be prudent to generalize the results of this study only to those secondary students who are enrolled in Environmental Science.

**Problems in methodology and pedagogy.** The exit interviews with the teachers who used the activities in this study indicated that their facility in managing the activities with structured controversy had improved with practice. This, they felt, had an effect on the quality of the dynamics of the simulations and the follow-up discussions. This indicates that these teachers may have benefited from a period of practice in teaching the activities with structured controversy, beyond that presented in the training workshop. If the teachers had additional practice with the activities, it could have influenced students' scores in this condition.

In addition, interviews with the teachers who taught the activities-with-videos condition indicated that some of them felt they would have
benefited from an additional week of class time to cover all the materials in greater detail. However, that week would have been the week before the Christmas break, which might have influenced the outcome of the posttest. An additional trial period of using the activities-with-videos would probably have eliminated this problem.

Another issue that warrants consideration is that the teachers in the combined condition of activities-with-videos may have been provided too much material to adequately cover in the period of study. Because of the time frame, teachers may have simply devoted less discussion time to each lesson. The scores of students in the videos-only or the activities-only showed that these methods of infusion are at least as effective as the lecture method alone, and in some cases was significantly better for certain learner types. The most telling lesson may be that it is better to teach fewer lessons well than cover a lot of material.

Problems in instrumentation. The contrast between the impressionistic evidence from the teacher interviews and the students' scores in conditions with activities indicates that there was an additional behavioral effect not accounted for. Those behaviors were characterized by the teachers as positive, favorable reactions. While the NEPS did not purport to measure these behaviors, the confusion is indicative of the problems discussed regarding attitudinal research. This is not so much a reflection on the instruments used, as on those not used. Additional qualitative research would provide information about students' reactions and teaching methods. In this case, it represents a new direction for future investigations that study process as well as content.
Implications

Future research. This research illustrates that an infusion approach of instruction, using regionally based, STS oriented videos or activities, can be an effective method of increasing students' knowledge. This research also shows that students with certain learner styles, as indicated by their locus of control, can be more effectively taught with certain infusion methods of instruction that match their particular orientation.

While the findings of this study suggest some clear implications regarding students' knowledge acquisition, other questions emerged that warrant further research. The disparity between the attitudinal scores and the impressionistic evidence gathered from teacher interviews suggests that an additional approach to inquiry is warranted.

For example, what is the nature of the behavioral effects of the videos or activities on students, and how can they be measured? What are the students' personal preferences and do they vary with condition and, or learner preference? The exit interviews with teachers indicated that students responded favorably to both the activities and videos, yet in different ways. These responses could be further identified by qualitative analysis that includes interviews with the students.

Often, studies focus on product outcomes such as changes in cognition and attitudes, and fail to consider the process of instruction and learning. A key distinction in this type of analysis could transcend the product-oriented methodology, and focus also on that process. This process could include such variables as teachers' and students' motivation, interest, prior knowledge, as well as the effect of the materials on classroom dynamics.

And from the teachers' perspective—are there teacher characteristics that make a particular method of instruction more effective with certain
students? This would be relevant regarding both the videos and activities condition. For instance, evidence gathered in the teacher interviews suggests that teachers may have benefited from training in managing structured controversy.

Concerning the videos, questions emerge such as identifying what specific element of the videos condition influenced students' cognitive learning. Future investigations could center on production elements of the videos, such as the captioned words, the video guide, the regional context, or the use of the videos before or after the activities.

Given the variety of teaching conditions that were presented, an additional investigation could explore the nature of what students learned. Rote learners in comparison with conceptual learners, may have performed as well on the knowledge instruments in the short term, but if tested for retention, they may not do as well. Qualitative, in-depth interviews with students would provide a broader picture about the differences and effects based on the various conditions of infusion.

**Classroom practice.** This research also indicated the need for training teachers in the use of new materials, which includes a period of practice under classroom conditions. This would provide teachers an opportunity to more effectively manage student-directed methods of instruction and allow them to schedule new materials within the constraints of the class period.

Curriculum developers often disregard the constraints of real world classrooms and the needs of both teachers and students. Teachers are frequently limited by the class time available for actual time on task. Presenting teachers with new curricula along with recommended methods of instruction may only be the first step in their inservice training. Additional practice time in teaching new curricula may benefit teachers by boosting their
confidence in managing those materials, by providing them practice in fielding unexpected outcomes, and in giving them a better sense of when to become an active (versus passive) mentor in student-directed activities.

In addition, the findings suggest that presenting universal science concepts in a regional context in a lecture method alone, may not be enough to challenge all students' cognitive skills. This may be especially true for more capable students. It also suggests that content should not be considered in isolation from the method of instruction. It also confirms the belief that different students can benefit from different methods of instruction that match their learning styles.
BIBLIOGRAPHY


Munby, H. (1983). An investigation into the measurement of attitudes in science education. SMEAC Information Reference Center, Ohio State University, Columbus, Ohio.


Seginer, R. (1980). Game ability and academic ability: dependence on SES and psychological mediators. Simulations and Games, 11 (December), 403-421.


APPENDIX A
ENVIRONMENTAL SCIENCE
CONTENT OUTLINE
ENVIRONMENTAL SCIENCE CONTENT OUTLINE

ECOLOGY
I. GENERAL ECOLOGY
   A. Introduction
   B. Ecological Organization
   C. Components of an Ecosystem

[WETLANDS MODULE]
D. Population Dynamics
E. Life Span and Life Expectancy

II. HUMAN ECOLOGY
A. Human Population
B. Human Population and Food

RESOURCES
I. INTRODUCTION

[REDFISH MODULE]
II. SOIL
   A. Production
   B. Productivity - Types
   C. Erosion

III. WATER
   A. Water Habitats
   B. Characteristics
   C. Availability
   D. Water Use
   E. Water Treatment
   F. Pollution
   G. Controlling Pollution
   H. Trends and Sources

IV. WILDLIFE
   A. Importance
   B. Management

[ALLIGATOR MODULE]
APPENDIX B
WILD UNIT PLANS - WUPs
FOR
BACKGROUND INFORMATION
SIMULATION-GAMING ACTIVITIES
AND
INSTRUCTIONAL VIDEOS
GOALS
1. To promote a general awareness and an appreciation of the importance of wetlands.
2. To provide the learner an opportunity to assess the contributions of wetlands—including aesthetic, ecological, scientific, political, commercial, economic, recreational, and intrinsic values.
3. To develop an understanding of ecological principles as they affect aquatic wildlife, other wildlife, and people.
4. To create a historical perspective of the impact of cultural traditions on wetlands.
5. To give learners opportunities to apply knowledge gained in class to controversial issues and to assess the consequences of various solutions.
6. To provide learners an opportunity to recognize issues, evaluate them, and make responsible choices in their own lives.
7. To demonstrate the importance of management of wetlands and aquatic habitats.

DAY ONE - Background Information

Objectives
1. The learner will understand why wetlands are self-sustaining ecosystems. (Goal 1, 2, 3)
2. The learner will discuss the importance of wetlands and how wetland loss would affect his or her life. (Goal 1, 2, 3)
3. The learner will list conditions necessary for wetland survival. (Goal 3, 5)
4. The learner will define ecological concepts related to the wetland environment. (Goal 1, 2, 3)

Teaching Methods and Learning Tasks
Roll call (3 minutes)
Activity 1 (7 minutes)
Introduce the wetland module and relate it to any relevant concepts or examples previously taught. These concepts could include: biomes, niche, biotic and abiotic factors, energy transfer, food chains, biological accumulation, and interdependence. (Obj. 4)

Activity 2 (10 minutes)
Distribute wetland glossary handouts found in the beginning of the wetland module. Review any new terms, such as aesthetics, carrying capacity, ecosystems, emigration, eutrophication, greenhouse effect, marsh, mortality, and saltwater intrusion. (Obj. 4)

Activity 3 (25 minutes)
Lecture using the introductory material found in the beginning of the wetland module as background information. The following outline is provided. (Obj. 1, 2, 3, 4)

Aids/Materials/Suggestions

VANISHING WETLANDS OF LOUISIANA

A. Wetland—an area that is regularly wet or flooded and which has a water table that stands at or above the land surface for at least part of the year
Any Louisiana map

1. Types of wetlands
   a. Coastal wetlands
      (1) extend inland from estuaries including:
         (a) salt marshes
         (b) tidal basins
         (c) mangrove-dominated marshes
      (2) coastal marshes extend from the Pearl River on the Miss./La. border to the Sabine River on the Tex./La. border
   b. Inland freshwater wetlands
      (1) consist of:
         (a) swamps
         (b) marshes
         (c) bogs

Fig. 1—Erosion at Grand Isle

2. Importance of wetlands
   a. Buffer the force of storms
   b. Filter out pollutants
   c. Provide commercial benefits such as fishing, trapping, and hunting
   d. Act as nursery grounds for aquatic species

Fig. 2—Shrimp Life Cycle

3. Effects of wetland loss
   a. Loss of habitat for wildlife
   b. Decrease in recreational activities
   c. Loss of income
   d. Loss of hurricane buffer zones
   e. Loss of a pollutant filter

Conservation

4. Survival of the wetlands depends on:
   a. Control of natural and man-made factors contributing to wetland loss
   b. Balance between use and wetland protection

Activity 4 (3 minutes)
Review glossary terms covered in today's lesson, including wetlands, marsh, tidal basins, nursery grounds, estuary, mangroves, habitat. (Obj. 4)

Homework (2 minutes)
Make a list of at least five friends or relatives who are dependent upon the wetlands either directly or indirectly for income or recreation Explain how each person uses wetlands and how each would be affected by wetland loss (Obj. 2)

Examples: oil field worker, grocery store employee, service station employee, trapper, shrimper.

Evaluation
1. Class participation
2. Homework assignment

DAY TWO - Background Information

Objectives
1. The learner will describe the historical impact of land building by the Mississippi River. (Goal 3, 4, 5)
2. The learner will determine the effects of man's influence on the Mississippi River. (Goal 3, 4, 5)
3. The learner will identify the impact of wetlands on the local economy. (Goal 2, 3, 6)
4. The learner will identify the effects of man-made influences on wetland loss. (Goal 1, 2, 4, 5)

WUPS 3
Teaching Methods and Learning Tasks

Roll call (3 minutes)

Activity 1 (7 minutes)
Review the previous assignment and correlate previously studied material to today's lesson. Emphasis will be placed on direct and indirect value of wetlands. (Obj. 3)

Activity 2 (25 minutes)
Lecture on the morphology and value of wetlands using the following outline. (Obj. 1, 2, 3, 4)

Aids/Materials/Suggestions

Background Information Outline

B. Morphology of wetlands

Fig. 3—Mississippi Deltaic Lobes
Fig. 4—Historic Land Loss and Gain

1. In the last 7000 years the Mississippi River has produced four major deltas
   a. Teche delta
   b. St. Bernard delta
   c. Lafourche delta
   d. Modern delta

Fig. 5—Leveeing of the Mississippi River
Analogy to water hose flood

2. Man's influence on the Mississippi River
   a. Army Corps of Engineers leveed the river in the late 1920s to control flooding and maintain navigation
   b. The Mississippi water flow was narrowed from a 20-mile-wide plain to a one-half-mile-wide river between levees, increasing the water flow and pressure
   c. At present, the river deposits its sediment load beyond the continental shelf so no land building occurs

Any Louisiana map

3. Man's influence on the Atchafalaya River
   a. Atchafalaya Bay is receiving 30% of the Mississippi's water flow by a diversion at the Old River Control Structure
   b. This has increased land building in Atchafalaya Bay, but does not offset land loss elsewhere

Fig. 6—New Delta Lobe Formation

C. Value of wetlands

1. Louisiana contains 40% of this country's coastal marshes
2. Mississippi River drains 41% of the U.S., carrying sediment from land erosion
3. Majority of Louisiana residents live within 50 miles of the coastline including the Spanish, French, Acadians, Germans, and American Indians

Fig. 7—Mississippi River Drainage
Cultural impact

4. Commercially, Louisiana produces 25% of the nation's fur harvest and 30% of the nation's fish and shellfish harvest. It also serves as wintering grounds for two-thirds of the nation's migratory waterfowl
5. Louisiana produces one-sixth of the nation's oil and one-third of its natural gas

Economic impact
Homework (15 minutes)
Divide the class into four groups. Each group is assigned one of the following topics: leveeing, dredging, channelization, spoil banks.

Purpose: Students are to use their prior knowledge to determine the effect that each of these topics has on land loss.

DAY THREE - Background Information

Objectives
1. The learner will discuss the effects of man's influence on wetland loss. (Goal 4, 6)
2. The learner will identify the effects of nature's influence on wetland loss. (Goal 1, 2, 3)
3. The learner will describe the effects of saltwater intrusion into freshwater areas. (Goal 3, 5)
4. The learner will recognize the effects on land loss by subsidence, sea level rise, saltwater intrusion, hurricanes/storms, and tidal movements. (Goal 3, 5, 6)

Teaching Methods and Learning Tasks
Roll call (3 minutes)

Activity 1 (15 minutes)
Have a representative of each group present the group's results. Lead the class in a discussion by asking low-order (rote content recall) and high-order (synthesis) questions. (Obj. 1, 3, 4)

Activity 2 (30 minutes)
Using the following outline, lecture on components of wetland loss including man-made and natural influences, and relate them to Activity 1.

Aids/Materials/Suggestions

Background Information Outline

Fig. 8—Spoil Bank Diagram
Fig. 9—Louisiana Channels and Canals
Fig. 10—Present Louisiana Shoreline

D. Components of wetland loss

1. Man-made influences
   a. Reduction of sediments as a result of
      (1) leveeing—prevents natural and overbank flooding
      (2) dredging—removes sediments
      (3) channelization—allows saltwater intrusion
      (4) spoil banks—prevents the natural hydrologic flow
   b. Alteration of natural ecosystems
      (1) urban and agriculture development—draining and filling of wetlands
      (2) urban runoff and industrial development—pollution which destroys aquatic life and decreases water quality

2. Natural influences
   a. Sea level rise
      (1) Greenhouse effect—results from
         (a) increased CO₂ emission traps heat radiated from the earth's surface
         (b) temperature rise may melt polar ice caps and increase sea levels
b. Saltwater intrusion
   (1) Saline water enters brackish and freshwater environments through canals and channels
   (2) Kills existing vegetation, which allows erosion, transforming the area into open water
   (3) Results in destruction of habitat through loss of food and shelter

c. Subsidence
   (1) Compaction and sinking of wetland areas that no longer receive replenishment of nutrients
   (2) Occurs naturally but can be accelerated by levees and spoil banks

d. Hurricanes and storms
   (1) Alter shoreline characteristics by:
       (a) shifting beach sands
       (b) breaching barrier islands
       (c) flooding freshwater marshes

e. Tidal movement
   (1) Carries eroded materials into coastal bays and lakes or out to sea
   (2) Moves saltwater into freshwater areas

Homework (2 minutes)
List three consequences of wetland loss
(based on the value of wetlands). (Obj. 1, 2, 3, 4)

Evaluation
1. Homework assignment
2. Class participation

DAY FOUR - Background Information

Objectives
1. The learner will discuss the consequences of man's actions on wetlands. (Goal 6, 7)
2. The learner will discuss the function of plants in preventing erosion. (Goal 7)
3. The learner will list the legislative measures that can be taken to slow down or prevent wetland loss. (Goal 2, 6)
4. The learner will describe freshwater diversion and how it decreases wetland loss. (Goal 5, 6, 7)

Teaching Methods and Learning Tasks
Roll call (3 minutes)

Activity 1 (10 minutes)
Review the previous assignment by calling on students to read their answers. Other students will be called upon to comment on the appropriateness of the answers. Emphasize the long-term consequences of wetland loss. (Obj. 1)

Activity 2 (25 minutes)
Lecture on the consequences of and solutions to wetland loss using the following outline. Emphasize the results of the class assignment during the discussion.

Aids/Materials/Suggestions
Refer to homework assignment

3. Consequences of wetland loss
   a. Real estate loss
      (1) Every 15 minutes, Lafourche Parish loses enough land to equal one football field
      (2) Louisiana loses approximately 50 square miles each year
   b. Freshwater marsh loss includes
      (1) Loss of shelter for waterfowl and mammals
Fig. 11—An Example of a Louisiana Food Chain
(2) Destruction of vital links in the food chain
c. Loss of quality of life
(1) Loss of job opportunities
(2) Loss of local culture

E. Solutions to wetland loss

1. Marsh management
   a. Constructing water control structures
   b. Planting new vegetation
      (1) holds soil together
      (2) slows down water flow
      (3) traps sediments in water

2. Legislation
   a. Limits the creation of new canals and waterways
   b. Decreases the use of marsh buggies
   c. Eliminates marsh burning
   d. Requires boaters to follow safe speed limits to reduce wave action
   e. Establishes strict pollution penalties
   f. Provides economic incentives for new technology

3. Freshwater diversion
   a. Alters flow of major rivers and bayous
   b. Injects nutrient-laden sediment into coastal marshes

4. Rebuilding wetlands
   a. Beach and barrier island restoration
   b. Rebuilding marshes with dredge spoil

Activity Three (12 minutes)
Distribute the review questions to students. These questions will summarize the background information on wetlands and prepare students for the video program or activities to follow. Students should answer the questions voluntarily during class.

1. What is a wetland?
2. Name two types of wetlands.
3. How are wetlands important to us?

4. Why is sediment deposited by the Mississippi River being lost?
5. List the aesthetic and economic values of wetlands.
6. What man-made and natural influences have increased wetland loss?
7. Name and describe one possible solution to wetland loss.

Evaluation
1. Participation in classroom discussions
2. Answers to review questions
DAY ONE - Video Plan

Objectives

1. The learner will describe why wetlands are self-sustaining ecosystems. (Goal 1, 2, 3)

2. The learner will differentiate and describe causes of natural and man-made wetland loss. (Goal 1, 4)

3. The learner will describe man's activities that influence wetland loss. (Goal 1, 4, 5)

4. The learner will predict the effect of wetland loss on Louisiana economically, culturally, and aesthetically. (Goal 1, 2, 5, 6)

5. The learner will identify ways that man can slow wetland loss. (Goal 4, 5)

Teaching Methods and Learning Tasks

Roll call (3 minutes)

Activity 1 (5 minutes)

Introduce the video "Vanishing Wetlands," to provide reinforcement and to expand on the information presented in the wetland background information unit. The Teacher's Video Guide includes learning objectives, pre- and postviewing questions, vocabulary, a concept mapping exercise and a video quiz. (Obj. 1, 2, 3, 4, 5)

Activity 2 (20 minutes)

After reviewing the objectives and vocabulary terms, discuss each previewing question. These questions will help assimilate the student's previous knowledge and experiences with the new information in the video. (Obj. 1, 2, 3, 4, 5)

Activity 3 (22 minutes)

Divide the class into groups A and B. Distribute the incomplete concept maps to the designated groups. Overhead transparencies of maps A and B can be made and used in class while the students are viewing their concept maps. Read the map and the concepts aloud, explaining to the students how to complete their maps.

Students will use prior knowledge in attempting to complete the map, without knowing the information in the video. Group A will not work with group B at this time. The completion of the map may be finished as homework, providing each student the opportunity to determine the correct responses before viewing the video. (Obj. 1, 2, 3, 4, 5)

Evaluation

1. Participation in classroom discussion
2. Homework assignment

DAY TWO - Video Plan

Objectives

1. The learner will describe why wetlands are self-sustaining ecosystems. (Goal 1, 2, 3)

2. The learner will differentiate and describe causes of natural and man-made wetland loss. (Goal 1, 4)

3. The learner will describe man's activities that influence wetland loss. (Goal 1, 4, 5)

4. The learner will predict the effect of wetland loss on Louisiana economically, culturally, and aesthetically. (Goal 1, 2, 5, 6)

5. The learner will identify ways man can slow wetland loss. (Goal 4, 5)

Teaching Methods and Learning Tasks

Roll call (3 minutes)

Activity 1 (10 minutes)

Review the concept map and have students justify their answers. This exercise brings forth information stored in the students' long-term memory and allows them to familiarize themselves with the entire message communicated by the map. (Obj. 1, 2, 3, 4, 5)

Activity 2 (25 minutes)

Instruct the students to follow the concept map and to check their answers as the video play.
progresses. Once the video is complete, review the map and discuss any concepts that may have been confusing to the students. (Obj. 1, 2, 3, 4, 5)

Activity 3 (10 minutes)
Group the students into pairs, matching an A map with a B map. Have the pairs connect the concept maps with as many lines and linking words as they can to link A map with B map. The linking words justify the students' connection between concepts. This will allow students to use cooperative learning and critical thinking skills. (Obj. 1, 2, 3, 4, 5)

Homework (2 minutes)
Assign the postviewing questions found in the Teacher's Video Guide as a review of the video and preparation for a quiz.

Evaluation
1. Participation in classroom discussion
2. Participation in group activity
3. Homework assignment

DAY THREE - Video Plan

Objectives
1. The learner will describe why wetlands are self-sustaining ecosystems. (Goal 1, 2, 3)
2. The learner will differentiate and describe causes of natural and man-made wetland loss. (Goal 1, 4)
3. The learner will describe man's activities which influence wetland loss. (Goal 1, 4, 5)
4. The learner will predict the effect of wetland loss on Louisiana economically, culturally, and aesthetically. (Goal 1, 2, 5, 6)
5. The learner will identify ways man can slow wetland loss. (Goal 4, 5)

Teaching Methods and Learning Tasks
Roll call (3 minutes)
Activity 1 (15 minutes)
Review the students' connected maps. Have the pair tell why they decided to connect the various concepts. Have the other students discuss the appropriateness of the connections. (Obj. 1, 2, 3, 4)

Activity 2 (20 minutes)
Discuss the answers to the postviewing questions by having selected students respond. Other students may offer a critique or add to their responses. (Obj. 1, 2, 3, 4, 5)

Activity 3 (12 minutes)
The remainder of the period should be allowed for the quiz. The video quiz found in the Teacher's Video Guide will test students' knowledge and understanding of the information presented in the wetland video unit. (Obj. 1, 2, 3, 4, 5)

Evaluation
1. Participation in classroom discussions
2. Video quiz
APPENDIX C
TEACHERS' VIDEO GUIDE TO
WILD LOUISIANA VIDEOS

VANISHING WETLANDS VIDEO GUIDE
AND
CONCEPT MAPS
Using *Wild Louisiana* Videos

Each of the topics covered in *Wild Louisiana* includes a video program that reinforces and expands the information presented in the printed activities. The videos should be viewed before starting the activities to give the class a common base of knowledge. The following describes how to most effectively use the videos through delineating key concepts, promoting critical thinking, and offering a variety of extension questions so that students can use their newfound knowledge in other contexts.

1. **Review vocabulary words with the class.**
   Reviewing the vocabulary words allows the student to understand each concept individually before it is linked with other concepts.

2. **Review learning outcomes.** By telling the class exactly what information the student is expected to know by the end of the comprehensive learning unit, the student is cued to information that will be relevant in the upcoming video.

3. **Ask the previewing questions.** The questions are designed to activate a student's previous knowledge. When the student relates new information to old information already in long-term memory, the student is more likely to learn and remember the new information. There is an answer key given; however, due to the nature of the previewing questions, it is not all inclusive and other answers should be considered.

4. **Duplicate, present half the class concept map A and half the class concept map B and review the incomplete concept maps.** Notice that there is a choice of concepts that can be selected at the bottom of the map. Map organization follows the organization of the videos. Notice that the conceptual flow of the map starts at the top with the broader concepts and works down to the supporting details near the bottom of the map. The concepts are structured into a hierarchy by linking words. Transparencies can be made of the incomplete and complete concept maps if needed.

5. **Show the video and have each student fill in the blanks on their respective concept map.** Filling in the concept map changes the student from a passive learner to an active learner involved in developing his or her own meaning from the videos.

6. **After the video, review the concept maps.** You can use the maps to identify the concepts that the student finds confusing and review them for clarification. The student's completed map also reveals any common misconceptions that might need further instruction.

7. **Group the students into pairs (a student with concept map A and a student with concept map B), have the pairs connect the concept maps together with as many lines as the pair feel they need.** Each linkup has to have a few connecting words describing the nature of the link. See the combined concept map for an example. Cooperative learning allows peers to learn from peers, and the students explore all possibilities before presenting their choice in front of an authority figure.

8. **Review the combined concept map.** Remember that the combined concept map only gives one set of correctly linked maps; other linked maps may also be correct.

9. **Steer the class through the post-viewing questions.** These questions allow the student to extend the knowledge learned in the videos into different contexts by the use of critical thinking. The generalization of new information is important. The more mental representations the student has of the new information, the more useful it is in different situations. Some of the discussion questions could be used as a basis for a homework assignment or a research project. There is an answer key given; however, due to the nature of the post-viewing questions, it is not all inclusive and other answers should be considered.

10. **Assign the multiple questions for homework and review next class period.** The questions may be graded or not, depending upon teacher discretion. Studies have shown that reinforcement and feedback are influential in helping students learning new material.

Normally, the *Wild Louisiana* activities follow the post-viewing questions, but the videos and the activities are independent and may be used separately. However, it is recommended that the video programs be used with the previewing questions, the concept maps, and the follow-up questions in conjunction with the activities as a comprehensive learning unit.

VIDEO GUIDE 1
Vanishing Wetlands Video Guide

**WETLAND VIDEO LEARNING OUTCOME**

Students should be able to:

1. describe how wetland loss is occurring.
2. differentiate and describe causes of natural and man-made wetland loss.
3. describe some of man’s activities in wetlands that influence wetland loss.
4. recognize the benefits and costs in preserving wetlands.
5. identify ways man can slow wetland loss.

**WETLAND VIDEO VOCABULARY**

1. Barrier island: a long, narrow, coastal, sandy island, that is above high tide, parallel to the shore, and commonly has dunes, vegetated zones, and marsh and swamp extending lagoonward from the back of the island.
2. Channel or canal: an artificial open waterway used for transportation or irrigation, normally straight and steep-sided.
3. Dredge spoil: soil that is left over from the excavation of a channel or canal.
4. Erosion: the wearing away of the land, chiefly by running water (including rain), waves, currents and wind.
5. Habitat: the arrangement of food, water, shelter or cover, and space suitable to an animal’s or plant’s needs.
6. Levee: a man-made levee is a steep ridge of soil deposited on the banks of a stream to prevent flood waters from spreading out from the channel onto the adjacent landscape. A natural levee is a low, barely perceptible ridge of soil which parallels the bank of a stream channel, sloping gently away from the steam on both banks.
7. Mitigation: to substitute some benefit for losses that have occurred.
8. Storm surge: an abnormal, sudden rise in sea level along an open coast caused by wind pressure on the ocean’s surface, resulting in water piling up against the coast. Also called a storm wave.
9. Tidal water bottoms: ponds and streams that empty and fill with the tide.

**WETLAND PREVIEWING QUESTIONS**

1. What is a wetland? Name some examples. Would your quality of life change if wetlands didn’t exist? Why or why not?
2. What is happening to Louisiana’s wetlands?
3. What do you think are the causes?
4. What are the economic and aesthetic benefits of wetlands to humans? What are the benefits to animals?
5. Draining wetlands occurs for a variety of reasons: to build housing and shopping centers or to produce farm crops. Some argue that this converts “unproductive land” into jobs, homes, and food. Discuss this issue.

**WETLAND PREVIEWING ANSWERS**

1. a. A wetland is a temporarily or permanently flooded habitat with reduced soils and a suite of plants adapted to flooded conditions.
   b. Some examples of wetlands include:
      • marsh
      • swamp
      • bogs
      • bottomland hardwood forest
   c. Yes
   d. Our quality of life would change through the limitation of:
      • recreation
      • food
      • other resources indigenous to wetlands
2. Our wetlands are rapidly disappearing.
3. Some of the causes of wetland loss include:
   • canal and channel building
   • erosion by wave action
   • subsidence
4. a. Some of the economic and aesthetic benefits of wetlands to humans include:
   • seafood production
   • animal skin and meat production
   • recreation
   b. Animals benefit by having habitats to live in.
5. * Wetlands provide habitat for many plants and animals that are economically valuable to man.
• Developing wetlands results in a loss of jobs to people who make a living by harvesting plants and animals that live in wetlands.

WETLAND POST-VIEWING QUESTIONS
1. Why is wetland loss occurring? What evidence of wetland loss did you see on the video?
2. Joe Billiot's grandfather said that the worst thing that could have happened to the land is when they closed the river. What do you think he meant?
3. What do you predict that the grandchildren of the three people interviewed in the video would say 50 years from now? Will they still live near the coast? Where will the coast be in 50 years?
4. What can an individual do to help reverse wetland loss? How would you go about it?
5. Solving the problem of wetland loss may require some risks. What are some of the short- and long-term benefits to solving the problem?
6. Because of the westward current in the Gulf of Mexico, some of the fishery stock produced in Louisiana wetlands migrate to Galveston Bay. Do we have an ethical responsibility to Texas to save our wetlands when Texans derive economic gain through fishing? Why?

WETLAND POST-VIEWING ANSWERS
1. a. Wetland loss can be natural or man-made:
• migration of a barrier island
• dredging
b. Some of the evidence on the video included:
• exposed graves
• the partially washed away cemetery
• Joe Billiot's land under water
2. Joe Billiot meant that the land wasn't being rebuilt and replenished because water and sediment from the river were prevented from reaching the marsh by control structures and levees.
3. * Scenario 1: Our grandfathers were right and we have had to move from the coast because the jobs that were dependent on wetlands are gone. The coast is still there, but it has moved inland and the limited wetlands cannot support commercial and recreational fisheries.
• Scenario 2: We have turned back the threat to our wetlands with regulation, mitigation, and restoration. The wetlands are still disappearing, but we have significantly reduced the rate and our grandchildren will still have the benefits we enjoy from these wetlands.
4. Some of the ways an individual can help to change wetland loss include:
• write letters to elected officials to spend tax dollars on mitigation measures and to pass legislation to prohibit wetland destruction.
• volunteer to participate in beach cleanups and other projects in your area.
• join environmental protection groups that lobby lawmakers and publicize environmental problems.
5. a. Risks incurred in solving wetland loss include:
• the expenditure of money to save, protect, and restore wetlands
• loss of potential new growth by industry, housing, and farming
b. Benefits of wetlands include continued:
• availability of seafood
• recreation
• aesthetics
• hurricane protection
• hunting and trapping
6. Wetlands contribute lasting economic and aesthetic benefit to people who live in Louisiana. While we derive short-term benefit by developing wetlands, we not only short-change ourselves, but our neighbors in Texas and future Louisianians.
wetlands concept map

A.

WETLAND LOSS

resulting in

HABITAT LOSS

causing loss to

BARRIER ISLANDS

TIDAL WATER BOTTOMS

COASTAL MARSHES

FURS AND HIDES PRODUCTION

COMMERCIAL FISH AND SHELLFISH PRODUCTION

HUMAN RECREATION

for example

BOATING  FISHING  HUNTING  AESTHETICS
A.

WETLAND LOSS
resulting in
HABITAT LOSS

causing loss to

BARRIER ISLANDS
TIDAL WATER BOTTOMS

causing loss to

COMMERCIAL FISH AND SHELLFISH PRODUCTION

HUMAN RECREATION

for example

BOATING AESTHETICS

WORDS: fishing, levees, coastal marshes, furs and hides production, shoreline erosion, hunting
B.

**WETLAND LOSS**

is due to

- **SHORELINE EROSION**
- **SUBSIDENCE**

that are influenced by

**ACTIVITIES OF MAN**

accelerating loss are

- **LEVEES**
- **DREDGE SPOIL AND LANDFILL**

decelerating loss are

- **MARSH REVEGETATION**
- **FRESHWATER DIVERSION**
- **ALTERNATIVES TO CANALS**

**WORDS:** canals and navigator channels, fishing, canal plugging and backfilling, coastal marshes, saltwater intrusion, soil dispersion
WETLAND LOSS

is due to

SHORELINE EROSION  SUBSIDENCE  SALTMAR WINTERUSION

that are influenced by

ACTIVITIES OF MAN

accelerating loss are

CANALS AND NAVIGATION CHANNELS  LEVEES  DREDGE SPOIL AND LANDFILL

decelerating loss are

CANAL PLUGGING AND BACKFILLING  MARSH REVEGETATION

SOIL DISPERSION  FRESHWATER DIVERSION  ALTERNATIVES TO CANALS
WETLAND LOSS

due to

SHORELINE EROSION

SUBSIDENCE

SALTWATER INTRUSION

causes

HABITAT LOSS

for

COMMERCIAL FISH AND SHELLFISH PRODUCTION

FURS AND HIDES PRODUCTION

HUMAN RECREATION

accelerated by

COASTAL MARSHES

BARRIER ISLANDS

TIDAL WATER BOTTOMS

activities of man

such as

BOATING

HUNTING

AESTHETICS

FISHING

WATERFOWL

MAMMALS

CANALS AND NAVIGATION CHANNELS

DREDGE SPOIL AND LANDFILL

LEVEES

can be mitigated by

FRESHWATER DIVERSION

SOIL DISPERSION

CANAL PLUGGING AND BACKFILLING

MARSH REVEGETATION

ALTERNATIVES TO CANALS
MULTIPLE CHOICE: Select the one response that you believe is the best answer.

1. Coastal wetlands include only
   a. tidal basins, salt marshes
   b. swamps, marshes, and bays
   c. freshwater, intermediate, and saline marshes
   d. inland freshwater, brackish, and saline marshes

2. Proper management of coastal wetlands is essential for
   a. protection of Louisiana beaches
   b. storing pollutants safely
   c. preventing oil spills and industrial discharges
   d. preservation of those wetlands for future generations

3. Ecologically, the wetlands are important to us because they
   a. protect us from storm surges
   b. prevent saltwater intrusion
   c. act as nursery grounds for aquatic species
   d. prevent the overpopulation of a particular species

4. Which of the following is not a result of the loss of wetlands?
   a. loss of shelter and food for wildlife
   b. decrease in saltwater intrusion
   c. decrease in recreational grounds for outdoor enthusiasts
   d. loss of income for trappers, fishermen, and industrial personnel

5. In order for coastal wetlands to survive, there must be
   a. legislation on the local level to protect the wetlands
   b. total evacuation from the wetlands
   c. balance between wetland use and wetland protection
   d. less use of wetlands by the petroleum industry

6. Reduction in Mississippi River sediment reaching coastal wetlands is a result of
   a. sediment being pushed beyond the continental shelf
   b. leveeing of the Mississippi River
   c. very dense saltwater pushing sediments back to freshwater areas
   d. channelization of coastal wetlands

7. Spoil banks contribute to wetland loss by
   a. preventing the natural flow of water through wetlands
   b. allowing saltwater to move into freshwater areas
   c. preventing the growth of salt-tolerant vegetation
   d. allowing erosion to occur by wave action

8. Which is not a contributing factor to subsidence?
   a. compaction of wetland soil
   b. extraction of oil and gas
   c. barrier island erosion
   d. lack of sediment flow through the wetlands
9. What effect has wetland loss had on migratory waterfowl populations?
   a. shifting of nesting colonies in Louisiana
   b. decrease in birth rate
   c. increase in death rate
   d. increase in food supply

10. The introduction of diverted fresh water from the Mississippi River into
    marshes will
    a. inject nutrient-laden sediment into the marshes
    b. increase the growth of salt-tolerant plants
    c. dilute saltwater concentrations
    d. both a and c

11. Which of the following answers would be the best solution to saltwater
    intrusion?
    a. erosion control structures
    b. legislation
    c. freshwater diversion
    d. barrier island restoration
    e. beach vegetation projects

Using the scenario below, answer the following questions.
Science students were examining factors affecting plant growth in various saline
solutions. A common freshwater plant, elodea, was used in water with various levels of
salinity. Three containers of equal amounts of water were used in the experiment. One
had fresh water, the second had a 10% saline solution, and the third had a 20% saline
solution. Containers were kept in sunlight and observed daily.

12. Which of the following is the best statement of the problem being investigated?
    a. Does the amount of water affect plant growth?
    b. Does the amount of salt in water affect plant growth?
    c. Is there a relationship between plant growth and sunlight?
    d. None of the above

13. Which of the following best describes the variable of the experiment?
    a. amount of water       b. type of plant
    c. amount of salt        d. amount of sunlight

14. The students observed that the plant in container number three had less
growth than number two, and number two had less growth than number one.
Which of the following graphs best illustrates these results?

   A.  
   B.  
   C.  
   D.  

15. If you used saltwater plants, intolerant to fresh water, in the experiment, which
    of the above graphs best illustrates the expected results?

Answers
APPENDIX D

WILD LOUISIANA

SIMULATION-GAMING ACTIVITIES

MODULE

WETLANDS SURVIVAL SIMULATION
Wetland Survival Simulation

PURPOSE

This simulation activity emphasizes the different kinds of land use and the alternatives necessary for planning. The purpose of this activity is to develop an awareness that problems relating to environmental issues are not easily solved and involve many areas.

PROCESS OBJECTIVES

Students will be able to develop or improve their skills in observing, inferring, classifying, recognizing number relations, recognizing space/time relationships, communicating, predicting, and decision-making by:

1. Evaluating the effects of different kinds of land use on wetland habitats

2. Identifying the needs of individual residents concerning the marsh and coastal areas

3. Evaluating the problems associated with meeting the needs of all local residents

4. Designing a wetlands use plan that best meets the needs of the people and the environment

5. Developing decision-making skills and predicting potential outcomes

Concepts

Interrelationship of organisms, levels of ecological organization, ecosystem, community, habitat, niche, biotic and abiotic factors, energy production, limiting factors, population pressures, carbon cycle, limit to resources, cultural factors, soil formation, soil productivity, erosion, land use, land pollution, land resources, preservation, impact of recreational use, conservation, protection of species, wildlife management, renewable and nonrenewable resources, recycling, effects of water pollution, importance of estuarine zone, and coastal zone management.

Curriculum Guide Reference

Louisiana Department of Education Bulletin 1792, obj. 1, 2, 3*, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17*, 18*, 19*, 21*, 22*, 25, 27, 41*, 49, 52, 55*, 56, 57, 58*, 59*, 102, 103, 105, 106, 111, 117, 118, 130, 132, 156, 161, 163, 166, 173, 174, 175, 186.

*Louisiana Education Assessment Program Exit Test Generalization.

METHOD

Students simulate a parish council (police jury) meeting to decide how a wetland will be used.

BACKGROUND

The use of land by humans affects wildlife and habitat positively or negatively. Priorities and lifestyle help to determine how man interacts with the land. Undeveloped areas of the natural environment are sometimes seen by people as little more than raw materials for human use. However, some people believe that the natural environment is to be preserved without regard for human needs, and still others look for a balance between a healthy natural environment and economic growth.

Growth is the center of many land use issues. But growth has its limits in natural systems, limits that are imposed by a power balance between energy and all aspects of the system. The energy in a natural system is transferred into food, water, shelter, and space. The ability of an ecosystem to be self-regulating depends on the vitality of the natural system. All natural members of an ecosystem can live in harmony if the system has the capacity to be self-regulating, and consideration of all life forms in a system is vital to its success.

Plants and predators are important to a system as are microbes, but the natural dynamic balance of all these essential parts is what is usually disturbed. Humans have the ability to overload a system, thus exceeding its natural limits and producing an imbalance in the system.

For example, communities build levees to protect themselves from floods, to improve transportation, or to drain wetlands for homes and buildings, activities that affect wildlife habitat in many adverse ways.

Wetlands are often envisioned as swampy, dirty wastelands, but are actually nurseries for hundreds of forms of wildlife. Astounding numbers of reptiles, birds, amphibians, fish, insects and plants all survive because of the wetlands. Wetlands are vulnerable to development, pollution, and a variety of other forms of human interference that upset natural hydrology in a wetland. Many acres of valuable...
wetlands are lost each year to dredging, draining, filling, and pollution.

With humans having such a major impact on wetlands, it is vital that we make responsible decisions and it's important that students be exposed to all aspects of land-use management. This simulation activity is modified from the Project WILD and Project CLASS format. The students will determine the use of a wetland area after careful consideration of all factors concerned.

SETTING THE STAGE

This simulation is designed to represent the possible options that could be decided upon by St. Mary Parish residents for future disposition of land willed to the parish by a private landowner. The inherited property is almost exclusively freshwater marshland. These options range from restricted or no development to extensive commercial development in coastal and inland areas. The role simulations are designed to be realistically representative of the vested interests that bring pressure to bear on those who determine the future of our Louisiana environment. The students will use the information to make responsible, far-reaching decisions concerning environmental management and problems associated with environmental and natural resources.

The land in question is an 84,000-acre tract of wetland located in St. Mary Parish between the Atchafalaya River and Bayou Sale, below the Atchafalaya basin (see Figure H and topographical map). This area is bounded on the north by the communities of Patterson, Calumet, and Centerville, and on the south by the Atchafalaya Bay and delta. The freshwater marshland is located within the Atchafalaya River floodplain and, unlike many wetlands, does not have saline transitional marshlands bordering gulf shores. The land is relatively flat with elevations ranging from 0 to 2 feet above sea level. These wetlands are in a major flyway and are the winter feeding grounds for many species of waterfowl and other migratory birds. The marsh serves as a nursery for many developing species of aquatic organisms and supplies organic matter from extensive vegetative communities, including water hyacinth, alligatorweed, maidencane, hydrocotyl, and bulltongue. The extensive vegetation also acts as a filter for pollutants transferred through the Atchafalaya drainage system.

Millions of small shrimp, developing crabs, small fish, and various other aquatic organisms are abundant in the Atchafalaya Bay coastal zone and are dependent upon these marshlands for their early development.

The marshland also supports a large population of deer, muskrat, nutria, alligators, and other marsh inhabitants. Countless shore birds and wading birds are year-round residents, adding to the teeming wildlife community present in this wetland.

This land has remained in private ownership since the original Spanish and French land grants in the 1700s. The land has remained relatively undeveloped by the owners and their descendants and has not been affected by commercial development except for oil and gas exploration, and leasing to trappers and recreational hunters.

Figure H. Location map for Wetland Survival Simulation activity. See also topographical map in Wetlands reference material.

PROCEDURE
1. Prepare copies of the role definition scripts and rebuttal cards for each participant. These
pages are attached at the end of each activity and can be copied onto appropriate index cards. Explain the activity. Tell the class that students will act as the representatives of special interest groups and will have an opportunity to be heard.

**Special Interest Group**

<table>
<thead>
<tr>
<th>Organization</th>
<th>Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audubon Society</td>
<td>Hank Heron</td>
</tr>
<tr>
<td>Shrimpers United</td>
<td>Nguyen Net</td>
</tr>
<tr>
<td>Industry Consortium</td>
<td>Joe Wildcat</td>
</tr>
<tr>
<td>Army Corps of Engineers</td>
<td>Capt. Larry Levee</td>
</tr>
<tr>
<td>LUMP</td>
<td>Ernest Meyer Flash</td>
</tr>
<tr>
<td>Concerned Citizens</td>
<td>Billy Savus</td>
</tr>
<tr>
<td>Ducks Unlimited</td>
<td>Billy Buckshot</td>
</tr>
<tr>
<td>Save Our Marsh</td>
<td>Chris Craft</td>
</tr>
</tbody>
</table>

The remaining students will represent the public who own the land.

2. Distribute the scripts and rebuttal cards to the "actors."

3. The parish president will act as the moderator. The president should show an overhead transparency or maps representing the land area in question (see topographic map).

4. Using a town meeting format, the president of the parish council reads the rules of order and statement of the problem as follows.

The land shown on the map has been donated to the parish for use as the citizens see fit. A use plan has to be developed with inputs from the residents and commercial interests involved in the parish tax base.

Representatives from regulating agencies will have two minutes to explain their agency's role in the permit process and can discuss activities that will receive favorable and unfavorable comment in the permit review process.

Each group requesting to be heard will be given two minutes to present its position. Any other interest group registered to make a presentation (including government agencies) can have one minute to rebut any argument presented by another group (Rebuttal cards may be used). This will not count against their time allocation for their primary presentation in favor of their position but rebuttal time can only be used to comment on another person's presentation.

5. Each class member should make his own list of pros and cons for each land use plan.

6. After the final presentation, the president should compile a list of these pros and cons.

7. The students will then vote as a representative population of the community, as to how they think this area could best be used. Students could do this as a homework activity, listing their reasons and justifying their votes.

8. Students will also vote for the best portrayal of a role by an individual.

**EVALUATION**

1. What guidelines might be used by a community to decide what would be appropriate use of wetlands? What is permitted by law?

2. How would you, as a voting citizen of a community, help to determine the proper management of a wetland?

3. Define the wetland environment and describe how it is similar to and different from other types of environments (i.e., mountains, desert, upland forests).

4. Have students define the term ecology in terms of their environment.

5. Have the students describe the levels of ecological organization within a wetland environment.

6. Have students identify the components of the wetland community.

7. Examine the various habitat areas in the Louisiana coastal regions.

8. Identify the various *abiotic* and *biotic* factors of a wetland and provide examples.

9. Discuss the limitations of earth's processes to "recycle" materials.

10. Describe how human population affects individual use of the wetlands.

11. How has the south Louisiana culture affected the use of the wetlands?

12. Describe the way soil is formed in the wetlands of Louisiana and compare it with soil found in western Arkansas or in the Florida parishes.

13. Describe soil productivity and the differences between the soil in the delta region of Louisiana and rain forest of the Amazon.

14. Describe human actions that have contributed to soil erosion.
EXTENSIONS

1. Have students devise an environmental impact statement based on how the land is to be used.

2. Find out about federal and local wetland use laws and determine if your decision is feasible.

3. Trace the history of a local wildlife refuge and what procedures were followed to determine its function.

4. Invite community leaders to participate in a panel discussion. Encourage news media to attend and raise public awareness.

VOCABULARY

Abiotic Factors
Biotic Factors
Ecosystem
Eutrophication
Habitat
Niche
Wetlands
HANK HERON (Audubon Society)

As a representative of the National Audubon Society we are interested in preserving this area as a refuge for shorebirds, wading birds, and migratory fowl. This large tract of land between the Wax Lake Outlet and the Atchafalaya serves as a gathering ground for several species of waterfowl which breed nowhere else in the lower United States. The largest brown pelican rookery in the country is located in St. Mary Parish. Commercial development of this marshland would destroy habitat and greatly jeopardize the continued existence of many organisms.

NGUYEN NET (Shrimpers United)

I am a shrimp fisherman and I've worked hard to establish my shrimp business. I had nothing when I came to this country in 1975; now I own two shrimp trawlers and I depend on the wetland areas in the coastal zone to support my livelihood—no wetland marshes, no shrimp. I don't want developers or the oil industry or anyone else interfering with the marsh.

JOE WILDCAT (Industry Consortium)

I represent an oil and gas consortium that can pump a lot of revenue into your parish. You are in a unique position as private owners of a large tract of land to be the recipients of oil tax revenues and profit sharing, and we will even build the new high school that you’ve had trouble collecting funds to build. If you will allow us to develop the land as we deem most profitable and cost effective for us, I think we both will profit immensely.
LARRY LEVEE (Army Corps of Engineers)

My name is Captain Levee and I represent the Army Corps of Engineers. We are interested in constructing a ship channel west of the Atchafalaya River which would connect the Intracoastal Canal to Atchafalaya Bay. This ship channel would reduce travel time for ship traffic between Atchafalaya Bay and Morgan City. Additionally, this channel would connect ship traffic between western and central Louisiana coastal areas from Lake Charles to Morgan City and the Atchafalaya gulf outlet.

EARLIE MEYER FLASK (LUMP)

I am a representative of the Louisiana Universities Marine Program, LUMP, which is interested in conducting a 10-year study on the formation of the new delta now occurring in Atchafalaya Bay. We also wish to assess the impact of land-building on the marshland bordering Atchafalaya Bay. The construction of a ship channel by the Corps or exploitation of the wetlands by the oil consortium may greatly alter the natural dynamics of this marshland. LUMP feels that this area study will greatly enhance our information and knowledge of delta formation and this may be used in planning strategies for dealing with landloss in other coastal areas where delta formation is restricted or nonexistent.

SALLY SAVUS (Concerned Citizens)

I have lived in this area for 45 years. My father and brother used to crab and fish here when I was a child. This area has remained in a relatively pristine state during my lifetime, and I don't want to see it altered, exploited, or changed in any way. My children have developed an appreciation for the wetlands, and I want their children to experience this area in its natural state.
BILLY BUCKSHOT (Ducks Unlimited)
I represent Ducks Unlimited which is interested in managing this land tract. These marshlands are located in a major flyway between North and South America and are a winter feeding area for thousands of waterfowl and other migratory fowl. Ducks Unlimited has been instrumental in managing and maintaining stable populations of waterfowl in numbers that will ensure their continued existence. We feel that development of the marshland, in particular draining of the area and channelization, would destroy habitat and deprive many winter residents of a food supply. The hunting industry brings money into your economy each year and will continue to do so if the waterfowl remain here. If this marshland is exploited the hunting income will end.

CHRIS CRAFT (Save Our Marsh)
The Atchafalaya Bay area is one of the richest fishing grounds of coastal Louisiana. The yearly income to the state from recreational fishing is vast, and local economies like yours could profit greatly if that sportfishing industry could be developed along our coastline and in your inland waters. Development of marinas will draw sport fishermen who will dock their boats here year-round. In addition, the hotel and restaurant industries will profit from these recreational activities.

GARY GAVEL (President, Parish Council)
As president of the parish council, I will conduct the meeting to determine the fate of these wetlands. This is a unique situation in that the parish has the opportunity to develop management plans to preserve the wetlands donated to the people of St. Mary Parish. It is important that decisions made here not only reflect the interests of the majority of the people, but also ensure that wildlife and fisheries resources will not be adversely affected.
Oil and gas development disrupts natural habitat by the dredging of navigation, pipeline, and rig access canals. These canals also encourage land loss by allowing saline gulf waters to penetrate fresh marshes, killing the vegetation.

Land loss is accelerated by canal dredging, not only because marsh is actually removed, but because the spoil banks created by dredging disrupt the natural flow of water and sediments over the surrounding marsh, starving the area of nutrients needed for maintenance and growth.

This area is already accessible by an interconnecting network of natural waterways. Only limited canal dredging would be required and the drilling companies can backfill access and pipeline canals when no longer needed. No saltwater intrusion will be experienced because of dominance of Atchafalaya River water in the area at all seasons. The federal Coastal Zone Management Act calls for balanced conservation and development, and our operations are compatible with fish and wildlife interests. We have many examples of improvement of fish and wildlife habitat by our industry. For example, oil rigs in the Gulf act as artificial reefs, attracting fish. The revenues from oil and gas royalties are far greater than all the others put together and these activities do not preclude activities associated with other renewable resources and aesthetic interests. Any land loss experienced will be reversed because of high sedimentation from the Atchafalaya River. Preservation brings in no revenues and precludes any development no matter how little it affects the environment.
Rebuttal to Ducks Unlimited
(Shrimpers, Save Our Marsh)

The management of marsh for duck hunters is an elitist approach to the use of this land. The average person who is not a landholder or wealthy lessee will not benefit from this activity. Management of marsh habitat for ducks precludes most other recreational use. The sensitivity of duck hunters to the use of their ponds and pirogue ditches by others is common knowledge. Management of marsh to favor freshwater aquatics by the installation of water control structures interferes with the migration of estuarine dependent species in and out of these waterways. These control structures also block use by recreational and commercial fishermen who have a right to access these state-owned water bottoms. Levees and water control structures are basically marsh fences which are frequently designed to keep fish and shrimp in and keep fishermen out.

Rebuttal to Shrimpers
(Ducks Unlimited)

These marshes are predominantly freshwater habitat and are not used extensively for nursery habitat by larval and juvenile shrimp. The Atchafalaya Delta and adjacent brackish marshes are appropriate and sufficient nursery grounds for the shrimp fishery in this area. We don't need to allow this marshland to become dominated by saltwater intrusion to make more habitat available for the fishery industry. There can be an additional use by leasing of trapping rights in the adjacent marshes.
Marina development is inappropriate for this area. Road access is a requisite for marina development and is as important as water access to the fishing grounds. There is ample road access to these wetlands adjacent to Highway 90 in places like North Bend, Calumet, Bayou Vista, and Idlewild. We are already losing 50 square miles of marsh annually to coastal erosion. It would be inappropriate to dredge and fill in these wetlands in order to build roads, camps, boat slips, and support facilities. The concentration of oil and gas found in marinas would serve to contaminate these relatively undisturbed wetlands. Boat wakes from recreational craft would further accelerate bank erosion in canals and natural waterways.

Rebuttal to Army Corps of Engineers
(LUMP)

The proposed ship channel west of the Atchafalaya River is poorly designed and out of balance with the natural processes operative in the area. This channel would cut directly through natural marshes, destroying the natural water circulation patterns and providing a direct path for saltwater intrusion. Levees associated with the channel would prevent large areas of marsh from receiving overflow from the Atchafalaya River. In addition, the Avoca Island cutoff channel east of the Atchafalaya River would have to be kept open for the drilling rig construction activities in Amelia. The offshore rigs constructed there cannot pass through the locks on the Intracoastal Waterway and therefore could not be taken through the proposed new channel west of the Atchafalaya River.
Rebuttal to LUMP
(Corps)

The need to study an area is not a justification for preservation. We have been studying the Atchafalaya Delta for 20 years and we know enough from the published literature to make national decisions about the use of our wetlands. It's time to stop studying and start doing something. LUMP's assertion that the study of the Atchafalaya Delta will help understand the dynamics of land loss in other coastal areas is ill conceived. The Atchafalaya Delta is in a building stage and is building over older deltas. The rest of the deltaic coastal plain is in a destructional phase of the delta cycle and was built over the exposed erosional surface of the continental shelf. How can the study of the constructional phase of a second-cycle delta help us understand the dynamics of the destructional phase of a first-cycle delta?
APPENDIX E

WILD LOUISIANA

BACKGROUND INFORMATION

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VANISHING WETLANDS
INTRODUCTION

A wetland is an area that is regularly wet or flooded and has a water table that stands at or above the land surface for at least part of the year. Coastal wetlands extend inland from estuaries and include salt marshes, tidal basins, and mangroves or mangrove-dominated marshes. Inland freshwater wetlands consist of swamps, marshes, and bogs.

Louisiana's coastal wetlands extend from the Pearl River on the Mississippi-Louisiana border to the Sabine River on the Texas-Louisiana border. This wetland region is vital to both wildlife and human life (Figure A).

Proper management is crucial to the survival of the coastal wetlands, which are inextricably tied to the quality of life in Louisiana. Not only do wetlands offer protection by buffering the force of storms, they also filter out pollutants from the agricultural, industrial, and domestic wastes that wash down through our waterways. Commercially the wetlands are important to fisheries, trapping, and hunting. Ecologically, coastal wetlands act as nursery grounds for aquatic species as well as wintering grounds for waterfowl.

Loss of wetlands means the loss of shelter and food for wildlife, the decrease in recreational grounds for outdoor enthusiasts, the loss of income to the commercial fishing and trapping industries in Louisiana, and the loss of hurricane buffer zones for storm surges from the Gulf of Mexico.

Louisiana coastal wetlands are disappearing at the rate of 50 square miles per year. Both natural and man-made factors interact to contribute to this loss. There must be balance between wetland use and wetland protection if Louisiana coastal wetlands are to survive.

COASTAL WETLANDS' MORPHOLOGY AND VALUE

The Mississippi River has altered its course at least six times over 7,000 years, creating major delta complexes extending from the Mississippi-Louisiana border to Vermilion Bay in south-central Louisiana. As the river builds a delta that expands farther and farther out into the shallow shelf areas of the Gulf of Mexico, its course becomes long and inefficient. It then seeks a shorter path to the Gulf, thereby changing the location of the delta (Figure B). The old deltaic

Figure B. Four of the delta lobes created by the Mississippi River.

Figure A. The coastal wetlands of Louisiana account for 40 percent of the nation's coastal wetlands.
lobe, no longer actively fed by river sediment, slowly erodes and subsides as its soft sediments compact, leading to deterioration and, finally, disappearance.

With new deltas always building, there was a continual net coastal land gain until the early 1900s when wetland loss in coastal Louisiana became greater than land building. Louisiana's wetland loss represents about 80 percent of the nation's annual loss of coastal wetlands.

Historically, the river's sediment load flowed into the wetlands and nurtured the coastal marshes. The lower Mississippi River has been leved to some extent for about 250 years, although failures in this system occurred periodically until the late 1920s. The U.S. Army Corps of Engineers succeeded in containing the river within the levees and floodways in Louisiana immediately after the devastating flood of 1927. Today, the river deposits most of its sediment load in the deep waters of the Gulf of Mexico beyond the continental shelf, thereby losing much potential for creating new wetlands (Figure C).

The one exception to this land loss is occurring at the Atchafalaya delta. In 1839, the removal of a log jam increased the flow of the Mississippi River into the Atchafalaya River. At present, 30 percent of the Mississippi's water and sediment is diverted by the Old River control structure into the Atchafalaya. This diversion has increased land building in Atchafalaya Bay, but not enough to offset land loss in other coastal areas.

Louisiana's coastal zone is one of our prime geological, biological, and cultural resources, containing 40 percent of the country's coastal marshes. These wetlands were formed by the nation's largest river, the Mississippi, which drains 41 percent of the United States and parts of Canada. The diversity and productivity of the plants and animals that inhabit the wetlands are unsurpassed in the United States (Figure D).

The majority of Louisiana's citizens live within 50 miles of the coast, and most of them depend on the healthy functioning of the wetlands for their livelihoods. Coastal marshes provide flood and hurricane protection, as they absorb storm surges and reduce flood damage. Their natural beauty and varied wildlife create an attraction for tourists from all over the world. The coastal area is a collage of cultures, including French, Acadian, Spanish, German, and American Indian.

Louisiana's wetlands are also of enormous commercial importance. According to recent figures from the U.S. Army Corps of Engineers, Louisiana wetlands produce $17 million worth of furs and hides and $680 million worth of commercial fish and shellfish annually. In addition, $299 million are spent each year on boating and sportfishing in the coastal area and $38 million on waterfowl hunting. The fur and hides produced represent 25 percent of the national totals.
nation's entire harvest. Louisiana has the largest coastal fish and shellfishery in the country, producing two billion pounds of fish and shellfish annually. This represents 30 percent of the nation's annual commercial harvest. The wetlands are the wintering ground for two-thirds of the ducks and geese that migrate south in the Mississippi Flyway each year. Louisiana's coastal wetlands and offshore waters produce about one-sixth of the nation's oil and one-third of its natural gas.

The Louisiana coastal zone is a geographic feature unique in the world. Preserving and protecting it for its natural beauty, commercial value, and cultural heritage is a responsibility of us all.

COMPONENTS OF LAND LOSS

Man-Made Influences

A major cause of coastal land loss is the reduction of sediments available for replenishing the wetlands. The construction of mainline Mississippi River levees prevents overbank flooding along the lower Mississippi. As a result, sediments carried by the river are swept out into the Gulf's deep water, where their land-building potential is lost.

Dredging removes sediment from the wetlands and allows saltwater intrusion. Access canals for oil and gas drilling, pipelines, and navigation channels provide a pathway for saltwater to invade wetland vegetation, which destroys the marsh by killing its plants (Figure E).

Spoil banks (piled-up dredged material) destroy wetlands by converting them to dry land. As this dredged material is deposited onto the marsh vegetation, it destroys it. Also, the natural flow of water into the wetlands near the channel is halted by the spoil bank and nutrients are no longer available for the vegetation (Figure F).

Diagrams of Natural Levee and Spool Bank

Figure E. The navigation channels and industrial canals dredged throughout Louisiana's coast aid saltwater intrusion.

Figure F. Spoil banks prevent the natural flow of water over the marsh, robbing vegetation of the nutrients needed for maintenance and growth.
Wetlands have been destroyed by converting them to dry land for urban development and agriculture. The draining and filling of coastal wetlands is another example of how man has contributed to the destruction of coastal wetlands. In addition, pollution from urban runoff and industrial waste can spoil water quality, kill plants, contaminate fish and shellfish, and reduce the abundance of wildlife.

The extraction of oil, gas, and groundwater can lead to land subsidence because, as these materials are removed, a sinking of the soil occurs. Bank erosion causes the widening of canals and natural waterways. As boat wakes wash against the banks, it can cause unprotected canals to double in width in as few as 20 years. As the amount of open water increases, so will the rate of land loss.

Natural Influences

Research has indicated that sea level has been rising at a rate of six inches per century worldwide. A greenhouse effect—the gradual warming of the earth's atmosphere—may result from increased CO₂ emissions into the atmosphere. The CO₂ acts as a barrier, trapping heat radiated from the earth's surface. The global warming of the earth's atmosphere may cause polar ice caps to melt, creating subsequent increases in sea levels worldwide.

Saltwater intrusion, the introduction of saline water into brackish and freshwater environments, kills existing vegetation and transforms the area into open water, or into a saltwater marsh if the intrusion is gradual. The resultant destruction of habitat deprives waterfowl and mammals of food and shelter.

Subsidence is the compaction and sinking of wetland areas when they no longer receive replenishment from the deposition of sand, clay, and mud through periodic flooding. This is counterbalanced in healthy wetlands by vertical accretion from sediment trapping and marsh build-up.

Hurricanes and storms may profoundly alter shoreline characteristics by shifting beach sands, breaching barrier islands, and flooding freshwater marshes, thus increasing salinity levels in these environments and killing freshwater plants. Pounding waves erode mud, clay, and sand, and water currents carry them away from the shoreline. Normal tidal movements also contribute to land loss by carrying eroded materials into coastal bays and lakes or out to sea (Figure G).

CONSEQUENCES

As the wetlands vanish, so do shelter and food for wildlife, including migratory waterfowl.
and shorebirds. Louisiana marshes form the largest wintering ground for migratory waterfowl in the United States. Two-thirds of the Mississippi Flyway's birds use Louisiana as their path. Research indicates that there is more shifting of water-bird nesting colonies in Mississippi, Alabama, and Louisiana than in the Atlantic coast states. In St. Bernard parish alone, wintering waterfowl numbers have been reduced from 250,000 to 20,000 in recent years, as saltwater intrusion caused by channel dredging has destroyed habitat. Estuaries are the nursery grounds for oysters, shrimp, crab, trout, mullet, flounder, and redfish. In fact, 90 percent of the species important to the seafood industry depend upon estuaries for nurture and growth.

Statistics indicate that there are 35,000 commercial fishermen in Louisiana, a number expected to increase because of the widespread unemployment caused by the decline of other industries in the state, and that the catch per trawl has fallen off 90 percent since the 1940s. It is also estimated that the loss of waterfowl hunting will exceed 336,000 recreational days by the year 2000.

Real Estate Loss

It is estimated that, in Louisiana, a wetland area the size of one football field is lost every 15 minutes. The wetlands are a natural storm buffer, providing protection to the coastal communities, which are already at the mercy of hurricanes. In Lafourche Parish alone, if coastal erosion continues unchecked, the parish will lose an estimated $240 million in land value, with an annual production yield of $39 million.

Freshwater Marsh Loss

As saltwater enters freshwater marsh areas, it destroys the marsh by killing the plants. If the intrusion is gradual, the fresh marsh may become a brackish marsh, but it will no longer shelter waterfowl and mammals requiring freshwater habitat. Thus, the ecosystem is drastically altered.

Loss of Quality of Life

Because the wetlands are vital to wildlife and to human life, it behooves us to be prudent in our use of these valuable resources. For generations, this coastal area has been blessed with an abundant wildlife and natural beauty, all very important to its citizens.

SOLUTIONS

While there are no short-term, easy solutions to the problems facing our wetlands, there are measures that can be taken to reduce the degree of land loss. Some of these measures come under the general classification of marsh management. This includes the construction of water control structures that regulate the flow of water into and out of the marsh. New vegetation can be planted to hold soil in place, to slow down water flow, to collect sediment, and to filter pollutants. However, improperly designed marsh management projects can actually increase land loss ratios.

Citizens can also push for legislation that will protect the wetlands. Laws can be enacted to limit the creation of new canals and waterways. Marsh burning and the use of marsh buggies can be curtailed. Boaters can be required to follow safe speed limits so that wake size is limited. Harsh penalties can be inflicted for the illegal dumping of pollutants into waterways or for any action that results in wetland destruction. Legislative bodies can encourage new technologies through economic incentives.

Freshwater diversion is one way to fight coastal erosion and saltwater intrusion. An increased flow from the state's major rivers and bayous into marsh areas can be accomplished by altering strategic canals and levees. This influx will inject nutrient-laden sediment, while diluting saltwater concentration in coastal bays and lakes.

The federal government is taking a more active role in wetland management by redefining the concept of "wetlands". The primary identification of wetlands will now be determined by soil moisture content, presence of aquatic plants, and the amount of hydrogen in the soil. This broader definition of wetlands will place larger areas under the protection of federal regulations.

Wetland rebuilding can be done through beach and barrier island restoration projects and by building marshes with materials from dredging projects. All of these solutions are expensive to implement but not nearly so expensive as the consequences if nothing is done to alleviate the problem of land loss.
GLOSSARY

Abiotic Factors - The nonliving or physical and chemical factors that impinge on organisms (salinity, temperature, oxygen).

Aesthetics - A condition or appearance that is beautiful to the eye.

Biotic Factors - Living organisms and their interactions with one another in their environment.

Carrying Capacity - The maximum population size that a given ecosystem can support for an indefinite period or on a sustainable basis.

Ecosystem - Self-sustaining and self-regulating natural community of organisms interacting with one another and with their environment.

Emigration - Movement of people or organisms out of an area to establish residence elsewhere.

Eutrophication - The enrichment of a body of water with nutrients, consequently reducing dissolved oxygen and, thus, favoring plant over animal life.

Greenhouse Effect - Mechanism that explains atmospheric heating caused by increasing carbon dioxide. CO₂ is believed to act as the glass in a greenhouse, permitting visible light to penetrate but impeding the escape of infrared radiation, or heat.

Habitat - Place where an organism or community of organisms naturally lives or grows.

Marsh - A type of wetland that is characterized by various types of grasses in a permanently flooded habitat. The types include inland marshes or bogs and tidal marshes (fresh, brackish, or saltwater).

Mortality - The death rate.

Niche - The description of the unique functions and habitats of an organism in an ecosystem.

Saltwater Intrusion - The phenomenon of seawater moving back into aquifers or estuaries. It occurs when the normal outflow of fresh water is diverted or removed for use.

Subsidence - The sinking down of part of the earth's crust because of compaction of the sediment below the surface. Withdrawal of fluids (e.g., water) can contribute to compaction.

Wetlands - Land areas that are flooded all or part of the time. These may be inland freshwater bogs, marshes, and swamps or coastal wetlands such as salt marshes, tidal basins, and mangrove swamps.
APPENDIX F
DIRECTIONS
AND
INSTRUMENTS

LOUISIANA ENVIRONMENTAL KNOWLEDGE TEST
NEW ENVIRONMENTAL PARADIGM SCALE
NOWICKI STRICKLAND SCALE
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VITA

Lyle Mark Soniat du Fossat was born in New Orleans, Louisiana, on November 28, 1948. He is the son of Joel Jean Soniat du Fossat and Margaret Boudreaux Soniat du Fossat.

He attended Warren Easton High School and Louisiana State University where he received a bachelor of science degree in 1975 and a master of science degree in 1977. He is a veteran, having served in the U.S. Navy as a member of Underwater Demolition Team 11, and SEAL Team One during the Vietnam theater of operations.

Presently working for the Louisiana Sea Grant College Program as a Marine Educator, he is a member of the Louisiana Science Teachers' Association, the National Science Teachers' Association, and the National Marine Education Association. He is the 1991 recipient of the Governor's Conservation Educator of the year award, achieved in part for the work upon which this study is based.

He is married to the former Karen Lee Meredith and has one daughter, Meredith Margaret.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Lyle Soniat

Major Field: Education

Title of Dissertation: The Effect of Instructional Videos and Simulation-Gaming Activities in the Environmental Science Curriculum on Knowledge and Attitudes

Approved:

S. Kim Macgregor
Major Professor and Chairman

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Date of Examination: May 18, 1992