Learning styles and attitude toward hypermedia

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Learning styles and attitude toward hypermedia

by

Charles Andrews Schlosser

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY

Major: Education (Curriculum and Instructional Technology)

Major Professor: Michael R. Simonson

Iowa State University
Ames, Iowa
1997
Graduate College
Iowa State University

This is to certify that the Doctoral dissertation of

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For the Graduate College
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CHAPTER 1. INTRODUCTION

This chapter has seven major sections. The first section introduces, by means of a scenario, an educational hypermedia program, Loess Hills Interactive, and describes its use by middle school students. The second section defines and describes hypermedia and its role in education. The third section discusses learning style and explores the theory base underlying the study, Jung's theory of psychological type, followed by an outline of the relationship between psychological type and learning style. The fifth section describes the research problem, and the sixth section lists the research questions asked. The final section describes the significance of the study.

Wednesday, Fourth Period

In a small room off a middle-school media center, four students—three boys and a girl—crowd around a television. Pointing a remote control at a black box near the television, they enter their names and a password, and are admitted to a hypermedia program, Loess Hills Interactive. On the television, a young man introduces himself as Justin, the host and narrator of the program. Although Justin is a real person, he stands in an artist's rendering of what is intended to represent a library interior.

Justin describes the program and then offers a tour of the library. There is a television and a shelf of videotapes with titles printed on their edges. Nearby, a small table offers references, including a dictionary and transcripts of the program. A large world map hangs on the wall, offering access to other maps. A nearby camera on a tripod offers photographs. An exit sign above a door indicates how students may exit the program.

Justin explains how each of these elements of the library may be used to learn about the Loess Hills, a geographically distinct region of western Iowa. He points out the icons the students will use to pause, advance, rewind, and stop the videos. He explains how students can seek on-screen help. He suggests a good starting point, a five-minute video about the origin and geology of the Loess Hills. Finally, Justin reassures the students that he will remain in the library, ready to help.

After deciding that Justin probably offers good advice, the students select the geology video, intently watching the screen. The video, featuring narration and music, is full-motion and is of high quality. The students laugh at a humorous segment, in which students of about their age
quiz small-town Loess Hills-area residents about the definition of “loess.” Later, the students rewind the video to view a segment a second time.

At the end of the video, an animated frog appears on the screen, holding a sign with a question mark. A multiple-choice question then appears on the screen, and the students hear Justin asking how the Loess Hills were formed. The students watch and listen as their four choices are presented, then choose the correct answer—that loose, wind-borne soil—“loess”—was deposited along the eastern bank of the Missouri River, the river that forms the western border of Iowa. The correct answer is rewarded with the reappearance of the frog, whose tongue darts out and back with a slurping sound, and who says, “Ya got it. Three points!” The children laugh and mimic the frog: “Ya got it. Three points!”

The points earned will be accumulated with points from subsequent questions to “buy” video clips, still photographs, maps, and text, from which a presentation may be assembled. The presentation by the four students will be the capstone of their class’ examination of the Loess Hills.

As the students explore Loess Hills Interactive, they answer questions on a worksheet. In hushed tones, they discuss the best strategy for finding answers to the questions. One student proposes watching the videos, while another suggests that reading transcripts of the videos would be more efficient, while a third student urges that the group consult the on-line dictionary. In the end, each of these strategies is tried, with varying degrees of success and enthusiasm.

It is clear that members of the group have differing interests and motivations. One of the students is especially interested in pelicans, and seeks as much information about them as is available: video, a still photograph, and text. Another student enjoys watching videos, to the exclusion of the other program options. A third student, motivated by the quizzes, wants to answer as many questions as possible. The fourth student seems content to do whatever the rest of the group members want to do.

At one point, the image on the television screen freezes. This problem has happened while other groups used the program, so the students are prepared. They reset the program, reenter their group name and password, and continue. The malfunction costs the group about five minutes.

At the end of their 45-minute session with the program, the students shut off the television and head to their next class. They will return to the media center for one period in each of the next three days, for a total of about three hours with the program. On the fifth day, the group will
make a presentation about the Loess Hills to their classmates.

**Loess Hills Interactive**

"Wednesday, Fourth Period," is a composite of student encounters with *Loess Hills Interactive*, a hypermedia product developed by Iowa Public Television (IPTV) and pilot-tested in the spring of 1996. Four Iowa middle schools, five science teachers, and approximately 300 students in grades 6, 7, and 8 participated in the project. An evaluation of *Loess Hills Interactive* and its implementation, by Schlosser and Adamson (1996), indicated that the students and teachers who participated in the pilot test found the program interesting and believed it to be of high quality (Appendix E).

At the core of the project was a two-hour program about the Loess Hills region of western Iowa. *Land of the Fragile Giants* had been broadcast by IPTV the year before, and had generated a companion book and traveling art exhibit.

Exploring ways to repurpose the hours of video that had been made at considerable cost and, mindful of their educational mission, IPTV created an innovative hypermedia product. Building on IPTV strengths—high-quality video and access to Iowa’s statewide fiber-optic network, the development team rejected traditional storage media such as laser- or compact-disc. Instead, the program was stored on a video server at the network’s headquarters and distributed to schools via the Iowa Communication Network (ICN).

*Loess Hills Interactive* is just one of a growing category of instructional applications called hypermedia that have been created for instructional use. The following section will define hypermedia and briefly outline its history, characteristics, and applications.

**Hypermedia**

Hypermedia may be defined by describing the two technologies from which it is descended: multimedia and hypertext. Multimedia, a term used since the 1950s (Burton, Moore, & Holmes, 1995) is the older of the two antecedents. As its name implies, it is "the use of multiple media formats for the presentation of information" (Tolhurst, 1995, p. 25). In practice, multimedia may include text, video, audio, graphics, and still photos. Multimedia applications may be as simple as a filmstrip with accompanying recorded narration or soundtrack, or as technically sophisticated as
a computer-controlled program combining slides, video, and sound.

Hypertext is "nonlinearly organized and accessed textual information" (Tolhurst, 1995, p. 25). The concept of hypertext, embodied in a hypothetical machine called a "memex," was first described in 1945 (Bush, 1945). The first commercial applications of hypertext were developed in the late 1960s. Computer-based, they allowed the creation of text as well as the rapid, non-linear retrieval of text. In practice, it is accepted that hypertext may include graphics, such as diagrams, pictures, and tables, but not moving images (such as video) or audio (Tolhurst, 1995).

Hypermedia has sprung from both multimedia and hypertext. Like multimedia, hypermedia allows the use of a variety of media, including text, audio, graphics, still images, and video. Like hypertext, it allows rapid and non-linear access to information. At the center of all hypermedia systems is the computer. Hypermedia may be defined as "any computer-based system that allows the interactive linking, and hence nonlinear traversal, of information that is presented in multiple forms that include text, still or animated graphics, movie segments, sounds, and music" (Tolhurst, 1995, p. 25).

The theoretical underpinnings of hypermedia are an amalgam of its predecessors' theoretical bases. From multimedia comes the belief that media complement each other, that the use of multiple media is superior to the use of any single medium, thereby facilitating instruction and learning. From hypertext comes the belief that the human mind operates in an associational, non-linear manner, and that the special power of hypermedia is that its design mimics the way people think (Bush, 1945).

While the concept of hypermedia dates from the 1960s, it was not until the 1980s that significant hypermedia applications appeared. An early example was the Electronic Encyclopedia, a prototype of which was introduced in 1984. Although it was primarily text-based, its developers proposed a number of forward-looking features, including that of a humanlike guide to assist users with searches (Myers and Burton, 1994), a feature included in Loess Hills Interactive (with its host, "Justin").

HyperCard, a hypermedia program introduced by Apple in 1987, was bundled with Macintosh computers, thereby having significant impact. For the first time, microcomputer users, even those with only modest levels of expertise, could create hypermedia products incorporating a wide variety of media. In 1988, IBM introduced LinkWay, a hypermedia program for use with
DOS-type computers.

Hypermedia authoring programs have grown in sophistication in the intervening years. However, sophisticated hypermedia applications have proliferated at an even faster rate. The best-selling encyclopedia is now Microsoft’s Encarta, on CD-ROM.

The defining characteristics of hypermedia—use of multiple media, nonlinear access to data, and learner control of pace and path through hypermedia programs—have led educational researchers to speculate upon and investigate the potential of hypermedia to adapt to students’ learning styles. In the following section, the subject of learning styles will be introduced, with special emphasis on one conception of learning styles, Jung’s theory of psychological type.

**Learning Styles**

Lawrence (1993) defines learning styles broadly, addressing four aspects of psychological makeup:

1. Cognitive style in the sense of preferred or habitual patterns of mental functioning, information processing, formation of ideas, and judgments.

2. Patterns of attitudes and interests that influence what a person will attend to in a potential learning situation.

3. A disposition to seek out learning environments compatible with one’s cognitive style, attitudes and interests, and to avoid environments that are not congenial.

4. Similarly, a disposition to use certain learning tools, to use them successfully, and to avoid other tools (p. 39).

While there is general agreement on what learning styles are, there are considerable differences among psychologists and educators about the basis for the various learning styles, the names they are given, and the instruments that are used to determine them.

Among the better known conceptions of learning style are field-dependence/field-independence, usually measured with the Group Embedded-Figures Test. Four styles of learners, known as divergers, assimilators, convergers, and accommodators, are identified by the Kolb Learning Style Inventory. The Dunn, Dunn, and Price Learning Style Inventory assesses student preferences in four categories—environmental, emotional, sociological, physical—and identifies not only how students prefer to learn, but also under what conditions (Jordan, 1993).

Each of the preceding three conceptions of learning style has strengths, weaknesses—and
adherents. Type theory, another of the competing ways to describe and explain learning style, is introduced in the next section.

Psychological Type

The Swiss psychologist, Carl G. Jung, developed the theory of psychological type to explain human personality—the way individuals prefer to perceive and make judgments. In the book *Psychological Types*, published in German in 1920 and in English in 1923, Jung proposed that conscious mental activity can be classified into the two perception processes of sensing (S) and intuition (N) as well as the two judgment processes of thinking (T) and feeling (F) (Lawrence, 1993). To these two dimensions of personality—perception and judgment—Jung added a third, extraversion (E) versus introversion (I), to explain the individual's direction of interest—to the outer world of people, things, and experiences, or to the internal world of inner processes and reflections (Myers, 1993).

The mother-daughter team of Katharine C. Briggs and Isabel Briggs Myers expanded on the work of Jung in two important ways. First, Briggs and Myers determined that there is a fourth dimension of human personality; the individual's attitude toward the outside world, either judging (J) or perceiving (P) (Lawrence, 1993). Second, Myers developed, in 1943, the Briggs-Myers Type Indicator (renamed the Myers-Briggs Type Indicator, or MBTI), a test to determine an individual's psychological type. The MBTI identifies 16 distinct psychological types, each identified by a combination of four letters—one from each of the four dimensions of personality, such as ISTJ, or its opposite, ENFP (see Appendix A for brief descriptions of all 16 types). As Myers (1993) described these two personality types,

**ISTJ** = a person who

- I: Draws energy from and pays attention to the inner world
- S: Likes to take in information through the senses
- T: Prefers to use Thinking to make decisions
- J: Uses Judging in the outer world

**ENFP** = a person who

- E: Draws energy from the outer world of people and events
- N: Likes to take in information by seeing the big picture and making connections between facts
- F: Prefers to use Feeling to make decisions
- P: Uses Perceiving in the outer world (p. 6)
The MBTI is used in self-development, career development, relationship counseling, education and curriculum development, among many other applications. Although it is based on more than 50 years of research and development, and was first published in 1962, it was not widely available until 1975 (Lawrence, 1993). It is now the leading type-identifying instrument, with more than three million administered each year in the United States alone (Myers, 1993).

The MBTI has been validated for adults and children 14 years of age and older. Because the subjects of this study were in grades six through eight (about 11 to 13 years of age), the Murphy-Meisgeier Type Indicator for Children (MMTIC) was used to determine psychological type and learning style. The MMTIC, introduced in 1986, is based on the same theory and principles as the MBTI and uses the same terminology, but its 70 items are designed to be comprehended by children in grades two through eight.

The MMTIC reports type in the same manner as the MBTI, with one exception. The designation “U” (for “undetermined”) is used to indicate that the child may not have a firmly developed preference for one or more of the functions. So, if an introverted child who prefers the mental process of sensing and whose attitude toward the outside world is judging, but has no clear preference between the judgment process of thinking and feeling, the child’s type is reported as ISUJ.

Psychological Type and Learning Style

Learners with all 16 psychological types have distinct learning styles. However, because of similarities between the learning styles and because such a large number of learning styles can be unwieldy to study, it is common practice to examine learning style along only two dimensions: extraversion/introversion and sensing/intuition. Although the dimensions are sometimes examined separately, when the two dimensions are combined, the resulting four learning styles are: IS, IN, ES, and EN.

Zeisset (1991) offered brief descriptions of each of these four learning styles:

The IS student prefers learning situations that are practical and realistic, routine, give time to think through a problem, have clear step-by-step directions, and recognize the student’s ability to memorize facts and pay attention to detail. (p. 1C)

The IN student prefers learning projects that have important ideas behind them,
allow the student to follow his or her curiosity and creativity in depth with time to think things out, and have a minimum of routine and imposed standards. (p. 2C)

The EN student also likes projects that challenge the imagination and involve a minimum of routine, but this student wants to figure things out by trying ideas without facing penalties for mistakes and by working in a group. (p. 2C)

The ES student prefers to think out loud and work with a group in learning activities that involve concrete, hands-on experiences, have practical results, and meet specified goals on a realistic schedule. (p. 2C)

IS types, theory would suggest, would have a favorable attitude toward hypermedia, as they tend to enjoy learning from computer-assisted instruction and films. ES types may particularly enjoy the opportunity to present their hypermedia-created reports to classmates. EN types would likely have a favorable attitude toward working through hypermedia programs with a group, while IN types, who generally prefer working individually, would likely have a negative attitude toward this use of hypermedia (Lawrence, 1993; Zeisset, 1991).

Theory would also suggest that learning style would likely influence the path students take through hypermedia programs. Students with an intuition preference are likely to appreciate the non-linear construction of the program, while sensing students are likely to prefer advancing though the program step-by-step.

With the recognition of varied learning styles has come pressure to tailor instruction to better accommodate those styles. Methods of instruction are tried, then replaced. Always the results are the same: the new method works well, but for a different group of students than the first method. No one method of instruction works equally well for all learners. Tailoring instruction for individual students is the ideal, but is a practical impossibility. This, however, is precisely what supporters of hypermedia claim as a unique characteristic of hypermedia.

The claims made for hypermedia have been extravagant (Maddux, 1994) but, so far, have been largely unsubstantiated. While a significant body of literature about hypermedia exists, the literature addressing the relationship between hypermedia and learning style consists primarily of anecdotal accounts and speculation based on theory. Although some empirical research has been conducted, it has been of small scale and of limited scope.
Statement of the Problem

A basic assumption of hypermedia design is that, because of its unique combination of attributes including its use of multiple media and the potential for high levels of learner control of pace and path, hypermedia appeals to all learners. Learning style theory and literature, however, suggest that no single instructional method appeals to all learners—that different types of learners, by their very nature, prefer different ways of learning. A primary purpose of this study was to address this apparent contradiction—that learners, regardless of learning style, have equally positive attitudes toward learning with hypermedia.

A second purpose of this study was the development of an inventory to gauge student attitude toward three defining elements of hypermedia: multiple media, learner control, and non-linearity.

Research Questions

1. Are there differences among students of four learning styles in their attitude toward learning with multiple media in a hypermedia lesson?

2. Are there differences among students of four learning styles in their attitude toward learner control of a hypermedia lesson?

3. Are there differences among students of four learning styles in their attitude toward non-linear use of a hypermedia lesson?

4. Are there differences among students of four learning styles in their overall attitude toward hypermedia?

Significance of the Study

While numerous studies have examined hypermedia and its use for instruction, and there is a significant body of literature on learning styles, little research has been reported on the relationship between these two concepts. The rapid adoption of hypermedia in the schools has been accompanied by increasing demand that student learning styles be addressed. To the extent that this study addresses the seeming contradiction between hypermedia and learning styles literatures, it makes a useful contribution.
Summary

It is generally accepted that hypermedia is unique, that it can do what no other instructional technology or method of instruction can do: provide an environment for learning that is equally effective and appealing for various types of learners. The study introduced by this chapter put this claim to the test.

This chapter defined and described hypermedia, learning styles, and the theoretical underpinning of the study, Jung’s theory of psychological type and two measures of psychological type; the MBTI and the MMTIC. A hypermedia program, Loess Hills Interactive, was described, along with a scenario illustrating its use. A statement of the problem addressed by the study and a list of the research questions to be examined were followed by an explanation of the significance of the study.

In the following chapter, the literature addressing the major concepts addressed by the study—hypermedia, learning style, and psychological type—will be reviewed.
CHAPTER 2. REVIEW OF THE LITERATURE

Introduction

This chapter contains six major sections. The first section contains a brief review of literature related to the issue of instructional media effects, a recurring theme in the field of instructional technology. This information provides a backdrop for the subsequent sections of this literature review. The second section discusses the theory of psychological type; the development of the theory by Jung, its expansion by Myers, the development of instruments measuring type, the use of these instruments in education, and research that has been conducted on and with these instruments. The third, closely related to the previous section, examines learning styles; the various ways learning styles are defined and measured, the importance of identifying learning styles and how they may be addressed in the classroom, and research that has been conducted on learning styles. The fourth section of the chapter discusses hypermedia; its essential characteristics, its philosophical and theoretical bases, the use of hypermedia in education, and research that has been conducted on hypermedia. The fifth section of the chapter describes and discusses prior research studies that have addressed psychological type, learning styles, and hypermedia in education. The final section summarizes the previous sections.

Instructional Media Effects

Media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition. (Clark, 1983, p. 445)

Whenever you have found a medium or set of media attributes which you believe will cause learning for some learners on a given task, ask yourself if another (similar) set of attributes would lead to the same learning result. If you suspect that there may be an alternative set or mix of media that would give similar results, ask yourself what is causing these similar results. It is likely that when different media treatments of the same informational content to the same students yield similar learning results, the cause of the results can be found in a method which the two treatments share in common...give up your enthusiasm for the belief that media attributes cause learning. (Clark, 1994, p. 28)

A belief in the powerful and unique effects of instructional media has been widespread and persistent (Thompson, Simonson, & Hargrave, 1996). Studies designed to discover and measure these effects, and to compare the effects of the many instructional media, have been conducted for
more than 70 years and have dominated the field of instructional technology. With few exceptions, however, these studies have shown that there is no significant difference in the educational effectiveness of media. As early as the 1960s, media were branded "mere vehicles" (Russell, 1993), but media-effectiveness and media-comparison studies continued to be conducted, with consistent "no significant difference" results.

A series of meta-analytic studies conducted in the late-1970s and early-1980s, however, seemed to indicate that computers possessed unique and powerful instructional effects. Instructional technologist Richard Clark (1983) reviewed decades of research and reanalyzed the meta-analyses and concluded that the studies had confounded media with instructional methods.

In a strongly worded article (Clark, 1983) that yielded at least one memorable, oft-quoted line, Clark called for an end to media comparison studies. By comparing media to grocery trucks, he pointed out that the important characteristics of instruction—its active ingredients—are the content of the instruction and the method of instruction used, not the medium by which instruction is delivered. Some media may be used to deliver instruction more efficiently or more inexpensively than others, but not more effectively. Counterintuitive as it seems, there is no significant difference in educational effectiveness among the many communication media.

Clark may have been justified in believing that the issue of media effects had been put to rest, but the issue was resurrected just over a decade later, in an article by instructional technologist Robert Kozma. Kozma (1994) accepted Clark's conclusion that decades of research had failed to identify effects unique to any one medium, but cited several factors that would justify that the media effects debate be reframed. In light of new, interactive computer technologies and the ascendancy of a cognitive psychology and constructivist theory, Kozma asked if "perhaps the appropriate question is not do but will media influence learning" (Kozma, 1994, p.7).

Kozma (1994) argued that "there is a certain urgency about this question and a reason to revisit it now. In the not-too-distant future, we will be faced with a situation where telephone, cable television, and digital computer technologies will merge" (p. 8). If educational researchers fail to understand or create a relationship between media and learning, he suggested, they may "find [them]selves on the sidelines of [their] own game" and the technologies...may be used primarily for interactive soap operas and on-line purchasing of merchandise with automatic funds transfer. Its educational uses may be driven primarily by benevolent movie moguls who design edutainment virtual reality
adventure games and the contribution of educational technologies will be minimal.

(p. 8)

In rebutting Kozma’s arguments, Clark (1994) was unswayed, reiterating his long-held and oft-cited position, clearly and forcefully:

In brief, my claim is that media research is a triumph of enthusiasm over substantive examination of instructional processes in learning and instruction. Media and their attributes have important influences on the cost or speed of learning but only the use of adequate instructional methods will influence learning....I claim that any absolutely necessary teaching method can be delivered to students by many media or a variety of mixtures of media attributes—with similar learning results. (p. 27)

Jonassen, Campbell, and Davidson (1994), agreed with both Kozma and Clark, but suggested that, given contemporary learning theory (constructivism), the two were debating the wrong issue. Instead, the debate and practice of instructional design should be shifted “from instruction-and media–centered to a learner–centered conception of learning” (p. 31). The proper focus of the debate, they argued, was upon “the role of media in supporting, not controlling, the learning process” (p. 31). For Jonassen, Campbell, and Davidson, media, especially computer-based media, are empowering tools that allow learners to create their own knowledge.

In offering an overview of the media effects debate, Termyson (1994) contrasted the “big wrench” position with an integrated approach. In Termyson’s terminology, proponents of the “big wrench” approach believe that media have clear and powerful effects. Such is their faith in these effects, that proponents of the “big wrench” may become evangelists for one or another medium. Into this category, Termyson places Kozma, with his advocacy of interactive learning environments such as ThinkerTools and the Jasper Woodbury series.

Contrasted with the “big wrench” approach is, in Termyson’s terminology, an “integrated approach” that “media do not improve learning but when linked to a given method within a specific situation can contribute to improved learning” (p. 26).

In summary, reaction to the Clark-Kozma media effects debate has been extremely varied. It has been noted that Clark’s position, while technically correct, may be too narrow (Reiser, 1994). Kozma’s position, on the other hand, has been judged useful but unpersuasive (Morrison, 1994). Others have suggested that both are correct but are arguing about the wrong thing (Jonassen, Campbell, & Davidson, 1994), or are both correct but from different perspectives (positivistic versus applied) (Ross, 1994). Finally, others, such as Shrock (1994) “...think they are both right and they
are both wrong. More specifically, I like Clark's research question and Kozma's research methods” (p. 52).

Hypermedia

Referring to a 1994 review of the multimedia literature, Burton, Moore, and Holmes (1995), commented, “What does the research say about multimedia and its interactive technologies [such as hypermedia]? Unfortunately, not much” (p. 364). The existing literature in the field, they noted, was plentiful, if not especially useful. “Though hypermedia is relatively new, there are hundreds of reports and studies about its implementation. However, most of them deal with the excitement of adopting this new technology or envisage its potential in education. Only a few of the reports are experimental studies” (p. 363).

The shortcomings of the multimedia literature noted by Burton, Moore, and Holmes did exist in 1994. However, the body of research has grown and, while much research remains to be done, it is now possible to offer research-based conclusions about hypermedia design and implementation. That said, much of the literature that can help shed light on hypermedia is, strictly speaking, about earlier, traditional computer-based instruction technologies.

Further, it should be noted that a number of problems challenge the generalizability of the existing research literature. Many studies are of very small scale and experimental studies often have very brief treatments. Further, there is a problem with terminology. There remains some confusion about just what exactly is computer-based instruction versus multimedia versus interactive multimedia versus hypermedia (Galbreath, 1992). Confusion also remains about related areas of interest, such as learner control (what is the learner controlling, and in what degree) and learning styles (whose conception of learning style).

Within the field of hypermedia, a number of research issues have come to the fore. Among them are learner control, cooperative learning, motivation, and use of hypermedia authoring systems as “cognitive tools.” In the following sections, the literature in these areas will be summarized. Learning styles and their role in students' use of hypermedia will be the subject of a separate, major section of this review of literature.
Learner Control

As discussed above, one of the defining characteristics of hypermedia is its provision of a high level of learner control—over choice of medium through which to learn, over pace of progress through a lesson, and over path through a lesson. It is this level of learner control that is touted as one of the main benefits of hypermedia. The idea of learner control is appealing because learners “should best know their own needs and are uniquely qualified to act on that knowledge” (Hannafin & Sullivan, 1995, p. 19)

At its most basic level, learner control refers to giving learners the opportunity to make choices for themselves in an educational environment. Learner control has been implemented in the classroom through contract systems, negotiated objectives, and flexible time frames. However, while learner control may be applied to many aspects of the learning experience, since 1980 learner control research has been primarily concerned with computer-assisted instruction, of which hypermedia is a subset (Hicken, 1992).

In the context of computer-assisted instruction, learner control refers to “…the design features...that enable learners to choose freely the path, rate, content, and nature of feedback in instruction” (Reeves, 1993, p. 821). At the other end of the continuum is program control, the opposite of learner control.

Because computer-assisted instruction programs vary widely in their location on the learner/program control continuum, and because the definition of learner control is so broad, it is sometimes difficult to determine just what learner control is, in practice. This is also why comparing and synthesizing studies of learner control can be so difficult. In discussing what he has termed “the ‘control of what’ question,” Reeves has noted that in some learner control studies the student controls context of examples, while in others the learner controls amount of review. The student may have control over something as simple as rate or order of screen presentation or as complex as “activation of multiple microworlds and support systems within a complex learning environment in which the learner virtually authors his/her own CBI” (Reeves, 1993, p. 823).

Learner control in computer-based instruction has been widely investigated, including expressed preferences for instructional methods, learners’ selection of events within an instructional sequence, and learner control and individual differences (Carrier, Davidson, Higson, & Williams, 1984). Although enthusiasm for learner control is high, the evidence of its effectiveness is mixed.
Allowing learners to choose their own method of instruction has “strong intuitive appeal,” but has received little empirical support. Students, it seems, tend to “prefer methods that they perceive will require less of them in terms of work, concentration or time” (Carrier, Davidson, Higson, & Williams, 1984, p. 49).

Learner control of events within computer-based instruction, the usual subject of “learner control” studies, has been extensively researched. Numerous studies have indicated that, given control of their pace and path through a program, learners will have a more positive attitude toward the program and computing in general (Hannafin & Sullivan, 1995). However, studies of learner achievement under varying conditions of learner/program control have yielded mixed results. While some studies have shown that achievement rises under conditions of learner control (Hannafin & Sullivan, 1995; Pridemore & Klein, 1993; Simsek, 1993), the bulk of studies have shown that students do no better or even worse under learner control than under program control (Hannafin, & Sullivan, 1995). In general, research has indicated that smaller amounts of learner control result in greater achievement gains than do larger amounts of learner control, and that performance may increase if the learner is offered even the perception of control (Hicken, Sullivan, & Klein 1992).

The mixed results of learner control research can be explained, in part, by individual differences. Carrier, Davidson, Higson, and Williams (1984) note that learners differ with respect to how well they “like self-control over events within instruction, ...will perform under such conditions, and ...will use their skills in executing such controls” (p. 50). Among individual differences that may affect students’ responses to learner control are ability, level of prior knowledge of subject or computer technology, learner locus of control, age, and cognitive style (Carrier, Davidson, Higson, & Williams, 1984; Hannafin & Sullivan, 1995).

While offering little support for achievement gains from learner control, studies have shown that the provision of learner control in computer-based instruction leads to increased motivation as well as a more positive attitude toward both the instructional program and the computer technologies used (Hannafin & Sullivan, 1995; Becker & Dwyer, 1994; Simsek, 1993).

Because of limited evidence of increased student achievement resulting from learner control in computer-based instruction and but because of the attitudinal and motivational gains from learner control, it has been proposed that instructional designers “offer the perception of control or
to allow learners to control instructionally benign aspects of the program...” (Hicken, 1992, p. 25).

Learner control studies have been criticized for employing too-brief treatments, for measuring inconsequential or irrelevant outcomes, for small sample sizes, and for large attrition rates (Reeves, 1993, p. 825). It should be noted that these criticisms have been lodged against much of the research conducted in the field of instructional technology in general and computer-based instruction/hypermedia in particular.

Cooperative Learning

Traditionally, computer-based instruction programs were designed for individual use. Hypermedia, with its presumed ability to adapt to individual interests and learning styles, has typically been viewed as appropriate for use primarily by individuals as well. The predominance of whole-group instruction and the relative scarcity hypermedia-capable computers in schools has led some observers, such as Maddux (1994), to suggest that “the future of interactive multimedia or hypermedia looks relatively bleak...” (p. 24). Cooperative learning, however, offers a practical solution to inadequate numbers of computers in classrooms and may offer significant advantages over traditional individualized hypermedia use.

Cooperative learning has been extensively researched. There is general agreement that this method of instruction is at least as effective as traditional instruction (Burton, Moore, & Holmes, 1995; Simsek, 1993). In a study of sixth-graders’ use of a computer-based tutorial, Temiyakarn and Hooper (1993) found that students in cooperative learning groups achieved at a higher level than did students learning individually. Cooperative learning groups (using a program offering learner control) “spent more time interacting with the lesson; they also checked their concept learning more than those in individual learning groups” (p. 1029). For Temiyakarn and Hooper, the study’s findings meant that “cooperative learning mediates deeper content processing and that achievement gains are the result of greater exploration in the learning process” (p. 1029).

If cooperative learning is generally agreed to enhance learning with computer-based instruction, such as hypermedia, there is less agreement on how to implement it (Litchfield, 1993), particularly as regards composition of the group (Simsek, 1993). In a review of the cooperative learning literature, Simsek (1993) noted that heterogeneous grouping is most common, that numerous
studies have indicated that students in heterogeneous groups learn more than students working alone, and that less able students, especially, benefit from heterogeneous grouping. However, some studies have shown that the performance of higher-ability students may be hindered by partners of lesser ability.

A study of fifth- and sixth-grade students' use of a computer-based tutorial in cooperative learning groups (Simsek, 1993) found that students in heterogeneous groups developed more positive attitudes and outperformed students in homogeneous groups. Students of lower ability benefited more from heterogeneous grouping than did students of higher ability.

The designers of Loess Hills Interactive were aware of the benefits—practical and instructional—of small-group use of computer-based instructional products, such as hypermedia. The program was designed specifically for use by cooperative learning groups of three to four students. Composition of these learning groups, whether heterogeneous or homogeneous, was left to the teachers' discretion.

Motivation

It is generally agreed that computer-based instruction, including hypermedia, is inherently motivating for students, although this may be primarily due to novelty (Lee and Boling, 1996, Litchfield, 1993). As computers and computer-based instruction are more fully integrated into schools, students' enthusiasm may wane and motivational elements of programs will likely become more critical. Among the factors which may affect learner motivation in computer-based instruction and multimedia programs are learner control and cooperative learning (discussed in previous sections, above), screen design (Lee & Boling, 1996), and humor (Teslow, 1995).

In reviewing the literature regarding screen design in computer-mediated instruction, Lee and Boling (1996) noted that aesthetically pleasing screen design "can attract and hold the learner's attention more successfully, and will promote cognitive learning better than, [designs]...constructed without regard for aesthetics" (p. 407). They cited the role of eye-catching (but legible) typography; graphical images that are "functional, elegant, appropriate, simple and economical, and consistent" (p. 404); and the selective use of animation and audio.

Although few published studies have addressed the role of humor in computer-based instruction, there is some evidence that the judicious use of humor may heighten learner

motivation. In citing studies of adult students' use of computer-based instruction programs, Teslow (1995) reported that humor seemed to have led students to "stick with instruction" and to have raised their level of concern about the subject matter, if not to have actually significantly improved learning and retention (p. 13). Teslow also noted the response of fifth- and sixth-graders to a humorous character in the Jasper Series, produced by the Cognition and Technology Group at Vanderbilt.

The developers of Loess Hills Interactive were aware that "motivation, for the learner, is the initial determining factor influencing everything in a learning event" (Litchfield, 1993, p. 5). Because of this, the program offered a moderate level of learner control; was intended to be used by small groups of learners; featured humorous elements and an attractive, easy-to-use interface.

**Hypermedia Authoring Systems as "Cognitive Tools"**

The hypermedia literature is largely devoted to use of hypermedia to access information. However, increasing attention is being given to the use of hypermedia authoring systems (such as HyperStudio or HyperCard) as "cognitive tools;" that is, use of such applications by students to create projects, thereby constructing their own knowledge.

The educational use of hypermedia authoring systems as cognitive tools is based, in part, on a branch of cognitive psychology called constructivism, which "holds that there is a real world that we experience. However, ...meaning is imposed on the world by us, rather than existing in the world independently of us" (Duffy & Jonassen, 1992, p. 3). Adoption of the constructivist perspective in the classroom may lead to a fundamental shift in the educational process—from teacher as transmitter of knowledge to collaborator, with the student, in the "knowledge construction process" (Jonassen & Reeves, 1996, p. 704).

The primary advantage of using hypermedia authoring systems as cognitive tools, supporters suggest, is "that students are likely to learn more by constructing hypermedia instructional materials than by studying hypermedia created by others" (Jonassen & Reeves, 1996, p. 704). As learners create hypermedia products, they are better able to integrate the information contained in them into new knowledge structures. In addition, students apply numerous skills, including those of project management, research, organization, representation, presentation, and reflection (Jonassen & Reeves, 1996). Student-created multimedia projects offer opportunities for
problem-solving, decision-making, higher self-esteem, and increased ability to function as self-directed learners (Agnew, Kellerman, & Meyer, 1996).

In their review of the literature, Jonassen and Reeves (1996) cited several research studies which examined middle school or near-middle school-age children’s use of hypermedia-authoring tools. In a 1994 study by Beicher, seventh- and eighth-grade students created a multimedia kiosk for a school. Jonassen and Reeves (1996) noted that, by combining “creative thinking...with real-world assignments, students learned the content, enjoyed the learning process, and recognized that they [had] created something worthwhile” (p. 705).

In a 1993 study by Lehrer, eighth-graders designed a lesson about the Civil War using the hypermedia program HyperAuthor. Although the students who created the lesson had high levels of involvement and engagement, they did no better afterward on a test of Civil War knowledge than did a control group that learned via traditional methods. However, interviews conducted a year later indicated that students in the design group retained more knowledge, and that knowledge was “richer, better connected, and more applicable to subsequent learning and events” (in Jonassen & Reeves, 1996, p. 705).

A related study, conducted in 1994 by Lehrer, Erickson, Love, and Cantrell, found that students who developed a hypermedia product about World War I exhibited increased on-task behavior and understood the benefits of the development process. Further, the students “developed generalizable skills such as taking notes, finding information, coordinating their work with other team members, writing interpretations, and designing presentations” (in Jonassen & Reeves, 1996, p. 705).

A study by Volker (1992) of K-12 students’ use of hypermedia authoring tools while learning about math and science, found that students believed that the process “helped the content come alive for them” (p. 872). However, the students felt that they “learned more about the technology than about the content area” (p 872).

Although Loess Hills Interactive is not a hypermedia authoring system, constructivist principles were incorporated into its design. An important feature of the program is the provision for learners to create their own multimedia presentations by capturing program elements (video clips, still photos, text, etc.). In this way, students may construct knowledge in personal, meaningful ways.
Learning Styles

Definitions of “learning style” are numerous and varied, reflecting the particular perspective of the person doing the defining. However, most definitions of learning style have a number of elements in common. Kalsbeek has defined learning style as “a person’s preferred approach to information processing, idea formation, and decision making; the attitudes and interests that influence what is attended to in a learning situation; and a disposition to seek learning environments compatible with these personal profiles” (in Cooper & Miller, 1991, p. 699). Sims and Sims (1995) suggest that learning styles are “the typical ways a person behaves, feels, and processes information in learning situations” (p. 195).

The different ways of defining and approaching learning style are reflected in the number of published instruments created to identify the different dimensions of learning style: at least 32 in 1991 (Sims & Sims, 1995). In the following section, the leading instruments will be identified and described.

Learning Style Instruments

Among the most widely-known of the instruments are the Dunn, Dunn, and Price Learning Style Inventory; the Kolb Learning Style Inventory; the Group Embedded-Figures Test; and the NASSP Learning Style Profile.

The Dunn, Dunn, and Price Learning Style Inventory (Dunn LSI) uses 104 true-false items to yield “22 variables relating to affective, physiological, and cognitive domains” (Fourqurean, Meisgeier, & Swank, 1990, p. 229). The Dunn LSI assesses five elements of learning style that “have been proven to correlate with and significantly affect student performance” (Jordan, 1993, p. 6): environmental, emotional, sociological, physical, and psychological. It is unique in its emphasis on environmental and physical elements of learning style (Sims & Sims, 1995). The Dunn LSI may be used at any grade level (between 3 and 12), is simple to administer and score, and is inexpensive (Jordan, 1993). The Dunn LSI has been called “the most reliable, most valid, and most widely used learning style instrument for school-aged children in the United States” (Jordan, 1993, p. 6). Others have acknowledged the widespread use of the Dunn LSI while noting that “it has received mixed reviews in the literature” (Fourqurean, Meisgeier, & Swank, 1990, p. 229).

The Kolb Learning Styles Inventory (Kolb LSI) identifies four learning styles that explain
how students perceive and process information:

- Divergers, who “prefer to grasp experience through the concrete, transforming it via reflective observation,”
- Assimilators, who “experience via abstract conceptualization, transformed through reflective observation,”
- Convergers, who “grasp experience through abstract conceptualization, transforming it through active experimentation,” and
- Accommodators, who “grasp experience through concrete experience, transforming it through active experimentation” (Jordan, 1993, p. 6).

The Group Embedded Figures Test (GEFT) identifies two learning styles: field independent and field dependent, measures of “how well a learner is able to restructure information based on the use of salient cues in a field arrangement” (Weller, Repman, & Rooze, 1994, p. 405). Field independent learners are better able to “perceive a particular relevant item in a ‘field’ of distracting elements” while field dependent learners “tend to be dependent on the total field and hence the parts embedded within the field are not easily perceived” (Hsu, Frederick, & Chung, 1994, p. 292). Because of this, field dependent learners tend to have greater difficulty learning when required to provide their own organization during learning (Hsu, Frederick, & Chung, 1994).

The National Association of Secondary School Principals (NASSP) Learning Style Profile (LSP) is a 126-item, multidimensional instrument whose unique feature is its “comprehensive assessment of cognitive style” (Frey & Simonson, 1993, p. 405). The LSP measures nine dimensions of cognitive style: analytical, spatial, discrimination, categorization, sequential, memory skills, visual perception, auditory, and emotive responses (Frey & Simonson, 1993).

The MBTI and the closely related MMTIC may also be used to identify learning styles. These two instruments are discussed within the context of Jung’s theory of psychological type, upon which both are based.

Psychological Type

In the introduction to Psychological Types, published in 1921, Carl Jung said the book resulted from 20 years of consideration of the phenomenon of type. However, he cited as a catalyst to thinking the personal and professional conflict between Sigmund Freud and Alfred Adler, with
whom he had worked closely during the years 1907-13. Freud and Adler had parted. bitterly. Although these two “had been working with the same kinds of cases, the same general body of data” (Singer, 1972, p. 160), they came to radically different explanations of the causes of neuroses. For Freud, neuroses were rooted exclusively in sexuality, while Adler believed that neuroses were rooted exclusively in the individual’s need for power (Singer, 1972).

While Jung found merit in each perspective, he realized, of course, that the two views were irreconcilable: “One simply cannot lay the two explanations side-by-side, for they contradict each other absolutely” (in Singer, 1972). The reason Freud and Adler could look at the same body of information but come to wildly different conclusions, Jung believed, was due to fundamental psychological differences between the two men:

But how comes it that each investigator sees only one side, and why does each maintain that he has the only valid view? It must come from the fact that, owing to his psychological peculiarity, each investigator most readily sees that factor in the neurosis which corresponds to his peculiarity. (in Singer, 1972, p. 163)

The theory Jung developed offers an explanation for some of the differences in human behavior. It explains how people prefer to take in information and how they organize that information and come to conclusions, as well as their orientation to the world (Myers, 1993).

Jung’s theory of psychological types has been faulted for being vague, with ill-defined concepts (Carlson, 1985), that “introversion” and “extraversion” are simplistic labels, and that the theory deals with end-products rather than processes (Samuels, 1985). Further, Jung has been taken to task for being unclear whether he regarded type as being innate and for failing to address type development (Samuels, 1985).

Criticisms of the MBTI

Although the MBTI is the leading measure of psychological type and is administered more than 3,000,000 times each year in the United State alone, it has attracted considerable criticism, on both theoretical and operational grounds. Critics have suggested that the MBTI distorts and contradicts Jung’s ideas (Bayne, 1995), neglects conceptual steps of the theory (Carlson, 1985) and, conversely, expands upon elements of type theory that Jung did not explicitly define or thoroughly develop (Murray, 1990). Observers have noted that, given the self-report nature of the MBTI, responses are easy to fake and that responses may be slanted in a direction deemed desirable by the
individual or institution administering it (Zemke, 1992). To some critics, claims for the explanatory power of the MBTI make it sound like a panacea (Zemke, 1992). Others fault type descriptions for being too vague and general (Bayne, 1995) and too positive, what one critic has called "vignettes of unrelenting virtue" (Bayne, p. 81).

Even McCaulley, who worked closely with Isabel Briggs Myers and was a founder of the Center for the Application of Psychological Type, acknowledges that "human personality is complex. No psychological measure can possibly describe any individual perfectly: no psychological instrument, including the MBTI, is perfect" (McCaulley, 1995, p. 10). Some criticisms of the MBTI, McCaulley believes, are not the fault of the instrument itself, but of "misuses of the Indicator, off-hand inaccurate statements, and popularizing applications in ways that trivialize the Indicator" (p. 10). McCaulley (1995) notes that critics will "alert us to areas where we need to expand our basic knowledge and competence," including:

- better normative data on distribution of types
- more comparisons with other, similar instruments
- identification of type differences in research which also describes mental activities
- expanded research in education, learning styles, and teaching styles
- quality research on type dynamics
- thorough examination of the psychometrics of the MBTI and research designs appropriate for the MBTI (p. 12)

A final, and significant, category of criticism of the MBTI (and of the MMTIC, after which it is patterned) is that of validity and reliability. These issues will be explored in the following section.

Validity and Reliability of the MBTI and the MMTIC

In his 1985 review of research on the MBTI, Carlson noted that relatively few studies on the reliability of the instrument had been conducted, and most of those were limited to studies of college students. However, the studies indicated satisfactory internal and test-retest reliability of the MBTI. The original reliability studies, reported in the MBTI manual, yielded split-half reliability correlations exceeding .80 (Carlson, 1985). However, the validity of the MBTI, Carlson noted, "remains in greater question than reliability" (p. 364). Comparisons of the the MBTI with
other measures of psychological type had offered support for construct validity, but a large proportion of the studies had examined only E-I scale, "leaving the question of validity of the bulk of the items on the MBTI still open to more thorough examination" (p. 364).

Five years later, in a 1990 review of research conducted on the MBTI, Murray noted that "its indices of reliability and validity have been extensively investigated and have been judged acceptable." Murray added, however, that only "four dimensions of the Myers-Briggs Indicator rather than 16 are well supported, although even these four may not reflect Jung's typological theory as accurately as the test authors hoped or claimed." Further research, including studies outside the "world of the university," Murray suggested, would "strengthen the value" of the MBTI (p. 1199).

Few studies have attempted to determine the reliability and validity of the MMTIC. In the initial research during development of the MMTIC, Meisgeier and Murphy (1987) examined three aspects of reliability of the instrument: internal consistency of discriminant function scores, reliability estimates for subgroups, and test-retest reliability. Validity of the instrument was addressed through examination of intercorrelations of preference scores and correlations with other instruments. Content validity was determined by having type experts evaluate each MMTIC item and the instrument as a whole.

Other Measures of Psychological Type

Lesser-known than the MBTI or the MMTIC as measures of psychological type are the Jungian Type Survey (JTS) and the Singer-Loomis Inventory of Personality (SLIP). The JTS, formerly known as the Gray-Wheelright Test, was introduced in 1964, only two years after the MBTI. It consists of 81 questions that yield six individual scales: introversion, extraversion, intuition, sensing, thinking, and feeling. Unlike the MBTI, the JTS does not yield a judging-perceiving scale, but does indicate dominant function and the degree to which a person uses each of their inferior functions. The JTS authors admit that the Survey is inadequately standardized and its validity is difficult to demonstrate (Karesh, Pieper, & Holland, 1994, p. 31). A comparison of the MBTI and the JTS found that the instruments "both indicated E-I with substantial agreement, S-N with moderate agreement, and T-F with limited agreement" (Karesh, Pieper, & Holland, 1994, p. 30).
The SLIP, while using terms similar to those of the MBTI, MMTIC and JTS, differs in structure and the way type is reported. The SLIP offers the subject 15 situations and eight ways of responding to each situation. The subject rates each of the eight possible responses on a scale of one to five, indicating the likelihood that the subject would respond in that way. Each of the responses suggests one of eight "cognitive mode preferences:" introverted intuition (IN), introverted sensing (IS), introverted thinking (IT), introverted feeling (IF), extraverted intuition (EN), extraverted sensing (ES), extraverted thinking (ET), and extraverted feeling (EF). Any combination of these eight scores is possible. The scores, when divided by the total of all the ratings, yield a percentage score that indicates the relative strength of each cognitive mode for the subject (Karesh, Pieper, & Holland, 1994).

The SLIP differs theoretically from the other three measures of psychological type in that its authors questioned Jung's assertion of bipolarity. Singer and Loomis asked if it was possible that thinking and feeling as well as sensing and intuition might not be opposites for all persons (Karesh, Pieper, & Holland, 1994). A study by Karesh, Pieper, and Holland (1994) indicated that the SLIP likely "measures something different from either the MBTI or the JTS, particularly on the sensation and thinking scales" (p. 37). The study also found "little support" for Singer and Loomis' challenge to type theory's bipolarity assumption (p. 37).

An alternative conception of psychological type, called temperament theory, identifies four temperaments: Idealist, Guardian, Rational, and Artisan. These four temperament correspond to the following combinations of psychological type: NF, SJ, NT, and SP (Fairhurst & Fairhurst, 1995). Although temperament may be identified through use of the MBTI or MMTIC, support for temperament theory is primarily anecdotal (Bayne, 1995).

**Type Theory, the MBTI, the MMTIC, and Learning Styles**

It should be noted that neither the MBTI nor the MMTIC were developed explicitly to identify learning style. Rather, they are instruments designed to identify psychological type (Myers, 1993; Meisgeier & Murphy, 1987). However, type theory, especially as formulated by Myers, recognizes the role psychological type plays in the learning process. Both instruments are commonly used to identify learning style. This is especially true of the MMTIC, which was, its creators note, "developed by educators for educators" (Meisgeier & Murphy, 1987, p. 1).
As noted in chapter one, when psychological type is used as a measure of learning style, it is common practice to truncate the 16 psychological types identified by the MBTI or MMTIC into four learning styles. The resulting "quadrants" are IS, IN, ES, and EN. Although this is done partly for practical reasons—a study would require a very large sample to ensure adequate representation of all 16 types—there is theoretical justification as well. As Zeisset (1991) notes,

The Extraversion-Introversion preference shows the preferred setting for learning. Does the student prefer to work in a group setting with opportunities to think aloud, try out ideas on others, and do what others do, or does the student prefer to learn as an individual, thinking quietly, working out ideas alone before trying them on others, and setting one's own standards? (p. 1C)

The sensing-intuition preference indicates the learner's preferred way of perceiving: Does the student learn best through the five senses, concrete experiences, practical application, and in moving through the learning experiences in a step-by-step manner, or does the student learn best through experiences that engage the imagination, through following hunches and inspirations, though looking for hidden meanings, relationships, patterns, symbols, and possibilities? (p. 1C)

In spite of theoretical support for the learning-style quadrants, studies that have addressed psychological type and computer-based instruction or related technologies have tended to examine each of the four dimensions of type separately. That is, studies have compared introverts with extraverts, sensing types with intuitive types, thinking types with feeling types, and judging types with perceiving types (Dawson & Guy, 1994; Grant, 1991; Alberty, 1987; Anderson, 1987; Petrone, 1987; Howard, 1986; Hammer, 1985). Murphy (1990) supported examination of learners' sensing-intuition and thinking-feeling dimensions independently, noting that "the S-N and T-F scale differences seem to be more keenly felt when there is learning occurring. These are the 'learning' differences" (p. 32). Other studies, such as one by Orr and Davidson (1993) have examined only the introvert-extravert dimension. Although such an approach makes practical sense when the sample is small, such studies fail to capitalize on the power of "type dynamics," the interaction of more than one dimension of type.

Although the psychological type literature abounds with applications of the MBTI and MMTIC as measures of learning style, such use has not received universal support. In comparing the MMTIC with two learning style inventories, one of the MMTIC's creators could find support only for the introversion-extraversion and judging-perceiving scales as useful measures of learning style (Fourquarean, Meisgeier, & Swank, 1990).
Davis (1985), however, found support for the MBTI (from which the MMTIC is derived) as a measure of learning style. When the MBTI and the Dunn, Dunn, and Price Learning Styles Inventory (LSI) were administered to 400 high school students, significant correlations between the two instruments were found. Of the 22 learning style elements of the LSI, 11 correlated significantly with the extraversion-introversion dimension of the MBTI, eight elements with the judging-perceiving dimension, seven with the sensing-intuition dimension, and five with the thinking-feeling dimension. Further, the Davis study indicated that introverts preferred a formal design of learning, while intuitives, feeling types, and perceiving types preferred an informal design of learning.

Research on Learning Style and Computer-Based Instruction

The Group Embedded-Figures Test (GEFT), a measure of field-dependence/independence, has been used in a variety of studies examining learning with computer-based instruction (including hypermedia).

In a small-scale study of eighth-graders’ use of hypermedia-based instruction (HBI), Weller, Repman, and Rooze (1994) found that field-dependent and field-independent students were “served differently” by hypermedia-based instruction (p. 402). Field-independent students learned more effectively from an HBI program on computer ethics than did field-dependent students. Further, the two groups of students differed in the ways they sought information in the HBI program (via question-answering and accessing of concept applications) and in the frequency with which they accessed hypermedia nodes during instruction.

In a second, larger study, Weller, Repman, Lan, and Rooze (1995) compared eighth-graders from a magnet school with students from a non-magnet school. The study found that field-independent students learned more effectively from an HBI lesson about computer ethics than did field-dependent students. Further, students from the magnet school learned more effectively than did students from the non-magnet school.

Liu and Reed (1994) examined the relationship between learning styles and learning strategies of international college students using hypermedia in an intensive English course. After using the GEFT to identify the students as field-independent, field dependent, or field-mixed, Liu and Reed determined that the groups differed in their choice of media, tools, and learning aids in a
hypermedia environment. Significantly, all three groups learned equally well, in spite of their
different approaches to hypermedia, providing "some evidence to the assumption that
hypermedia-assisted instruction could fulfill its promise of accommodating learners with different
needs" (p. 432).

Larsen (1992) used the Kolb Learning Style Inventory in a study of adults' use of interactive
video instruction (IVI, a subset of computer-based instruction) in a course on data communication
concepts. No significant relationship was found between learning style and effectiveness of IVI as
an instructional medium. Nor was learning style a factor in students' satisfaction with IVI
technology. Larsen cited the flexibility of IVI design and use, which offered the type of instruction
appropriate for each learner. However, Larsen noted that novelty or "learner appreciation for
being provided with state-of-the-art instruction" (p. 20) may also have been factors.

Pearson, Folske, Paulson, and Burggraf (1994) integrated multimedia presentation
technologies into a college-level mass communication course. It was determined that students of all
learning styles (as measured by the Kolb LSI) liked the multimedia-presented course materials
equally well. Also, there were no significant differences among learning style groups in their belief
that they learned more when multimedia technologies were used, and that they made the class
more interesting.

Frey and Simonson (1993) investigated the relationship between cognitive style (as
identified with the NASSP Learning Style Profile) and college students' choice of media in a
hypermedia lesson about historic costume. The study found that "students with strong analytic
skills used text significantly more frequently than did students with average analytic skills" (p.
416). Further, "students with strong analytic skills or spatial skills chose audio significantly less
often than did students with average or weak scores" (p. 417), and "students with stronger spatial
skills used more text than did those with average or weak spatial skills" (p. 417). From this study,
Frey and Simonson concluded that "students used hypermedia effectively as an educational tool to
accommodate learning style. It was possible to individualize instruction regardless of the learning
style when the hypermedia system was used within the same instructional package" (p. 403).

Although few studies examining the relationship between psychological type and students' use of hypermedia have been published, a number of studies have used the MBTI and MMTIC to
identify learning style in studies of related technologies, primarily computer-based instruction.
Generally, the four dimensions of type are examined separately or, in some cases, only the introversion-extraversion dimension is explored.

Boos (1986) administered the MBTI, the GEFT, the Computer Anxiety Index (CAIN) and a test of computer aptitude to 170 pre-service elementary and secondary teachers. There was no significant correlation between GEFT scores and level of computer anxiety, nor was there a significant relationship between introversion-extraversion and an individual’s level of computer anxiety or aptitude. However, there was a significant correlation between GEFT scores and computer programming readiness.

Orr and Davidson (1993) examined fourth- and fifth-graders’ use of computer-based instruction in cooperative learning groups. They found no significant relationship between learning style (defined as introversion-extraversion-undetermined, as measured by the MMTIC) and performance on computer-based instruction. Nor did they find a significant relationship between learning style and attitudes toward the lesson.

In a small-scale study of college students enrolled in a television-assisted course, Dawson and Guy (1994) found that intuitives (as identified by the MBTI) received significantly higher grades than did sensing types. This was counter to expectations, but Dawson noted that the televised portion of the class did not cover the same material as the course readings, and that the course exams were oriented toward skills possessed by intuitives.

In a small-scale study of middle- and high school social studies teachers, Grant (1991) found that introverts tended to progress through an interactive multimedia lesson in a nonlinear way, while extraverts were linear and sequential in their use of the program. Further, intuitives tended to choose greater detail than sensing types, and introverts were inclined to choose more elaborative functions than did extraverts.

In a study of nearly 400 undergraduate college students’ response to computer-assisted instruction, Alberty (1987) found that introverts took significantly more time and made more mistakes than did extraverts. Further, intuitives took more time, made more mistakes, and had a poorer attitude toward technology than did sensing types. Alberty also found that feeling types took more time, made more mistakes, and had a poorer attitude than thinking types. Finally, perceiving types made more mistakes and had a poorer attitude toward technology than did judging types.
Teachers' level of concern regarding computers was explored by Petrone (1987). No relationship was found between the teachers' level of concern and their preferred mode of perception (sensing or intuition), mode of judgment (thinking or feeling), or a combination of the two modes.

Anderson (1987) found no significant relationship between college students' psychological type and their attitudes toward computer technology. In a study of undergraduate college students' use of a computer-based instruction program on metrics, Howard (1986) found no significant relationship between the students' psychological type and either the amount they learned or their attitude toward microcomputers. In an examination of the media preferences of adults, Hammer (1985) found that, counter to previous research, there was no significant difference between sensing and intuitive types in the amount they read.

Summary

Hypermedia, a practical reality only since 1987, was hailed as an instructional technology with the potential to change the student-teacher relationship and restructure schools, but also with potentially unpleasant side-effects such as high cost, cognitive overload, and user-disorientation (Marchionini, 1988). A decade later, the student-teacher relationship and the schools are mostly unchanged, costs have dropped, and users are plagued by neither cognitive overload nor disorientation.

Because of its defining characteristics of multiple media, nonlinear access to data, and learner control of pace and path, hypermedia has always had the potential to adapt to the varying needs of learners. A growing body of literature, however, offers contradictory findings. Students seem to be able to learn with hypermedia, but some (such as high-ability and field-independent learners) appear to learn more effectively than others. Changes in hypermedia structure, such as the amount of learner control provided, and changes in implementation, such as composition of cooperative learning groups, have, in some studies, affected achievement with and attitude toward hypermedia. However, other studies have indicated no significant relationship between learning style and either achievement or attitude.

It may be, as Reeves (1993) has suggested, that the quality of the research is not very good or the methodology is inappropriate. Or, it may be, as others have suggested, that learning style
instruments are blunt instruments. Or perhaps, as Jonassen and Reeves (1996) have suggested, that hypermedia has not, generally, been used to its potential.

This chapter has reviewed the literature of hypermedia and learning styles, emphasizing one conception of learning styles, psychological type. The following chapter will describe the methodology used in a study of middle-school students' learning styles and their attitudes toward hypermedia.
CHAPTER 3. METHODOLOGY

This chapter contains five sections. First, students who were the study's subjects are described. The second section describes the manner in which *Loess Hills Interactive* was implemented. The third section describes the instrument used in the study, emphasizing development of the Attitude Toward Hypermedia Index (ATHI). The fourth section lists the research constructs and the 24 items of which the ATHI is composed. The fifth section addresses scoring of the instruments and estimates of their validity.

Subjects

The subjects of this study were students from four public middle- (or junior-high) schools in four Iowa communities.

School 1 is located in a small farming community in south-central Iowa. Its approximately 115 students are predominantly white and lower- to middle-class. Participants in the project included 43 seventh-grade and 7 eighth-grade science students of a range of ability levels. Participants were selected students of a single teacher and were selected by that teacher.

School 2 is located in a medium-sized town in north-central Iowa. Its approximately 350 students are predominantly which and middle-class. Participants in the projects included 78 sixth-graders of a range of ability levels. Participants were representative students of a single teacher and were selected by that teacher.

School 3 is located in a suburb of Iowa's largest city. Its approximately 1040 students are predominantly white and middle-class. Participants in the project included 87 seventh-graders of a range of ability levels. All students from four classes of one teacher participated in the project.

School 4 is located in a small farming community in south-central Iowa. Its approximately 160 students are predominantly white and lower- to middle-class. Participants in the project included 41 seventh-grade and 59 eighth-grade science students of a range of ability levels. All students from six classes of two teachers participated in the project.

There were 167 females (53%) and 150 males (47%). The students were predominantly Caucasian (298), with smaller numbers of other ethnicities: Asian (9), Native American (6), Black American (1), and Hispanic (1). Two students did not report their ethnicity. Three hundred-seventeen students from three grades participated in the study: 78 sixth-graders (25%), 171
seventh-graders (54%), and 66 eighth-graders (21%). Two students did not report their grade level.

Implementation of Loess Hills Interactive

The following brief summaries describe whether Loess Hills Interactive was integrated into the curriculum, how students were assigned to groups and scheduled to use the program, where the groups worked, if they were able to do any presentations, and whether or not they were graded on their work.

School 1

The participating teacher originally planned to integrate the students' use of Loess Hills Interactive into a unit on earth science. However, because of a several-week delay in delivery of the program, the teacher was unable to incorporate it into the the course curriculum as planned. Selected students were assigned to groups of four by the teacher and each group was scheduled to use the program one 50-minute class period each week for three weeks. The television monitor was located in a classroom adjacent to the school's main office, on a different floor and at the other end of the building from the science classroom. Because of intermittent technical problems with the IPTV video server, students did not have enough time to complete their projects. Students were not graded on their participation in the project.

School 2

Loess Hills interactive was not integrated into the class work because the curriculum did not have a unit appropriate for the program. Students, assigned by the teacher to groups of four, were sent to a workroom adjacent to the media center in the adjoining high school. Over a four-week period, groups of students used the program for approximately 45 minutes in each of four consecutive days, and made their presentation to their classmates on the fifth day. Students were not graded on their participation in the project.

School 3

Loess Hills Interactive was fully integrated into a unit on ecosystems. Students were assigned by the teacher to groups of three, four, or five. The teacher escorted each of her classes to
the media center of the adjoining high school. While each group of students used the program, the teacher held class with her remaining students in the adjacent classroom. Each group used the program for one-and-a-half 45-minute periods, approximately once each week for three weeks. Groups made presentations to their parents at the conclusion of the project. Students were graded on their final projects.

School 4

*Loess Hills Interactive* was not integrated into the class work because the curriculum did not have a unit appropriate for the program. Students, assigned to groups of three, four, or five by the two participating teachers to groups, used the program in a small room located between an office and a classroom down the hall from their own classrooms. Because of technical problems in program delivery, students were able to use *LHI* for only two 45-minute class periods and were unable to complete their final projects. Students were not graded on their participation in the project.

**Instruments**

Two instruments were used in this study. The first, the Murphy-Meisgeier Type Indicator for Children (MMTIC) was used to identify the learning style of each subject. The MMTIC was described in some detail in chapter one.

A second instrument, the Attitude Toward Hypermedia Index, was designed by the researcher. An eight-step process, as described by Henerson, Morris, and Fitz-Gibbon (1987) was used to develop the instrument:

1. Identify...what specific information you hope to obtain from the questionnaire
2. Choose response format
3. Identify the frame of reference of the respondents
4. Write the questions
5. Prepare the data summary sheet
6. Critique questions; try them out and revise them
7. Assemble the questionnaire
8. Administer the questionnaire (p. 57)

The following describes in greater detail the process used for survey development.
Step 1: Identify what specific information you hope to obtain from the questionnaire

The purpose of the survey was to assess each student’s attitude toward hypermedia. A review of the literature relating to the history, definition, and use of hypermedia suggested three salient characteristics of hypermedia: use of multiple media, nonlinear access to information, and learner control of pace and path through hypermedia programs (Azarmsa, 1996; Franklin & Kinnell, 1990; Marchionini, 1988; Nielsen, 1990; Agnew, Kellerman, & Meyer, 1996). The learning styles literature has indicated that, depending on learning style, students may have a positive attitude toward one or more of these characteristics of hypermedia, but a negative attitude toward other characteristics.

These characteristics were identified as the three main constructs to be addressed in the study. A fourth construct, overall attitude toward hypermedia, was added later.

Step 2: Choose response format

Because of the large number of students to be surveyed, it was determined that closed-response format items would be most appropriate. Closed-response items have the advantages of allowing quick and accurate summaries to be produced and are also easily and quickly completed by students. A six-point Likert-type format was used for all items, ranging from strongly-disagree to strongly agree.

Step 3: Identify the frame of reference of the respondents

Henerson, Morris, and Fitz-Gibbon (1987) note the need to determine the appropriate reading level and knowledge level of respondents. Given that respondents would be middle school students, the reading level of the questionnaire could be no higher than sixth-grade, and preferably slightly lower. It was deemed particularly important to avoid technical jargon.

Potential respondents' hypermedia knowledge level was determined through visits to the schools participating in the Loess Hills Interactive (LHI) project. It was determined that students had used a small number of interactive multimedia or hypermedia programs in addition to LHI.
Steps 4 and 5: Write the questions and prepare the summary sheet

Approximately 30 items were written by the researcher, roughly evenly divided between the study's three main constructs. Additional items were contributed by students in a graduate-level instructional technology research seminar. The students were asked to generate statements regarding three constructs: attitude toward multiple media/symbol systems in interactive multimedia, attitude toward non-linear sequencing of concepts in interactive multimedia, and attitude toward learner control of interactive multimedia. A data summary sheet was prepared to organize responses to items and allow for interpretation of the responses during the next step in the development process.

Step 6: Critique questions; try them out and revise them

All items were sorted into categories corresponding to the three constructs addressed by the questionnaire. Items judged redundant, unclear, or unrelated to the three constructs were discarded.

The pool of items was further refined after students in the instructional technology research seminar responded to the items. In a procedure described by Henerson, Morris, and Fitz-Gibbon (1987), high scorers and low scorers were identified and their responses tabulated. Items that failed to provide good discrimination between high and low scorers were eliminated.

Next, middle school students enrolled in an ISU Family and Consumer Sciences program responded to the items. From the discussion that followed, the researcher learned that the items were written at a reading level too high for middle school students. Although the students had used interactive multimedia programs, they were unfamiliar with some of the terminology used, including the term "interactive multimedia" itself. A somewhat lower reading level and a definition of interactive multimedia were features of subsequent versions of the instrument.

From a review of the instrument by experts with the Research Institute for Studies in Education (RISE) at ISU, the researcher determined that the items were too wordy. Items in subsequent versions of the instrument were shortened through use of a stem. RISE researchers also noted that the instrument included too many questions, a conclusion supported when the instrument was subsequently administered to a small number of middle school-age children. In response, the number of items was reduced slightly. Twenty items designed to measure the three constructs of interest were included in the final survey, plus four items designed to ascertain student attitude
toward learning with hypermedia in general.

Step 7: Assemble the questionnaire

The 24-item instrument, now called the Attitude Toward Hypermedia Index (ATHI) was bundled with 23 items measuring student attitudes toward the Loess Hills Interactive (LHI) program and 20 items measuring student reactions to their small group experiences while using LHI, and 5 demographic items. The resulting 72-item self-report instrument, titled "Loess Hills Interactive Student Survey" (LHISS), was printed on both sides of an 11" X 17" sheet, folded to yield four 8 1/2" X 11" pages. Four versions of the instrument were prepared, each differing only in that the name of the school for which it was intended was printed on its cover.

Step 8: Administer Questionnaire

The LHISS (including the ATHI) was administered by the researcher during science classes in each of the four schools. In each class, directions were read to the students by the researcher. Approximately 20 minutes was required for completion of the survey—slightly more for sixth-graders, slightly less for eighth-graders.

The MMTIC was administered immediately after students completed the LHISS. In each class, directions packaged with the MMTIC were read to the students. Approximately 25 minutes was required for completion of the MMTIC. Again, slightly more for sixth-graders, slightly less for eighth-graders.

Except for the students who were absent the day the instruments were administered, all students who had used LHI completed the two instruments. Copies of the instruments were left with each teacher for later completion by the remaining students. These completed instruments were returned to the researcher within a week. As a result, the return rate was extremely high; virtually the entire population of students (315 of 317) who had used LHI completed the instruments.

Research Constructs and Final Set of Items

The ATHI consists of four constructs with a total of 24 items. These constructs and items (with stem) are listed below.
Attitude Toward Learning with Multiple Media

When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

24. ...I learn better.
27. ...I learn things better when I can see and hear them.
28. ...I think I can learn better from a videotape than from an interactive multimedia computer program.
33. ...It is more interesting than regular classroom instruction.
34. ...I think I can learn better from books.
36. ...The choice of text, video, photographs, drawings, and sound make learning more fun.
47. ...Choices between text, video, photographs, drawings, and sounds are confusing.

Attitude Toward Learning in a Nonlinear Manner

When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

25. ...I don't learn much because the lessons are so mixed up.
26. ...I think exploring and searching for information is a good way to learn.
30. ...I like to explore and search for information.
43. ...It is confusing.
45. ...Exploring and searching for information is a waste of time.
46. ...It is a good way to learn because it does not have to be used the same way every time.

Attitude Toward Learner Control

When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

32. ...I feel I have control of my own learning.
37. ...I like to set the pace of my own learning.
38. ...I'm not sure what I'm supposed to be learning.
39. ...I like it because I don't have to watch parts I don't want to watch.
40. ...I like it because it lets me learn on my own.
41. ...It is a waste of time because there is no clear purpose.
42. ...It lets me learn the way I learn best.

**Overall Attitude Toward Hypermedia**

When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

29. ...I think it is a good way to learn.
31. ...I think I learn as much as in a regular class.
35. ...I would rather learn in a different way.
44. ...I would like to try other interactive multimedia programs.

**Data Analysis**

Data from the Attitude Toward Hypermedia Index (ATHI) were coded by two researchers, working independently. The MMTIC employs a machine-scoreable answer sheet, but for this study the indicators were scored by hand.

**Reliability of the instruments**

Reliability of the constructs was estimated using Cronbach Alpha. Cronbach Coefficient Alpha estimates indicate that the four constructs of the ATHI are reliable, with coefficients of .63 (overall attitude toward hypermedia), .69 (learning with multiple media), .77 (learning in a nonlinear manner), and .77 (student control of learning).

The authors of the MMTIC (Meisgeier & Murphy, 1987), provide internal consistency (split-half) reliability estimates by scale for the test's original and cross-validation (in parentheses) samples: EL, .62(.65); SN, .68(.63); TF, .65(.64); JP, .72(.75) (p. 27). The authors note that, "although the magnitudes of the reliabilities are generally less than reliabilities reported
for the MBTI adult samples, they are comparable to MBTI student samples” (p. 24). However, “given the developmental nature of type, one would expect lower reliabilities in younger populations” (p. 24).

Summary

The learning styles literature has noted that no one form of instruction—or one medium—is equally appealing to all learners. It is generally accepted in the hypermedia literature, however, that hypermedia is fundamentally different. The unique characteristics of hypermedia, including use of multiple media, nonlinear access to information, and high levels of student control of pace and path, make it accessible to all learners, that it should meet the needs of all learners.

This chapter described the methodology of a study to determine if learners of all styles do, indeed, have similar attitudes toward hypermedia. The subjects of the study and their environment were described. The process of developing a standardized attitudinal measure was discussed in detail. The constructs to be measured and the items created to measure them were listed. Finally, data supporting the reliability of the two instruments used in the study were presented. The next chapter will present results of analyses of the data.
CHAPTER 4. RESULTS

Introduction

This chapter has four main sections. The first section presents results of the Murphy-Meisgeier Type Indicator for Children (MMTIC) that was administered to project participants as a measure of learning style. The second section presents results of the Attitude Toward Hypermedia Index (ATHI) that was administered to all project participants as a measure of attitude toward three central aspects of hypermedia, as well as toward hypermedia in general. The third section presents results of tests addressing each of the study's four research questions. The fourth section presents results of additional tests addressing questions that, while not posed at the study's outset, were nonetheless suggested by implementation of the Loess Hills Interactive (LHI) pilot study.

MMTIC Results

The MMTIC was completed by virtually all participants in the LHI project (315 of 317). Table 1 shows the distributions of the four dimensions of psychological type used to identify the 16 distinct psychological types and four learning styles, as well as the expected distributions (Meisgeier & Murphy, 1987c). Setting the MMTIC apart from its adult-oriented predecessor, the Myers-Briggs Type Indicator (MBTI), is the presence of the undetermined band ("U-band"), which indicates that some children may not have clearly-developed preferences along one or more dimensions of personality. Because the U-band was present in either the extraversion/introversion or sensing/intuition dimensions (those used to determine learning style) of 100 respondents and were therefore unusable for this study, only 215 subjects' responses were used to answer the research questions. This is consistent with the majority of studies appearing in the literature, in which the U-band is not analyzed.

In general, the distributions obtained through this study's application of the MMTIC are similar to the expected distributions. As indicated in Table 1, the extraversion/introversion and feeling/thinking distributions are quite close to the predicted distributions. The intuition/sensing distribution, while varying somewhat from expected, nevertheless retains the expected rank ordering of feeling, thinking, and U-band elements. Only in the judging/perceiving distribution does this study's MMTIC results vary from the expected, with many more perceivers and fewer judgers than anticipated. The practical relevance of this result for the current study is minimal,
Table 1. Distribution of four dimensions of psychological type and expected distribution

| Dimension      | N   | %    | Expected %
|----------------|-----|------|------------
| Extraversion   | 207 | 65.7 | 55         |
| U (Undetermined)| 59  | 18.7 | 25         |
| Introversion   | 49  | 15.6 | 20         |
| Total          | 315 |      |            |
| Intuition      | 65  | 20.7 | 30         |
| U              | 48  | 15.2 | 22         |
| Sensing        | 202 | 64.1 | 48         |
| Total          | 315 |      |            |
| Feeling        | 195 | 61.9 | 64         |
| U              | 65  | 20.6 | 19         |
| Thinking       | 55  | 17.5 | 16         |
| Total          | 315 |      |            |
| Judging        | 29  | 9.2  | 28         |
| U              | 35  | 11.1 | 19         |
| Perceiving     | 251 | 79.7 | 53         |
| Total          | 315 |      |            |


however, as the judging/perceiving dimension is not normally used as a measure of learning style.

Distributions of the four learning styles identified by the MMTIC are indicated Table 2. Although the percentages of each learning style varies somewhat from expected, the rank order is as expected, with ES being most numerous, followed by EN, IS, and IN.

Table 2. Distribution of learning styles (no U-band) and expected distribution

| Learning Style | N   | %    | Expected %
|----------------|-----|------|------------
| EN             | 43  | 20.0 | 30.6       |
| ES             | 130 | 60.5 | 43.6       |
| IN             | 12  | 5.6  | 11.9       |
| IS             | 30  | 13.9 | 13.8       |
| Total          | 215 |      |            |

ATHI Results

The ATHI was created as a measure of student attitudes toward three critical aspects of hypermedia: learning with multiple media, non-linear access to data, and learner control of pace and path through a hypermedia lesson. A fourth construct, overall attitude toward hypermedia, was also measured.

The mean and standard deviation of student responses to the 24 individual ATHI items are listed in Table 3. The mean and standard deviation of each of the four constructs are also listed in this table. In general, students expressed very positive attitudes toward hypermedia, with means ranging from 3.72 to 5.16 (on a six-point scale) and almost all means well above 4.00. Means for the four constructs were all approximately 4.50, ranging from 4.47 to 4.68. Means for individual items within constructs varied somewhat, but items nonetheless discriminated between respondents and contributed to the constructs. Respondents who responded positively to one item tended to respond positively to other construct items, while those who responded less positively to one item tended to respond less positively to other items in the construct.

Several demographic items were included in the ATHI, including knowledge about the Loess Hills region of Iowa, ethnicity, grade level, and gender balance of the small groups within which the students worked. An overwhelming majority (80.5%) of students reported that they knew "nothing" about the Loess Hills region before using Loess Hills Interactive (LHI), while 16.5 percent of students reported knowing "a little" (Table 4).

The students participating in the LHI project were overwhelmingly (96.4%) white, with small numbers of other ethnicities (Table 5), about what would be expected in the four schools, their communities, and the state of Iowa. Students from three middle school-level grades participated in the study. Seventh-graders comprised just over half (53.7%), with sixth- and eighth-graders fairly evenly divided (24.8% and 21%), respectively (Table 6).

Students used LHI in small groups of three to five, whose gender balance varied. As shown in Table 7, there were five combinations, the most common being mostly females (32.7%), followed by mostly males (26.7%), equally male and female (22.5%), all female (10.5%), and all male (7.6%). Although gender balance was not a focus of this study, it was studied extensively in the early years of computer-based instruction, when it was feared that small groups dominated by boys would hinder girls' learning.
Table 3. Student responses to Attitude Toward Hypermedia Index

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>% SD</th>
<th>% D</th>
<th>% MD</th>
<th>% MA</th>
<th>% A</th>
<th>% SA</th>
<th>mean</th>
<th>s.d.</th>
<th>n</th>
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</thead>
<tbody>
<tr>
<td><strong>Attitude toward using multiple media</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>...I learn better.</td>
<td>1.9</td>
<td>3.5</td>
<td>5.7</td>
<td>20.0</td>
<td>34.0</td>
<td>34.9</td>
<td>4.85</td>
<td>1.18</td>
<td>315</td>
</tr>
<tr>
<td>...I learn things better when I can see and hear them.</td>
<td>2.2</td>
<td>1.6</td>
<td>3.5</td>
<td>12.1</td>
<td>31.7</td>
<td>48.9</td>
<td>5.16</td>
<td>1.11</td>
<td>315</td>
</tr>
</tbody>
</table>
| ...I think I can learn better from a videotape than from an interactive multimedia computer program.  
  
  ...It is more interesting than regular classroom instruction                      | 9.2  | 9.8 | 18.4 | 21.6 | 23.8| 17.1 | 3.92 | 1.53 | 315|
| ...I think I can learn better from books.                                         | 2.2  | 3.5 | 6.3  | 17.5 | 26.7| 41.3 | 4.82 | 1.38 | 315|
| ...I would rather learn in a different way.                                       | 3.8  | 6.0 | 12.7 | 22.5 | 20.3| 34.6 | 4.53 | 1.42 | 315|
| ...I think I can learn better from books.                                         | 2.2  | 1.9 | 4.1  | 16.2 | 34.0| 12.5 | 5.07 | 1.06 | 315|
| ...Choices between text, video, photographs, drawings, and sound are confusing.   | 5.0  | 6.0 | 10.5 | 21.3 | 30.8| 25.4 | 4.41 | 1.43 | 315|
|                                                                                   |      |     |      |      |     |      |      |      |   |
| **Attitude toward learner control of a hypermedia lesson**                        |      |     |      |      |     |      |      |      |   |
| ...I feel I have control over my own learning                                     | 4.1  | 2.9 | 3.8  | 26.0 | 31.7| 31.1 | 4.72 | 1.26 | 314|
| ...I like to set the pace of my own learning                                     | 3.5  | 1.0 | 5.4  | 19.4 | 34.3| 36.5 | 4.90 | 1.19 | 315|
| ...I'm not sure what I'm supposed to be learning                                 | 5.4  | 8.6 | 15.2 | 21.0 | 28.6| 21.3 | 4.23 | 1.44 | 315|
| ...I like it because I don't have to watch parts I don't want to watch.          | 3.5  | 4.1 | 8.3  | 17.1 | 30.8| 36.2 | 4.76 | 1.32 | 315|
| ...I like it because it lets me learn on my own.                                 | 3.2  | 3.8 | 6.7  | 21.3 | 35.2| 29.5 | 4.71 | 1.25 | 314|
| ...It is a waste of time because there is no clear purpose.                      | 4.8  | 5.4 | 9.5  | 18.7 | 23.2| 38.4 | 4.65 | 1.45 | 315|
| ...It lets me learn the way I learn best.                                        | 4.8  | 3.2 | 11.4 | 22.5 | 34.0| 23.8 | 4.50 | 1.31 | 314|

Scale: SD= strongly disagree (1), D= disagree (2), MD= moderately disagree (3), MA= moderately agree (4), A= agree (5), SA= strongly agree (6).

1Items are negatively worded; their scores have been reversed for ease of interpretation.
Table 3. (continued)

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>% SD</th>
<th>% D</th>
<th>% MD</th>
<th>% MA</th>
<th>% A</th>
<th>% SA</th>
<th>mean</th>
<th>s.d.</th>
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<tbody>
<tr>
<td><strong>Attitude toward non-linear use of a hypermedia lesson</strong></td>
<td></td>
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<tr>
<td>...I don't learn much because the lessons are so mixed up.</td>
<td>3.2</td>
<td>4.8</td>
<td>11.1</td>
<td>25.1</td>
<td>29.8</td>
<td>26.0</td>
<td>4.52</td>
<td>1.29</td>
<td>315</td>
</tr>
<tr>
<td>...I think exploring and searching for information is a good way to learn.</td>
<td>3.5</td>
<td>.6</td>
<td>6.7</td>
<td>22.9</td>
<td>34.6</td>
<td>31.7</td>
<td>4.80</td>
<td>1.18</td>
<td>315</td>
</tr>
<tr>
<td>...I like to explore and search for information</td>
<td>7.0</td>
<td>7.3</td>
<td>10.2</td>
<td>22.9</td>
<td>26.4</td>
<td>26.1</td>
<td>4.33</td>
<td>1.50</td>
<td>314</td>
</tr>
<tr>
<td>...It is confusing.</td>
<td>7.0</td>
<td>7.0</td>
<td>13.3</td>
<td>21.3</td>
<td>24.8</td>
<td>26.7</td>
<td>4.30</td>
<td>1.51</td>
<td>315</td>
</tr>
<tr>
<td>...Exploring and searching for information is a waste of time.</td>
<td>4.1</td>
<td>4.8</td>
<td>9.2</td>
<td>22.9</td>
<td>26.0</td>
<td>33.0</td>
<td>4.61</td>
<td>1.37</td>
<td>315</td>
</tr>
<tr>
<td>...It is a good way to learn because it does not have to be used the same way every time.</td>
<td>1.9</td>
<td>3.8</td>
<td>5.4</td>
<td>21.9</td>
<td>39.4</td>
<td>27.6</td>
<td>4.76</td>
<td>1.14</td>
<td>315</td>
</tr>
<tr>
<td><strong>Overall attitude toward hypermedia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...I think it is a good way to learn</td>
<td>2.9</td>
<td>1.6</td>
<td>5.1</td>
<td>21.6</td>
<td>32.7</td>
<td>35.6</td>
<td>4.88</td>
<td>1.17</td>
<td>313</td>
</tr>
<tr>
<td>...I think I learn as much as in a regular class</td>
<td>11.1</td>
<td>12.7</td>
<td>19.4</td>
<td>21.3</td>
<td>20.6</td>
<td>14.9</td>
<td>3.72</td>
<td>1.56</td>
<td>315</td>
</tr>
<tr>
<td>...I would rather learn in a different way.</td>
<td>4.4</td>
<td>6.3</td>
<td>10.2</td>
<td>25.4</td>
<td>27.0</td>
<td>26.7</td>
<td>4.44</td>
<td>1.38</td>
<td>315</td>
</tr>
<tr>
<td>...I would like to try other interactive multimedia programs.</td>
<td>5.4</td>
<td>3.2</td>
<td>6.7</td>
<td>13.0</td>
<td>29.5</td>
<td>41.9</td>
<td>4.84</td>
<td>1.40</td>
<td>315</td>
</tr>
</tbody>
</table>
Table 4. Level of student knowledge of the Loess Hills region

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
<td>247</td>
<td>78.5</td>
</tr>
<tr>
<td>A little</td>
<td>52</td>
<td>16.5</td>
</tr>
<tr>
<td>A lot</td>
<td>8</td>
<td>2.5</td>
</tr>
<tr>
<td>No response</td>
<td>8</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 5. Ethnicity of students participating in the *Loess Hills Interactive* project

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>296</td>
<td>94.0</td>
</tr>
<tr>
<td>Black American</td>
<td>1</td>
<td>16.5</td>
</tr>
<tr>
<td>Asian</td>
<td>9</td>
<td>2.9</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1</td>
<td>.3</td>
</tr>
<tr>
<td>Native American</td>
<td>6</td>
<td>1.9</td>
</tr>
<tr>
<td>No response</td>
<td>8</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 6. Grade level of students participating in the *Loess Hills Interactive* project

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sixth grade</td>
<td>78</td>
<td>24.8</td>
</tr>
<tr>
<td>Seventh grade</td>
<td>169</td>
<td>53.6</td>
</tr>
<tr>
<td>Eighth grade</td>
<td>66</td>
<td>21.0</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>.6</td>
</tr>
</tbody>
</table>

Table 7. Gender composition of student groups in the *Loess Hills Interactive* project

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All males in group</td>
<td>24</td>
<td>7.6</td>
</tr>
<tr>
<td>All females in group</td>
<td>33</td>
<td>10.5</td>
</tr>
<tr>
<td>Mostly males in group</td>
<td>84</td>
<td>26.7</td>
</tr>
<tr>
<td>Mostly females in group</td>
<td>103</td>
<td>32.7</td>
</tr>
<tr>
<td>Equally male and female</td>
<td>71</td>
<td>22.5</td>
</tr>
</tbody>
</table>
Research Question Results

This study had four research questions. In this section, results of tests designed to answer these questions will be presented.

Research Question One: Are there differences among students of four learning styles in their attitude toward learning with multiple media in a hypermedia lesson?

A one-way analysis of variance (ANOVA) found no significant differences among the four learning style groups in their attitude toward learning with multiple media in a hypermedia lesson (Table 8). The lack of significant differences among the four learning styles made further, post-hoc, analysis unnecessary.

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>2.49</td>
<td>.83</td>
<td>1.42</td>
<td>.24</td>
</tr>
<tr>
<td>Within Groups</td>
<td>211</td>
<td>123.09</td>
<td>.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>125.57</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Learning Style

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN</td>
<td>43</td>
<td>4.87</td>
<td>.75</td>
</tr>
<tr>
<td>ES</td>
<td>130</td>
<td>4.66</td>
<td>.76</td>
</tr>
<tr>
<td>IN</td>
<td>12</td>
<td>4.40</td>
<td>.70</td>
</tr>
<tr>
<td>IS</td>
<td>30</td>
<td>4.72</td>
<td>.83</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>4.70</td>
<td>.76</td>
</tr>
</tbody>
</table>

Scale: 1=Strongly disagree, 2=Disagree, 3=Moderately disagree, 4=Moderately agree, 5=Agree, 6=Strongly agree
EN=Extraverted intuitive, ES=Extraverted sensor, IN=Introverted intuitive, IS=Introverted sensor

Research Question Two: Are there differences among students of four learning styles in their attitude toward learner control of a hypermedia lesson?

A one-way ANOVA found no significant differences among the four learning style groups in their attitude toward learner control of a hypermedia lesson (Table 9). The lack of significant
Table 9. Student attitudes toward learner control of a hypermedia lesson, by learning style

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>4.64</td>
<td>1.55</td>
<td>2.00</td>
<td>.12</td>
</tr>
<tr>
<td>Within Groups</td>
<td>211</td>
<td>163.16</td>
<td>.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>167.80</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Learning Style

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN</td>
<td>43</td>
<td>4.88</td>
<td>.77</td>
</tr>
<tr>
<td>ES</td>
<td>130</td>
<td>4.62</td>
<td>.88</td>
</tr>
<tr>
<td>IN</td>
<td>12</td>
<td>4.27</td>
<td>.83</td>
</tr>
<tr>
<td>IS</td>
<td>30</td>
<td>4.52</td>
<td>1.04</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>4.64</td>
<td>.89</td>
</tr>
</tbody>
</table>

Scale: 1=Strongly disagree, 2=Disagree, 3=moderately disagree, 4=moderately agree, 5=agree, 6=strongly agree
EN=Extraverted intuitive, ES=Extraverted sensor, IN=Introverted intuitive, IS=Introverted sensor

differences among the four learning style groups made further, post-hoc, analysis unnecessary.

Research Question Three: Are there differences among students of four learning styles in their attitude toward non-linear use of a hypermedia lesson?

A one-way ANOVA found no significant differences among the four learning style groups in their attitude toward non-linear use of a hypermedia lesson (Table 10). The lack of significant differences among the four learning style groups made further, post-hoc, analysis unnecessary.

Research Question Four: Are there differences among students of four learning styles in their overall attitude toward hypermedia?

A one-way ANOVA found no significant differences among the four learning style groups in their overall attitude toward hypermedia (Table 11). The lack of significant differences among the four learning style groups made further, post-hoc, analysis unnecessary.

It should be noted that this study violated one of the underlying assumptions of ANOVA, that "the distributions of the populations from which the samples are selected are normal" (Hinkle, Wiersma, & Jurs, 1988, p. 346). This is generally unavoidable, as psychological type is not
Table 10. Student attitudes toward non-linear use of a hypermedia lesson, by learning style

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>1.52</td>
<td>.51</td>
<td>.64</td>
<td>.59</td>
</tr>
<tr>
<td>Within Groups</td>
<td>211</td>
<td>166.38</td>
<td>.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>167.91</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Learning Style

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN</td>
<td>43</td>
<td>4.69</td>
<td>.93</td>
</tr>
<tr>
<td>ES</td>
<td>130</td>
<td>4.60</td>
<td>.89</td>
</tr>
<tr>
<td>IN</td>
<td>12</td>
<td>4.29</td>
<td>.75</td>
</tr>
<tr>
<td>IS</td>
<td>30</td>
<td>4.59</td>
<td>.86</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>4.60</td>
<td>.89</td>
</tr>
</tbody>
</table>

Scale: 1=Strongly disagree, 2=Disagree, 3=moderately disagree, 4=moderately agree, 5=agree, 6=strongly agree
EN=Extraverted intuitive, ES=Extraverted sensor, IN=Introverted intuitive, IS=Introverted sensor

Table 11. Student overall attitude toward hypermedia, by learning style

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>5.15</td>
<td>1.72</td>
<td>1.92</td>
<td>.13</td>
</tr>
<tr>
<td>Within Groups</td>
<td>211</td>
<td>188.25</td>
<td>.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>193.40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Learning Style

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN</td>
<td>43</td>
<td>4.80</td>
<td>.89</td>
</tr>
<tr>
<td>ES</td>
<td>130</td>
<td>4.48</td>
<td>.94</td>
</tr>
<tr>
<td>IN</td>
<td>12</td>
<td>4.33</td>
<td>.85</td>
</tr>
<tr>
<td>IS</td>
<td>30</td>
<td>4.33</td>
<td>1.05</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>4.52</td>
<td>.95</td>
</tr>
</tbody>
</table>

Scale: 1=Strongly disagree, 2=Disagree, 3=moderately disagree, 4=moderately agree, 5=agree, 6=strongly agree
EN=Extraverted intuitive, ES=Extraverted sensor, IN=Introverted intuitive, IS=Introverted sensor
normally distributed. However, “ANOVA is robust with respect to violations of the assumptions, except in the case of unequal variances with unequal sample sizes” (Hinkle, Wiersma, & Jurs, 1988, p. 348). Levene’s Test for Equality of Variances indicated that the variances in this study were homogeneous; therefore, the effect of the violation of this underlying assumption of ANOVA likely had a minimal effect on Type I error rate.

Additional Analysis

During implementation of the Loess Hills Interactive project, several unanticipated questions were suggested. In the following section, results of tests pertaining to project implementation, preexisting knowledge, gender, small group gender composition, and grade level will be presented. Tables will be presented only where significant differences were found. Because learning style was not a factor in these questions, it was possible to use data from all 315 participants in the Loess Hills Interactive project. Tests using data from only the 215 participants whose learning style was identifiable yielded similar results, however.

LHI Implementation and Attitude

Because LHI was implemented somewhat differently among the four participating schools, there existed the possibility that implementation may have affected student attitude toward hypermedia in general and LHI in particular. Significant differences were found in student attitude toward three critical characteristics of hypermedia, as well as toward hypermedia in general, among the four schools.

A one-way ANOVA indicated a significant (p <.01) difference in student attitude toward learning with multiple media among the four schools (Table 12). A Scheffe’ test with a significance level of .05 found a significant difference between students at schools 2 and 4 in their attitude toward learning with multiple media. Scores at school 2 were significantly higher than scores at school 4.

Similarly, one-way ANOVA also indicated a significant (p <.01) difference in student attitude toward learner control of a hypermedia lesson (Table 13). A Scheffe’ test with a significance level of .05 found a significant difference between students at schools 2 and 4 in their attitude toward learner control of hypermedia. Scores at school 2 were significantly higher than
Table 12. Student attitudes toward learning with multiple media in a hypermedia lesson, by school

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>12.03</td>
<td>4.01</td>
<td>7.46</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>311</td>
<td>167.18</td>
<td>.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>314</td>
<td>179.22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49</td>
<td>4.75</td>
<td>.88</td>
</tr>
<tr>
<td>2</td>
<td>78</td>
<td>4.95</td>
<td>.67</td>
</tr>
<tr>
<td>3</td>
<td>86</td>
<td>4.69</td>
<td>.68</td>
</tr>
<tr>
<td>4</td>
<td>102</td>
<td>4.44</td>
<td>.74</td>
</tr>
<tr>
<td>Total</td>
<td>315</td>
<td>4.68</td>
<td>.76</td>
</tr>
</tbody>
</table>

Scheffe' Test\(^1\)

<table>
<thead>
<tr>
<th>School</th>
<th>4</th>
<th>3</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.44</td>
<td>4.70</td>
<td>4.75</td>
<td>4.95</td>
</tr>
<tr>
<td>School</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

\(^1\)Level of significance=.05  
X=Significant difference between schools
Table 13. Student attitudes toward learner control of a hypermedia lesson, by school

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>12.68</td>
<td>4.23</td>
<td>5.99</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>311</td>
<td>219.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>314</td>
<td>232.29</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49</td>
<td>4.63</td>
<td>.96</td>
</tr>
<tr>
<td>2</td>
<td>78</td>
<td>4.94</td>
<td>.73</td>
</tr>
<tr>
<td>3</td>
<td>86</td>
<td>4.65</td>
<td>.77</td>
</tr>
<tr>
<td>4</td>
<td>102</td>
<td>4.40</td>
<td>.91</td>
</tr>
<tr>
<td>Total</td>
<td>315</td>
<td>4.64</td>
<td>.86</td>
</tr>
</tbody>
</table>

Scheffe' Test

School

<table>
<thead>
<tr>
<th>Mean</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.40</td>
<td>4</td>
</tr>
<tr>
<td>4.63</td>
<td>1</td>
</tr>
<tr>
<td>4.65</td>
<td>3</td>
</tr>
<tr>
<td>4.94</td>
<td>2</td>
</tr>
</tbody>
</table>

1Level of significance=.05
X=Significant difference between schools
Table 14. Student attitudes toward non-linear use of a hypermedia lesson, by school

One-way Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
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<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>34.78</td>
<td>11.60</td>
<td>15.86</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>311</td>
<td>227.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>314</td>
<td>262.06</td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
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<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49</td>
<td>4.61</td>
<td>1.02</td>
</tr>
<tr>
<td>2</td>
<td>78</td>
<td>5.07</td>
<td>.72</td>
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<tr>
<td>3</td>
<td>86</td>
<td>4.47</td>
<td>.73</td>
</tr>
<tr>
<td>4</td>
<td>102</td>
<td>4.19</td>
<td>.95</td>
</tr>
<tr>
<td>Total</td>
<td>315</td>
<td>4.55</td>
<td>.91</td>
</tr>
</tbody>
</table>

Scheffe' Test

<table>
<thead>
<tr>
<th>School</th>
<th>4</th>
<th>3</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.19</td>
<td>4.47</td>
<td>4.61</td>
<td>5.07</td>
</tr>
<tr>
<td>School</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

1^Level of significance=.05
X=Significant difference between schools
Table 15. Student overall attitudes toward hypermedia, by school

**One-way Analysis of Variance**

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>20.61</td>
<td>6.87</td>
<td>8.07</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>311</td>
<td>264.55</td>
<td>.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>314</td>
<td>285.16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49</td>
<td>4.24</td>
<td>.95</td>
</tr>
<tr>
<td>2</td>
<td>78</td>
<td>4.78</td>
<td>.77</td>
</tr>
<tr>
<td>3</td>
<td>86</td>
<td>4.65</td>
<td>.85</td>
</tr>
<tr>
<td>4</td>
<td>102</td>
<td>4.19</td>
<td>1.06</td>
</tr>
<tr>
<td>Total</td>
<td>315</td>
<td>4.47</td>
<td>.95</td>
</tr>
</tbody>
</table>

**Scheffe’ Test**

\[ \begin{array}{c}
\text{School} \\
4 1 3 2 \\
\end{array} \]

<table>
<thead>
<tr>
<th>Mean</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.19</td>
<td>4</td>
</tr>
<tr>
<td>4.24</td>
<td>1</td>
</tr>
<tr>
<td>4.65</td>
<td>3</td>
</tr>
<tr>
<td>X</td>
<td>X X X</td>
</tr>
<tr>
<td>4.78</td>
<td>2</td>
</tr>
</tbody>
</table>

1Level of significance=.05
X=Significant difference between schools
scores at school 4.

A one-way ANOVA also indicated a significant (p < .01) difference in student attitude toward nonlinear use of a hypermedia lesson (Table 14). A Scheffe' test with a significance level of .05 found a significant difference between students at schools 1 and 4, 2 and 1, 2 and 3, and 2 and 4. Scores at schools 1 and 2 were significantly higher than at school 4, and scores at school 2 were significantly higher than scores at schools 1 and 3.

Finally, a one-way ANOVA indicated a highly significant (p < .01) difference in student overall attitude toward hypermedia (Table 15). A Scheffe' test with a significance level of .05 found a significant difference between students at schools 1 and 2, 2 and 4, and 3 and 4. Scores at school 2 were significantly higher than scores at each of the other schools and scores at school 1 were significantly higher than scores at school 4.

Preexisting Knowledge and Attitude

Because preexisting knowledge of the Loess Hills region may have affected student attitude toward LHI, and therefore toward hypermedia, a one-way ANOVA was used to determine if there were significant differences in student attitude toward three critical aspects of hypermedia and toward hypermedia in general. No significant differences were found among knowledge-level groups in their attitudes toward learning with multiple media, learner control of a hypermedia lesson, nonlinear use of a hypermedia lesson, or hypermedia in general.

Gender and Attitude

Because previous research has found differences between genders in attitudes toward computers and learning with computers, a t-test was used to determine if there was a significant difference between boys' and girls' attitudes toward three critical aspects of hypermedia as well as toward hypermedia in general. No significant difference was found between the genders in their attitudes toward the three critical aspects of hypermedia or toward hypermedia in general.

Small Group Gender Composition and Attitude

A one-way ANOVA indicated that there were differences in student attitudes toward learning with multiple media, based on the gender composition of the small groups within which
Table 16. Student attitudes toward learning with multiple media in a hypermedia lesson, by group gender composition

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>4</td>
<td>7.19</td>
<td>1.80</td>
<td>3.24</td>
<td>.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>311</td>
<td>172.02</td>
<td>.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>314</td>
<td>179.22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender Composition</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>All males</td>
<td>24</td>
<td>4.27</td>
<td>.76</td>
</tr>
<tr>
<td>All females</td>
<td>33</td>
<td>4.81</td>
<td>.67</td>
</tr>
<tr>
<td>Mostly males</td>
<td>84</td>
<td>4.60</td>
<td>.74</td>
</tr>
<tr>
<td>Mostly females</td>
<td>103</td>
<td>4.82</td>
<td>.70</td>
</tr>
<tr>
<td>Equal</td>
<td>71</td>
<td>4.67</td>
<td>.83</td>
</tr>
<tr>
<td>Total</td>
<td>315</td>
<td>4.68</td>
<td>.76</td>
</tr>
</tbody>
</table>

Scheffe' Test

<table>
<thead>
<tr>
<th>Gender Comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 3 5 2 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender^2 Mean Comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.27 1</td>
</tr>
<tr>
<td>4.60 3</td>
</tr>
<tr>
<td>4.67 5</td>
</tr>
<tr>
<td>4.81 2</td>
</tr>
<tr>
<td>4.82 4 X</td>
</tr>
</tbody>
</table>

^1Level of significance=.05

^21=All males, 2=all females, 3=mostly males, 4=mostly females, 5=equal

X=Significant difference between schools
they used \textit{LHI} (Table 16). A Scheffe' test indicated that there was a significant difference between the attitudes of students in all-male and mostly-female groups toward learning with multiple media. Scores of the all-male groups were significantly lower than those of the mostly-female groups. No significant differences were found among students groups toward either of the other two critical characteristics of hypermedia or toward hypermedia in general.

Grade Level and Attitude

A one-way ANOVA indicated that there were significant differences in student attitudes toward three critical aspects of hypermedia as well as toward hypermedia in general, based on the grade level of the student. Scheffe' tests found significant (p < .05) differences were among students in all three grades (6, 7, and 8) in their attitudes toward all three critical aspects of hypermedia (Tables 17, 18, and 19). Scores of sixth-graders were highest while scores of eighth-graders were lowest in each case. A Scheffe' test also indicated significant (p < .05) differences between students in grades six and eight as well as between grades seven and eight in their overall attitudes toward hypermedia (Table 20). Scores of students in grades six and seven were significantly higher than scores of students in grade eight.

Summary

This chapter presented data gathered by two instruments: the Attitude Toward Hypermedia Index (ATHI), which was used to determine students' attitudes toward three critical characteristics of hypermedia as well as toward hypermedia in general; and the Murphy-Meisgeier Type Indicator for Children (MMTIC), which was used to identify students' preferred learning style. Further, the chapter presented results of tests that were performed on these data to answer the study's four research questions as well as several other questions that were prompted during implementation of the \textit{Loess Hills Interactive} project. The following chapter will offer a discussion of these results and conclusions that may be drawn from them.
Table 17. Student attitudes toward learning with multiple media in a hypermedia lesson, by grade level

One-way Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>13.26</td>
<td>6.63</td>
<td>12.41</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>310</td>
<td>165.60</td>
<td>.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>312</td>
<td>178.85</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grade

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>78</td>
<td>4.95</td>
<td>.67</td>
</tr>
<tr>
<td>7</td>
<td>169</td>
<td>4.69</td>
<td>.74</td>
</tr>
<tr>
<td>8</td>
<td>66</td>
<td>4.34</td>
<td>.76</td>
</tr>
<tr>
<td>Total</td>
<td>313</td>
<td>4.68</td>
<td>.76</td>
</tr>
</tbody>
</table>

Scheffe' Test

Grade

<table>
<thead>
<tr>
<th>Mean</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.34</td>
<td>8</td>
</tr>
<tr>
<td>4.69</td>
<td>7</td>
</tr>
<tr>
<td>4.95</td>
<td>6</td>
</tr>
</tbody>
</table>

1 Level of significance=.05
X=Significant difference between schools
Table 18. Student attitudes toward learner control of a hypermedia lesson, by grade level

One-way Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
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<td>15.87</td>
<td>7.93</td>
<td>11.37</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>310</td>
<td>216.33</td>
<td>.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>312</td>
<td>232.20</td>
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<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>78</td>
<td>4.94</td>
<td>.73</td>
</tr>
<tr>
<td>7</td>
<td>169</td>
<td>4.64</td>
<td>.85</td>
</tr>
<tr>
<td>8</td>
<td>66</td>
<td>4.27</td>
<td>.92</td>
</tr>
<tr>
<td>Total</td>
<td>313</td>
<td>4.64</td>
<td>.86</td>
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Scheffe' Test

<table>
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<tr>
<th>Gender</th>
<th>Mean Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8  7  6</td>
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<tr>
<td>4.27</td>
<td>8</td>
</tr>
<tr>
<td>4.64</td>
<td>7</td>
</tr>
<tr>
<td>4.94</td>
<td>6</td>
</tr>
</tbody>
</table>

1Level of significance=.05
X=Significant difference between schools
Table 19. Student attitudes toward non-linear use of a hypermedia lesson, by grade level

One-way Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>33.22</td>
<td>16.61</td>
<td>22.63</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>310</td>
<td>227.53</td>
<td>.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>312</td>
<td>260.75</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>78</td>
<td>5.07</td>
<td>.72</td>
</tr>
<tr>
<td>7</td>
<td>169</td>
<td>4.48</td>
<td>.85</td>
</tr>
<tr>
<td>8</td>
<td>66</td>
<td>4.13</td>
<td>1.01</td>
</tr>
<tr>
<td>Total</td>
<td>313</td>
<td>4.55</td>
<td>.91</td>
</tr>
</tbody>
</table>

Scheffe' Test\(^1\)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Mean</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4.13</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>4.48</td>
<td>X</td>
</tr>
<tr>
<td>6</td>
<td>5.07</td>
<td>X</td>
</tr>
</tbody>
</table>

\(^1\)Level of significance=.05
X=Significant difference between schools
Table 20. Student overall attitudes toward hypermedia, by grade level

One-way Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>Ratio</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
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<td>22.12</td>
<td>11.06</td>
<td>13.07</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>310</td>
<td>262.24</td>
<td>.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>312</td>
<td>284.36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grade  

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>78</td>
<td>4.78</td>
<td>.77</td>
</tr>
<tr>
<td>7</td>
<td>169</td>
<td>4.51</td>
<td>.91</td>
</tr>
<tr>
<td>8</td>
<td>66</td>
<td>4.01</td>
<td>1.10</td>
</tr>
<tr>
<td>Total</td>
<td>313</td>
<td>4.47</td>
<td>.95</td>
</tr>
</tbody>
</table>

Scheffe' Test

Grade

<table>
<thead>
<tr>
<th>Mean</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.01</td>
<td>8</td>
</tr>
<tr>
<td>4.51</td>
<td>7</td>
</tr>
<tr>
<td>4.78</td>
<td>6</td>
</tr>
</tbody>
</table>

1Level of significance=.05
X=Significant difference between schools
CHAPTER 5. DISCUSSION OF RESULTS

This chapter contains five major sections. In the first section, the study’s research problem and method will be briefly summarized. In the second section, results of tests of the study’s four research questions will be discussed. The third section will discuss results of additional analyses. The fourth section will suggest and discuss limitations of the study. The final section will offer suggestions for further research.

Learning Style, Hypermedia, and Attitudes

The concept of learning style is not new, nor is the desire to make instruction accessible to learners of all styles. However, adapting instruction to the needs of all learners has been far easier in theory than in practice, given the reality of schools, with their large classes and too-full day. Various instructional technologies, primarily computer-based, have been proposed as solutions for this problem. However, the computer-based programmed instruction of the 1960s was inadequate to this task, as was early-1980s microcomputer-based instruction. These programs, primarily drill-and-practice and tutorial, were appealing to students, at least initially, but did little that earlier (and often cheaper) technologies could not do.

Hypermedia, however, has been touted as fundamentally different from earlier computer technologies, and is beginning to be widely used in schools. Among the supposed advantages of the educational use of hypermedia is, because of its unique combination of characteristics, hypermedia appeals to learners of all styles. While this has been generally accepted, little research has been conducted on the link, if any, between learning style and attitude toward hypermedia.

This study examined middle school students’ attitudes toward hypermedia as they participated in the pilot study of an innovative hypermedia product called Loess Hills Interactive. Three critical characteristics of hypermedia were identified: the use of multiple media, the provision of learner control of pace and path through the hypermedia program or lesson, and non-linear access to information within the program or lesson.

Learning style of the students in this study was measured with the Murphy-Meisgeier Type Indicator for Children (MMTIC) (Meisgeier & Murphy, 1987). With its theoretical roots in Jung’s theory of psychological type, the MMTIC is essentially an adaptation of the Myers-Briggs Type Indicator, the leading instrument for identifying type in older children and adults.
The students' attitudes toward hypermedia were measured with a 24-item questionnaire, the Attitude Toward Hypermedia Index (ATHI). For this study, ATHI was one section of the Loess Hills Interactive Student Survey, a 72-item questionnaire which included items measuring attitudes toward specific elements of Loess Hills Interactive as well as toward the small group learning experience (Appendix C).

Four research questions were posed by this study, and data were collected and analyzed to answer them. In the following section, results of these analyses will be discussed.

**Discussion of Results: The Four Research Questions**

**Research Question 1: Are there differences among students of four learning styles in their attitude toward learning with multiple media in a hypermedia lesson?**

This study found no significant differences among students of the four learning styles in their attitude toward this critical characteristic of hypermedia. Students in each of the four identified learning style groups had uniformly positive attitudes toward learning with multiple media in a hypermedia lesson. This finding is consistent with the hypermedia literature, which suggests that the inclusion of multiple media means that each learner's preferred medium for learning is available. In Loess Hills Interactive, as well as most effectively-designed hypermedia software, the learner may choose among text, videos, still photos, graphics, and sound. Each of these media offers valuable characteristics and supports the other media, but one medium is more likely to be intellectually accessible to each learner.

**Research Question 2: Are there differences among students of four learning styles in their attitude toward learner control of a hypermedia lesson?**

This study found no significant differences among students of the four learning styles in their attitude toward learner control of a hypermedia lesson. Students in each of the learning styles groups expressed consistently positive attitudes toward this critical characteristic of hypermedia. This conclusion is consistent with the learner control literature, which suggests that when students are offered at least a modicum of control over the learning process, they tend to have more positive attitudes toward the instructional program and the technologies used (Hannafin & Sullivan, 1995; Becker & Dwyer, 1994; Simsek, 1993). The hypermedia literature, building on the
learner control literature, has suggested that, when learners have control over their pace and path through a hypermedia program or lesson, they tend to have a more positive attitude toward hypermedia. In *Loess Hills Interactive*, students controlled their path through the program, choosing among a variety of topics about the Loess Hills region, such as the land, the flora, the fauna, and so on. They also controlled the media used to communicate that information, including text, videos, still photos, graphics, and sound. Further, they decided when they were ready to be tested over aspects of the program. Finally, the students controlled the pace of the program, taking the time required for full comprehension of the information it contained.

Research Question 3: Are there differences among students of four learning styles in their attitude toward non-linear use of a hypermedia lesson?

This study found no significant differences among students of the four learning styles in their attitude toward non-linear use of hypermedia. Students in all four learning style groups were consistently positive in their attitudes toward this critical characteristic of hypermedia. Closely related, conceptually, to learner control of path through a hypermedia lesson, non-linear use of a hypermedia lesson refers to the ability of the learner to blaze a trail through information, accessing information directly and immediately. Using *Loess Hills Interactive*, the student whose interest in snakes was piqued by a still photo of a snake could choose to learn more about snakes by immediately accessing a video of a snake hunt or could access information about the types of land forms preferred by rattlesnakes. The ability to access large amounts of information in a non-linear manner has been at the very core of the hypermedia concept, from its first explication—Bush's "memex," in 1945—to its most recent form, the World Wide Web.

Research Question 4: Are there differences among students of four learning styles in their overall attitude toward hypermedia?

This study found no significant differences among students of the four learning styles in their overall attitude toward hypermedia. Students of all four learning styles expressed uniformly positive attitudes toward hypermedia. This result was to be expected, given the lack of significant differences indicated by the three preceding questions concerning critical characteristics of hypermedia.
Given the hypermedia literature, a lack of significant differences among students of four learning styles was expected. The learning styles literature, however, which suggests that no one medium or method of instruction will be equally appealing to all learners, is not as contradictory as one might at first imagine. This is because hypermedia-assisted instruction employs multiple media and its flexibility offers, in effect, a variety of forms of instruction.

The hypermedia literature, as well as the broader instructional technology literature, suggest three additional explanations for the finding of no significant differences among students of four learning styles toward three critical characteristics of hypermedia and toward hypermedia in general: novelty, the Hawthorne effect, and the content of the program.

The hypermedia literature cautions that hypermedia and other computer-related technologies are inherently interesting for students, at least for a time after their introduction. Because using hypermedia was relatively new and infrequent for most of the students in the Loess Hills Interactive project, it was possible that they were somewhat more likely to have a positive attitude toward its use, independent of the user's learning style.

A second alternative explanation for the relative uniformity of the students' attitudes toward hypermedia may have been the Hawthorne effect. The students who used Loess Hills Interactive knew they were part of a special project involving only four schools in the entire state, that their use of the program was being studied, and that their opinions about the program would be solicited and valued. Because of this, the students, regardless of their learning style, may have approached the program with greater seriousness and valued their experience more highly.

Finally, another reason for the relative uniformity of students' attitudes toward hypermedia may have been that the content of Loess Hills Interactive was inherently interesting to the students. Coupled with the students' relative lack of experience with other hypermedia programs, it may not be possible to fully separate their attitudes toward the content of the program and toward hypermedia in general.

The role of novelty and the Hawthorne effect, as well as the specific content of Loess Hills Interactive cannot be ignored as factors that may have contributed to the very positive attitudes of the students toward hypermedia, as indicated by their responses to the ATHI. However, they do not account for the lack of variation between learning style groups in those very positive attitudes toward hypermedia. It seems more likely than an explanation (or explanations) lies elsewhere.
For this reason, additional analysis were conducted. The results of those analyses are discussed in the following section.

Discussion of Results: Additional Analyses

Although there were no significant differences among students of four identified learning styles in their attitude toward three critical characteristics of hypermedia and toward hypermedia in general, significant differences were found when different groupings of students were examined. Significant differences were found among the four schools participating in the Loess Hills Interactive project, among small learning groups of varying gender balance, and among the three grade levels participating in the project.

Differences Among the Schools

Significant differences among the schools were found with regard to their students' attitudes toward three critical characteristics of hypermedia, as well as toward hypermedia in general. These differences will be discussed in the following section.

Attitude Toward Learning with Multiple Media in a Hypermedia Lesson

Student attitudes toward learning with multiple media fell into a vary narrow range of average scores at the four schools, from a low of 4.44 (on a six-point scale) at school 4 to a high of 4.95 at school 2. The attitudes of students at school 2 toward learning with multiple media in a hypermedia lesson were significantly more positive than the attitudes of students at school 4. There were no other significant differences among the other schools.

Attitude Toward Learner Control of a Hypermedia Lesson

The average scores recorded at the four schools were similar to the above, in that they fell into a narrow range, from a low, again at school 4, of 4.40, to a high, again at school 2, of 4.94. The attitudes of students at school 2 toward learner control of a hypermedia lesson were significantly more positive than the attitudes of students at school 4. There were no significant differences among the other schools in their students' attitudes toward this characteristic of hypermedia.
Attitude Toward Non-linear Use of a Hypermedia Lesson

The average scores recorded at the four schools for attitude toward non-linear use of hypermedia fell into the broadest range of the four categories of attitudes examined, from a low of 4.19, again at school 4, to a high of 5.07, again at school 2. This difference was statistically significant, as was the difference between school 1 (4.61) and school 4 (4.19). The mean at school 2 was also significantly higher than the means at schools 3 (4.47) and 1 (4.61).

Overall Attitude Toward Hypermedia

The average scores recorded at the four schools for overall attitude toward hypermedia fell into a fairly narrow range, but again the low was at school 4 (4.19) and the high at school 2 (4.78). This difference was statistically significant, as was the difference between school 3 (4.65) and school 4 (4.19). The mean at school 2 was again also significant higher that schools 1 (4.24) 3 (4.65).

Differences Among Schools and Implementation of Loess Hills Interactive

In each of the above cases, the attitudes of students at school 4 were least positive, while those at school 2 were most positive, with the two other schools vying for second and third positions. The consistency of these findings is striking. One explanation of the differences in attitude among students at the four schools may involve the way Loess Hills Interactive was implemented.

In only one of the four schools (school 3) was the program integrated into the curriculum of the class. Similarly, only at that school were students graded on their participation in the project, and at only two schools (2 and 3) did students complete and present final projects. Amount of time the students spent with the program also varied among the schools. At school 1, students used the program for three 50-minute periods; school 2, four 45-minute periods (plus a fifth day for presentations); school 3, three sessions of about 67 minutes each; and school 4, two 45-minute periods. Increased amount of time spent with Loess Hills Interactive may have led students to have more positive attitudes toward hypermedia in general; students at school 2, who consistently had the most positive attitudes toward hypermedia, spent about twice as much time with the program than did students at school 4, who consistently had the least positive attitudes.
A series of technology-related problems plagued the implementation of the *Loess Hills Interactive* project. The most significant result of these problems was a three-month delay in the beginning of the pilot test, complicating the integration of the program into each school's curriculum. During these three months, most of the "bugs" that prevented the new i-TV technology from properly functioning over the ICN were removed. However, as was alluded to in the introductory scenario (chapter one), the program continued to occasionally "freeze," requiring the program to be restarted. In most cases, students handled the restarts with ease, but precious contact time with the program was lost. The technical problems had, perhaps, the greatest impact at school 4, where contact time was shortened significantly.

Another difference among the schools was that students of varying grade levels participated in the *Loess Hills Interactive* project. This issue is addressed in the following section.

**Differences Among Grade Levels**

Although scores were, in general, very positive, significant differences were found among students of all three grades (six, seven, and eight) in their attitudes toward all three critical characteristics of hypermedia and, with one exception (between grades six and seven), toward hypermedia in general. Further, in each case, sixth-graders had the most positive attitude, seventh-graders had a somewhat less favorable attitude, and eighth-graders had the least favorable attitude. Among the possible explanations for this finding are, as noted above, that grade level and school (implementation) are linked; that older students had more experience with hypermedia and were more critical or, at least, were less affected by novelty; and that *Loess Hills Interactive*, the program studied, was better suited to younger students than to older students.

It should be noted that, in none of the four schools, were all three grades represented. At schools 1, 3, and 4, seventh-graders participated in the project. Only at school 2 did sixth-graders participate, and only at schools 1 and 4 did eighth-graders participate. In this way, school and implementation were tied to grade level, and may have influenced the relationship between grade and attitude toward hypermedia.
Differences Among Small Group Compositions

The gender composition of the *Loess Hills Interactive* project learning groups seemed to have little relationship with attitude toward hypermedia, with one exception. Students in mostly female groups had a significantly more positive attitude (mean = 4.82) than students in all-boy groups (mean = 4.27). An explanation for the difference between the two groups is elusive. There was no significant difference between boys and girls in their attitudes toward any of the characteristics of hypermedia nor toward hypermedia in general. Little guidance is offered by the literature in this area, which is sparse (Adamson, 1997). Although females tend to prefer cooperative learning more than do males, differences that exist in lower elementary grades may not remain in middle school grades (Adamson, 1997).

Limitations of the Study

Several factors may limit generalizability of the study. Some are characteristic of any study of this type, while others are specific to this study. The potential role of novelty and the Hawthorne Effect were discussed above. Among other potential limitations are: size of the sample subgroups, validity of the instruments, and the participants’ relative lack of experience with hypermedia.

The sample used for this study was virtually the entire population of participants in the *Loess Hills Interactive* project; 317 sixth-, seventh-, and eighth-graders from four Iowa communities. Further, virtually all (315) of these participants completed both of the instruments. However, 100 of these students fell into the U-band on the MMTIC, and were not included in subsequent analyses. Because psychological type, hence the four identified learning styles, are not evenly distributed, two rather small cell sizes resulted; IS with 30 and IN with only 12. However, the test used, ANOVA, is robust. Because the variances of the four groups were homogeneous, effect on Type I error rate was likely minimal (Hinkle, Wiersma, & Jurs, 1988).

The instrument used to measure students’ attitudes toward hypermedia, the Attitude Toward Hypermedia Index (ATHI), was developed by the author and may suffer from the shortcomings common to similar instruments that have not been extensively tested. It is possible that the ATHI did not measure what it was intended to measure. However the instrument was carefully developed, employing a standardized, eight-step process (Henerson, Morris, & Fitz-
Gibbon, 1987). It is demonstrably reliable and possesses, at minimum, face validity.

The ATHI is a self-report instrument, subject to the shortcomings of such instruments. Self-report instruments are no more accurate than the responses provided by those completing them. It is possible that students responded in ways they believed the researcher or the program’s developer desired.

The students who participated in this study had relatively little experience with hypermedia programs other than Loess Hills Interactive. As such, their responses to questions about their attitude toward hypermedia may more accurately reflect their attitude toward Loess Hills Interactive.

Suggestions for Further Research

The lack of significant differences among the four identified learning style groups suggests two main avenues of further research. First, continued examination of the link (if any) between learning style and hypermedia, and second, more extensive examination of the study’s significant findings.

Continued examination of learning styles and hypermedia might employ a different measure of learning style. It is possible that the MMTIC is not the most appropriate instrument for the purpose, as even one of its authors has suggested (Fourqurean, Meisgeier, & Swank, 1990). A number of well-regarded learning style inventories, including those by Dunn and Kolb, may be considered for use in future research.

The other instrument used in the study, the ATHI, might benefit from continued refinement. It is likely that several of its items could be deleted or improved. Indeed, further careful examination of its constructs may lead to their revision.

Further research, using a different hypermedia product, may yield results different from those obtained by this study. The World Wide Web, while not usually considered a hypermedia product, nonetheless so clearly embodies the requisite elements of hypermedia that its examination in this context would be appropriate.

On the other hand, given that the study revealed no significant differences among students of four identified learning styles in their attitude toward hypermedia, it may be more profitable to abandon learning style and instead explore the other significant relationships identified by the
study, including links between attitude and software implementation, grade level (or age), and gender balance of the learning group.

This study raised intriguing questions about the link between attitude toward hypermedia and the manner in which hypermedia was implemented. How does amount of time spent with a hypermedia product affect student attitudes toward hypermedia? Does integration of hypermedia into the curriculum affect attitudes? What is the role of the teacher in shaping student attitudes toward hypermedia?

This study suggests a link between grade level (age) and attitude toward hypermedia. However, the impact of grade level was probably confounded by implementation and school. It may have been that *Loess Hills Interactive* was more appropriate for sixth-graders, who had the most positive attitude toward hypermedia, than to eighth-graders, who had the least positive attitude, even though all average scores were quite positive. Nevertheless, the significant differences among the three grades, especially with regard to learner control of hypermedia, suggests that further research is warranted.

The significant difference in the attitudes of students in all-boy groups and mostly-female groups was unanticipated. The potential relationship between group gender composition and attitude toward hypermedia, although beyond the scope of this study, warrants further examination.

The lack of significant differences among the four learning style groups in their attitude toward hypermedia may be due, in part, to the small number of students of two learning styles; IS (30) and IN (12). A future study could avoid the problem by studying equal numbers of students (perhaps 50) of each of the four learning styles. Given the characteristic uneven distribution of psychological type, a considerably larger number of MMTICs would have to be administered to ensure that enough students of the least-common learning styles were identified.

**Summary**

This chapter has discussed results of tests to answer the study's four research questions as well as subsequent analyses that addressed issues raised during implementation of the *Loess Hills Interactive* project. The finding of no significant differences among students of four learning styles toward three critical characteristics of hypermedia as well as toward hypermedia is consistent
with the hypermedia literature. The lack of significant differences among the groups would seem to conflict with the learning styles literature, which suggests that no single teaching method or medium is equally appealing to learners of all styles. The conflict is eliminated, however, if hypermedia, as its proponents claim, adapts to the needs and interests of its users, regardless of learning style (Liu & Reed, 1994; Frey & Simonson, 1993; Larsen, 1992).

Implementation of the Loess Hills Interactive project raised additional questions regarding attitude differences among students at the four schools, among students of different grades, and among students in learning groups of varying gender balance. Significant differences were found among each. Reasons for the significant findings for school and grade level were offered, although a definitive explanation would be difficult, given the relationship between grade and school in this study. The significant finding for learning group gender balance and attitude toward learning with multiple media is intriguing, but a rationale remains elusive, given the lack of significant differences between genders in their attitude toward hypermedia.

The use of hypermedia for instruction is likely to increase, as will interest in tailoring instruction to the needs and interests of learners of all styles. Although this study provides some evidence that hypermedia is equally appealing to learners of all styles, its finding also suggests that further investigation is warranted. Research that uses alternative measures of learning style or attitude toward hypermedia are potentially promising, as are studies that examine the roles of software implementation, grade level, and gender.
APPENDIX A. DESCRIPTIONS OF THE 16 PSYCHOLOGICAL TYPES
ENTJ: Intuitive, innovative organizer; analytical, systematic, confident; pushes to get action on new ideas and challenges.

ESTJ: Fact-minded, practical organizer; assertive, analytical, systematic; pushes to get things done and working smoothly and efficiently.

INTP: Inquisitive analyzer; reflective, independent, curious, more interested in organizing ideas than situations or people.

ISTP: Practical analyzer; values exactness; more interested in organizing data than situations or people; reflective, a cool and curious observer of life.

ESTP: Realistic adapter in the world of material things; good natured, tolerant, easy going; oriented to practical, first hand experience, highly observant of details of things.

ESFP: Realistic adapter in human relationships; friendly and easy with people, highly observant of their feelings and needs; oriented to practical, first hand experience.

ISTJ: Analytical manager of facts and details; dependable, decisive, painstaking and systematic; concerned with systems and organization; stable and conservative.

ISFJ: Sympathetic manager of facts and details, concerned with people's welfare; dependable, painstaking and systematic; stable and conservative.

ISFP: Observant, loyal helper; reflective, realistic, empathic; patient with details, gentle and retiring; shuns disagreements; enjoys the moment.

INFP: Imaginative, independent helper; reflective, inquisitive, empathic, loyal to ideals; more interested in possibilities than practicalities.

ESFJ: Practical harmonizer and worker-with-people; sociable, orderly, opinioned; conscientious, realistic and well tuned to the here and now.

ENFJ: Imaginative harmonizer and worker-with-people; sociable, expressive, orderly, opinioned, conscientious; curious about new ideas and possibilities.

INFJ: People-oriented innovator of ideas; serious, quietly forceful and persevering; concerned with the common good, with helping others develop.

INTJ: Logical, critical, decisive innovator of ideas; serious, intent, highly independent, concerned with organization; determined and often stubborn.

ENFP: Warmly enthusiastic planner of change; imaginative, individualistic; pursues inspiration with impulsive energy; seeks to understand and inspire others.

ENTP: Inventive, analytical planner of change; enthusiastic and independent; pursues inspiration with impulsive energy; seeks to understand and inspire others.

APPENDIX B. LOESS HILLS INTERACTIVE STUDENT SURVEY
Loess Hills Interactive Student Survey

You have recently been working in small groups with an interactive multimedia program called *Loess Hills Interactive*. We would like to ask you for your opinion about the program and the group learning experience.

**Section 1** Think about the Loess Hills program you have been using and respond to statements 1 through 23. Circle the number that best represents your views. Use the following scale:

<table>
<thead>
<tr>
<th>Statement</th>
<th>1=strongly disagree</th>
<th>2=disagree</th>
<th>3=moderately disagree</th>
<th>4=moderately agree</th>
<th>5=agree</th>
<th>6=strongly agree</th>
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<tbody>
<tr>
<td>1. The Loess Hills program was interesting.</td>
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<td>2. The program made me more interested in science.</td>
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<tr>
<td>3. The program helped me understand the importance of preserving the Loess Hills.</td>
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<tr>
<td>4. The graphics and animations looked professional.</td>
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<td>2</td>
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<tr>
<td>5. The video segments looked professional.</td>
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<td>2</td>
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<tr>
<td>6. The Loess Hills program was easy to use.</td>
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<tr>
<td>7. The remote control was easy to use.</td>
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<td>8. The icons (symbols) were easy to understand.</td>
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<td>9. The screens were easy to understand.</td>
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<td>10. The text on the screen was large enough and clear enough to read.</td>
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<td>11. The host, “Justin,” helped me understand the program.</td>
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<td>12. The worksheets were helpful.</td>
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<td>13. There were enough video segments to choose from.</td>
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<td>14. The dictionaries were helpful.</td>
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<td>15. The video segments were too long.</td>
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</table>
16. The maps were helpful.  
17. Doing the project helped me learn more.  
18. The feedback after answering the questions was helpful.  
19. The library was a good way to organize and display options.  
20. I could find the information I needed in the program to answer the questions.  
21. The Loess Hills program was a worthwhile activity.  
22. Overall, I was satisfied with the Loess Hills program.  
23. The Loess Hills program was a good way to learn.  

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Section 2  In the previous section, we asked your opinion about the Loess Hills program. The Loess Hills program is an example of an interactive multimedia computer program. Now think about your experience with other programs similar to the Loess Hills program and respond to the following statements. Circle the number that best represents your views. Use the following scale:  

1 = strongly disagree  2 = disagree  3 = moderately disagree  4 = moderately agree  5 = agree  6 = strongly agree

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</table>
When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

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<tr>
<th>Number</th>
<th>Statement</th>
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<tbody>
<tr>
<td>35.</td>
<td>I would rather learn in a different way.</td>
<td>1</td>
<td>2</td>
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<td>5</td>
<td>6</td>
</tr>
<tr>
<td>36.</td>
<td>The choice of text, video, photographs, drawings, and sound make learning more fun.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<td>6</td>
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<tr>
<td>37.</td>
<td>I like to set the pace of my own learning.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<tr>
<td>38.</td>
<td>I'm not sure what I'm supposed to be learning.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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</tr>
<tr>
<td>39.</td>
<td>I like it because I don't have to watch parts I don't want to watch.</td>
<td>1</td>
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<td>4</td>
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<tr>
<td>40.</td>
<td>I like it because it lets me learn on my own.</td>
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<tr>
<td>41.</td>
<td>It is a waste of time because there is no clear purpose.</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>42.</td>
<td>It lets me learn the way I learn best.</td>
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<td>6</td>
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<tr>
<td>43.</td>
<td>It is confusing.</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>44.</td>
<td>I would like to try other interactive multimedia programs.</td>
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<td>2</td>
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<tr>
<td>45.</td>
<td>Exploring and searching for information is a waste of time.</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<td>6</td>
</tr>
<tr>
<td>46.</td>
<td>It is a good way to learn because it does not have to be used the same way every time.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>47.</td>
<td>Choices between text, video, photographs, drawings, and sound are confusing.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</tr>
</tbody>
</table>

Section 3: Now think about your experience working in your group with the Loess Hills program and answer the following questions. Circle the number that best represents your views. Use the following scale:

1=strongly disagree  2=disagree  3=moderately disagree  4=moderately agree  5=agree  6=strongly agree

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
<th>SD</th>
<th>D</th>
<th>MD</th>
<th>MA</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>48.</td>
<td>Working in small groups makes learning fun.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>49.</td>
<td>I usually prefer to work by myself.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>50.</td>
<td>Working in small groups helps me learn better.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>51.</td>
<td>I liked working with my group.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>52.</td>
<td>I would have been more comfortable working alone.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>53.</td>
<td>I would choose to work in this group again.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td></td>
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<td>D</td>
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</tr>
<tr>
<td>54</td>
<td>My group worked too slowly for me.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>55</td>
<td>Group members helped each other complete the lesson.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>56</td>
<td>My group learned a lot from the program.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>57</td>
<td>I could have accomplished more working alone.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>58</td>
<td>Everybody in my group got to participate.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>59</td>
<td>The group listened to everyone’s ideas.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>60</td>
<td>Everyone in the group helped each other.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>61</td>
<td>My suggestions and explanations helped other group members with the lesson.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>62</td>
<td>I helped group members when they had questions about the lesson.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>63</td>
<td>I did not help answer questions in my group.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>64</td>
<td>I helped my group make decisions during the lesson.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>65</td>
<td>My group members were helpful to me.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>66</td>
<td>When I asked a question, my group members did not help me.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>67</td>
<td>Members of my group explained what I did not understand.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Section 4 Please circle the response that best describes how much you knew about the Loess Hills before you used the Loess Hills program.

1 = Nothing 2 = A little 3 = A lot

Now, we'd like you tell us a little about yourself. Please mark the appropriate response.

I am ___ male ___ female ___

My ethnic origin is ___ Caucasian ___ Black American ___ Asian/Pacific Islander ___

Hispanic ___ Native American ___ Other _____________

I am in grade ___ 5 ___ 6 ___ 7 ___ 8 ___ 9 ___

How many boys _____ and how many girls _____ were in your group (including yourself)?
APPENDIX C. PARENTAL PERMISSION LETTER
April 2, 1996

Dear Parent,

In the next few weeks, your child's class will be participating in an evaluation of a newly-developed Iowa Public Television program, *Loess Hills Interactive*. This program contains information about the archeology, geology, and animals of the Loess Hills region of Iowa. We would like your child to participate in the evaluation of this program. Students will be working with the program during science class for about one month.

After completion of the program, students will complete written surveys to determine 1) how well they liked the program; 2) their preferred learning style; and 3) their attitudes toward the small group learning experience in which they participated. These surveys should take a total of 45 minutes. The results of these surveys will be used to evaluate the effectiveness of the *Loess Hills* program for use in the classroom.

In addition to the surveys, some children may be asked to participate in hour-long group interviews to discuss their reactions to the program. This interview may be recorded.

Classroom observations will be conducted in the classrooms to assess how children interact with the *Loess Hills* program and in the small group learning experience. These observations may be videotaped.

All data collected will be confidential. Only Iowa State University personnel involved in analyzing the data will have access to the surveys and other recorded information. Information will be reported only for a group of students; no individual students will be identified. All recorded data will be destroyed within one year of the project.

Participation in this evaluation is voluntary and will not affect your child's science grade. If you have any questions, please contact Charles Schlosser or Jane Adamson at:

Research Institute for Studies in Education
E005 Lagomarcino Hall
Iowa State University
Ames, IA 50011
(515) 294-7009
(515) 294-9284 (fax)

If after consideration you do not want your child to participate in this evaluation, please sign the enclosed form and return it to your child's teacher or mail or fax it directly to the Research Institute at the address above.

Sincerely,

Charles Schlosser
Research Associate

P. O. Box 6450 • 6450 Corporate Drive Johnston, Iowa 50131 • 515-242-3100

11 Des Moines 21 Iowa City 24 Fort Dodge 27 Mason City 32 Sioux City 36 Waterloo 36 Council Bluffs 36 Red Oak
APPENDIX D. HUMAN SUBJECTS FORM
Information for Review of Research Involving Human Subjects
Iowa State University
(Please type and use the attached instructions for completing this form)

1. Title of Project: IPTV Loess Hills Interactive Television Project - Evaluation

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are protected. I will report any adverse reactions to the committee. Additions to or changes in research procedures after the project has been approved will be submitted to the committee for review. I agree to request renewal of approval for any project continuing more than one year.

Michael Simonson
Typed Name of Principal Investigator
1/22/96
Signature of Principal Investigator

C & T / RISE
Department
603 Tagomarcino Hall
Campus Address
206-7000
CampusTelephone

3. Signatures of other investigators

Date
Relationship to Principal Investigator

Michael Simonson
1/22/96
Co-Pi

4. Principal Investigator(s) (check all that apply)

X Faculty

X Staff

Graduate Student

Undergraduate Student

5. Project (check all that apply)

X Research

X Thesis or dissertation

Class project

Independent Study (490, 590, Honors project)

6. Number of subjects (complete all that apply)

# Adults, non-students

# ISU student

100 # minors under 14

other (explain)

# minors 14 - 17

7. Brief description of proposed research involving human subjects: (See instructions, Item 7. Use an additional page if needed.)

Problem: Examine the effectiveness of a distance-delivered interactive television instructional product about the Loess Hills in a middle school class setting.

Method: Participating schools were selected by Iowa Public Television and have agreed to be part of the study. Individual middle school teachers were contacted by IPTV and agreed to participate in pilot-testing the Loess Hills interactive television product. Four teachers are participating. These teachers and all students in their science classes will make up the respondent group.

Data will be gathered by survey instruments, interviews, and observations (draft instruments are attached).

(Please do not send research, thesis, or dissertation proposals.)

8. Informed Consent:

X Signed informed consent will be obtained. (Attach a copy of your form.)

X Modified informed consent will be obtained. (See instructions, item 8.)

Not applicable to this project.

See attached letters
9. Confidentiality of Data: Describe below the methods to be used to ensure the confidentiality of data obtained. (See instructions, item 9.)

Surveys: Names will be used only for matching data from separate instruments. Once surveys are matched, individual identifiers will be removed. Only the evaluators will have access to the matching information.

Interviews/observations: Individual names will not be recorded. Groups will be identified by school and type of group (i.e., all male, all female, mixed). Only the evaluators will have access to any recorded information. All records will be destroyed after one year.

10. What risks or discomfort will be part of the study? Will subjects in the research be placed at risk or incur discomfort? Describe any risks to the subjects and precautions that will be taken to minimize them. (The concept of risk goes beyond physical risk and includes risks to subjects’ dignity and self-respect as well as psychological or emotional risk. See instructions, item 10.)

None

11. CHECK ALL of the following that apply to your research:

- A. Medical clearance necessary before subjects can participate
- B. Samples (Blood, tissue, etc.) from subjects
- C. Administration of substances (foods, drugs, etc.) to subjects
- D. Physical exercise or conditioning for subjects
- E. Deception of subjects
- F. Subjects under 14 years of age and/or Subjects 14 - 17 years of age
- G. Subjects in institutions (nursing homes, prisons, etc.)
- H. Research must be approved by another institution or agency (Attach letters of approval)

If you checked any of the items in 11, please complete the following in the space below (include any attachments):

Items A - D Describe the procedures and note the safety precautions being taken.

Item E Describe how subjects will be deceived: justify the deception; indicate the debriefing procedure, including the timing and information to be presented to subjects.

Item F For subjects under the age of 14, indicate how informed consent from parents or legally authorized representatives as well as from subjects will be obtained.

Items G & H Specify the agency or institution that must approve the project. If subjects in any outside agency or institution are involved, approval must be obtained prior to beginning the research, and the letter of approval should be filed.

F - Letters will be sent to parents asking for permission for their children to participate. Teachers will read information to the students and notify them of their right not to participate (see attached letter and instructions for teachers)

H - IPTV has contracted for these evaluation services and has agreed to make some of the data available for use by ISU graduate students. Agreements with schools were made by IPTV (see attached letter).
Checklist for Attachments and Time Schedule

The following are attached (please check):

12. ☐ Letter or written statement to subjects indicating clearly:
   a) purpose of the research
   b) the use of any identifier codes (names, #s), how they will be used, and when they will be removed (see item 17)
   c) an estimate of time needed for participation in the research and the place
   d) if applicable, location of the research activity
   e) how you will ensure confidentiality
   f) in a longitudinal study, note when and how you will contact subjects later
   g) participation is voluntary; nonparticipation will not affect evaluations of the subject

13. ☐ Consent form (if applicable)

14. ☐ Letter of approval for research from cooperating organizations or institutions (if applicable)

15. ☐ Data-gathering instruments

16. Anticipated dates for contact with subjects:

   First Contact: 2/1/96  
   Last Contact: 6/1/96

   Month / Day / Year  Month / Day / Year

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:

   12/31/96
   Month / Day / Year

18. Signature of Departmental/Executive Officer  Date  Department or Administrative Unit

   Signature of Departmental/Executive Officer: Michael Simonson  Date: 2/21/96  Department or Administrative Unit: RISE

19. Decision of the University Human Subjects Review Committee:

   ☑ Project Approved  ☐ Project Not Approved  ☐ No Action Required

   Name of Committee Chairperson: Patricia M. Keith  Date: 1/35/96  Signature of Committee Chairperson: P 127 Kent

GC: 1/90
APPENDIX E. LOESS HILLS INTERACTIVE EVALUATION REPORT
Loess Hills Interactive

Charles Schlosser
Jane Adamson

November 1996
Loess Hills Interactive
Evaluation Report

Charles Schlosser
Jane Adamson

Michael Simonson, Principal Investigator

Technology Research and Evaluation Group
E006 Lagomarcino Hall
College of Education
Iowa State University
Ames, IA 50011
(515) 294-6919

November, 1996
Loess Hills Interactive: Evaluation Report

Introduction

This report was prepared for Iowa Public Television (IPTV) for the purpose of evaluating a pilot test of the multimedia program Loess Hills Interactive. The program was developed through a three-way partnership between IPTV, Interactive Resources (IR), and Wallace Technology Transfer Foundation of Iowa (WTTF). IPTV developed and designed the actual program, IR contributed the technical programming expertise, and WTTF provided the funding. The pilot test was conducted in four middle schools in Iowa in the spring of 1996, by a total of five teachers and 317 students. Both qualitative and quantitative data were obtained from participating teachers and students in order to determine direction for the future development of similar interactive educational programs by IPTV.

This report is organized into five main sections: (a) an introduction, (b) a brief description of the Loess Hills Interactive program, (c) a description of the methodology used to obtain quantitative and qualitative data for this report, (d) a presentation of the data, and (e) a summary and suggestions, followed by a brief conclusion.

Description of Loess Hills Interactive

Loess Hills Interactive was developed as a distance-learning resource for middle school science students in Iowa. During the video introduction to the program, students are told that the information in the program will help them accomplish the following educational objectives:

- explain why the Loess Hills of Iowa are important
- describe how the hills were formed
- identify the different environments found in the Loess Hills
- recognize species living in these environments
- understand ways to preserve the Loess Hills.
The program is an organized collection of video segments, still photos, and reference materials about the geology, environment, flora, fauna, and preservation of the Loess Hills region in western Iowa along the Missouri border. When students initially log-on to the program, they are introduced to their video program host, Justin. He explains how to use the video screen icons to move around the program and how the information is organized. The program is designed for small cooperative groups of students to use over three to four class periods.

Students have the opportunity to interact with the program in several ways. First, they must determine their group’s pathway and pace through the media. The information is organized around a library theme. Students may choose from elements of the library—a video rack, a reference desk, maps, a camera with still photos, and a special help and quiz-me section. On the video rack, students can access either the “main” videos—geology, environment, fauna, and preservation, or “alternative” videos—geology, school, archaeology, preservation, and China. Also on the video rack are “animal clips,” short video segments of species found in the Loess Hills. A map on the library wall offers access to a world map or a more detailed Iowa map. The camera allows students to access still photos of animals and the environment; the bookshelf lets students refer to a specialized dictionary, program credits, references for additional research, or written transcripts of the “main” videos. By using specific icons, students can fast forward, reverse, pause, or stop video segments as they desire. There are more than three hours of video for students to explore. They have full freedom to move among elements as they wish.

Second, students have the opportunity to earn points to develop a “project.” Groups gain points by correctly answering on-screen questions located in two places—the “main” videos and the “quiz-me” section. As they accumulate points, they are given on-screen menus of short media segments from which to make a selection. Groups must first determine what topic they want to learn about so they can choose elements that will support that topic. After students have completed their “projects,” they can give a presentation combining student-generated narrative with the selected media segments.

The program designer, Luiz Lobo, also developed a User Guide for students to use as they interact with the program. Included in the User Guide are complete written directions with graphics and several worksheets for students to complete while looking at the main videos.
Methodology

The data collection for the evaluation occurred after teachers and students used the program in their schools during a period of about four to five weeks in the spring of 1996. Online access to the program was provided by IPTV for each participating school by means of a digital audio-video interactive device (D.A.V.I.D.) box, connected to an incoming high-density phone line. A television monitor was connected to the box and the phone line. Groups of students worked with the program according to a schedule assigned by their teachers.

Before the end of the school year, the evaluation team scheduled one day at each school site with both students and teachers. Three evaluation elements were implemented:

- an attitudinal survey consisting of 23 six-point Likert-type scale questions grouped into five constructs: relevance of the content, quality of the product, ease of use, product design, and overall satisfaction with the product. The questions were based on input from the program developers. The survey was administered by the evaluation team to most participants at each school within two weeks of the students’ final use of the program. The purpose of the survey was to determine a quantitative measure of student attitude toward Loess Hills Interactive. Five additional questions on the survey were used to gather demographic information from the students (see Appendix A for survey).

- a focus group of between 8 and 11 students: School A, 10 students; School B, 10; School C, 8; and School D, 11. The groups, divided nearly equally by gender, were selected by the teacher(s). Focus groups were one period (approximately 45 minutes) in length and were conducted the same day as the surveys were administered. A standard set of eight questions was used with each group. The purpose of conducting the focus group was to get richer, qualitative data from students on attitudes and reactions to Loess Hills Interactive (see Appendix B for focus group questions).

- interviews of five teachers. Interviews varied in length from approximately 30 to 50 minutes. A standard set of 26 questions was used in each interview. The interviews served to collect the same type of information in qualitative form for the teachers as the survey and focus groups collected from the students (see Appendix C for interview questions).

Descriptions of the schools, teachers, and students

Teachers and students from four Iowa schools participated in the evaluation. The following brief descriptions identify the general geographical location of the schools, the predominant ethnicity and socioeconomic status of the students, the number and grade of students, the selection of students, and brief background information on the teachers.
School A is located in a small farming community in south-central Iowa. Its approximately 115 students are predominantly white and lower- to middle-class. Participants in the project included 43 seventh-grade and 7 eighth-grade science students of a range of ability levels. Participants were selected students of a single teacher. The teacher, who has a bachelor's degree, teaches seventh- and eighth-grade science.

School B is located in a medium-sized town in north-central Iowa. Its approximately 350 students are predominantly white and middle-class. Participants in the project included 78 sixth-graders of a variety of ability levels. Participants were representative students of a single teacher and were selected by that teacher. The teacher, who has taught eight years and has an master's degree, also teaches language arts and reading classes, as well as science.

School C is located in a suburb of Iowa's largest city. Its approximately 1040 students are predominantly white and middle-class. Participants in the project included 87 seventh-graders of differing ability levels. All students from four classes of a single teacher participated in the project. The teacher, who has 24 years experience and a master's degree, primarily teaches science.

School D is located in a small farming community in south-central Iowa. Its approximately 160 students are predominantly white and lower- to middle-class. The 102 participants in the project included 41 seventh-grade and 59 eighth-grade science students of a range of ability levels (two students did not report their grade level). All students from six classes of two teachers participated in the project. One teacher has a bachelor's degree and 21 years of experience, and teaches seventh- and eighth-grade science, social studies, and language arts. The second teacher has a bachelor's degree and 10 years experience, and teaches seventh- and eighth-grade science.

Implementation of the program

The following brief summaries describe whether Loess Hills Interactive was integrated into the curriculum, how students were assigned to groups and scheduled to use the program, where the groups worked, whether they were able to do any presentations, and whether or not they were graded on their work.

School A: The participating teacher originally planned to integrate the students' use of the program into a unit on earth science. However, due to a several-week delay in delivery of Loess Hills Interactive, the teacher was unable to incorporate the program into the course curriculum as planned. Selected students were assigned to groups of four by the teacher and each group was scheduled to use the program one class period each week for three weeks. The television monitor was located in a classroom adjacent to the school's main office, on a different
floor and at the other end of the building from the science classroom. Because of intermittent technical problems with the remote server, students did not have enough time to complete their projects. Students were not graded on their participation.

**School B:** *Loess Hills Interactive* was not integrated into the classwork because the scheduled curriculum did not have a unit appropriate for the program. Students, assigned by the teacher to groups of four, were sent to a workroom adjacent to the media center in the adjoining high school. Supervision was provided by a media center aide whose desk was in the workroom. Over a four-week period, groups of students used the program for four consecutive days, and made their presentation to their classmates on the fifth day. Students were not graded on their participation in the project.

**School C:** *Loess Hills Interactive* was fully integrated into a unit on ecosystems. Students were assigned by the teacher to groups of three, four, or five. The teacher escorted each of her classes to the media center of the adjoining high school. While the assigned group of students used the program, the teacher held class with her remaining students in the adjacent classroom. A large window separated the two rooms, allowing the teacher to supervise the students using the program. Each group used the program for one-and-a-half 45-minute periods, approximately once each week for four weeks. Groups made presentations to their parents at the conclusion of the project. Students were graded on their final projects.

**School D:** *Loess Hills Interactive* was not integrated into the classwork because the scheduled curriculum did not have a unit appropriate for the program. Students, assigned to groups of three, four, or five by the two participating teachers, used the program in a workroom located between an office and a classroom down the hall from their classrooms. Students were supervised by a number of individuals, including several paraprofessionals and two evaluators. Because of technical problems in program delivery, students did not have enough time on-line to complete their final projects. Students were not graded on their participation in the project.

**Demographics of the students**

Virtually all of the students who participated in the *Loess Hills Interactive* pilot project (317 of 318) responded to the attitudinal survey. They were:

- 47% male and 53% female
- predominantly Caucasian (298), with smaller numbers of other ethnicities: Asian (9), Native American (6), Black American (1), and Hispanic (1). Two students did not complete this item.
• 25% sixth-graders, 54% seventh-graders, and 21% eighth-graders. Two students did not report their grade level.

Most students were unfamiliar with the Loess Hills before they were involved in the pilot study. An overwhelming majority (80%) reported knowing nothing about the Loess Hills before using Loess Hills Interactive, while 17% reported knowing “a little,” and only 3% reported knowing “a lot.”

Student Attitudinal Survey Results and Discussion

The survey results indicated that the students held a generally positive attitude toward Loess Hills Interactive. A six-point scale, from strongly disagree to strongly agree, was used. For 15 of the items, more than three-quarters of the students indicated that they were satisfied, answering moderately agree, agree, or strongly agree. More than 75 percent, then, agreed that:

• the Loess Hills program was interesting (80.8%)
• the program helped me understand the importance of preserving the Loess Hills (80.4%)
• the graphics and animation looked professional (82.3%)
• the video segments looked professional (84.5%)
• the icons (symbols) were easy to understand (86.4%)
• the screens were easy to understand (89.0%)
• the text on the screen was large enough and clear enough to read (95.6%)
• there were enough video segments to choose from (81.45%)
• doing the project helped me learn more (80.4%)
• the feedback after answering the questions was helpful (81.7%)
• the library was a good way to organize and display options (83.6%)
• I could find the information I needed in the program to answer the questions (83.6%)
• the Loess Hills program was a worthwhile activity (77.9%)
• overall, I was satisfied with the Loess Hills program (75.7%)
• the Loess Hills program was a good way to learn (81.7%).
A level of 25 percent dissatisfaction was set by the evaluation team in assessing areas that may need improvement. Items where one-fourth or more of the students responded negatively were deemed areas where reasons need to be determined for the relatively high percentage of negative feedback. There were eight areas where student ratings indicated improvement may be needed. More than one-quarter of the students felt that:

- the program did not make me more interested in science (41.6%)
- the Loess Hills program was not easy to use (29.7%)
- the remote control was not easy to use (34.4%)
- the host, "Justin," did not help me understand the program (31.5%)
- the worksheets were not helpful (37.1%)
- the dictionaries were not helpful (30.9%)
- the video segments were too long (40.4%)
- the maps were not helpful (26.2%).

Overall, students indicated satisfaction with the program in the areas of educational interest and usefulness, motivation, and professional quality of the program. The areas that may need examination are the ease of use; the host, Justin; the length of some videos; and certain elements including the worksheets, dictionaries, and maps. Several factors may have influenced the negative student response rates for some of these items. One factor is the high incidence of technical programming problems which caused the program to freeze while students were trying to work with it. Many groups could not complete assembling their presentations because they could not get enough time on-line with the program.

A second technical factor is the limitation of the remote control; students could only move the cursor in a linear path around the screen. These two technical factors may account for the high negative response rate about ease of use of the program.

A third factor which may have influenced students' perception of the length of video segments might be the absence of interactive elements within some segments. Students were given opportunities to answer worksheet and on-screen questions in the "main" videos only.

A final factor is that if students did not choose to use the dictionary while they were working with the program, they could not have found the dictionary helpful. In the section Summary and Suggestions, these areas will be further discussed in light of the qualitative data collected from both students and teachers. See Table 1 for a detailed report on the responses for each question and construct.
### Table 1. Student responses to attitudinal survey

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>% SD</th>
<th>% D</th>
<th>% MD</th>
<th>% MA</th>
<th>% A</th>
<th>% SA</th>
<th>total % agree</th>
<th>mean</th>
<th>s.d.</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construct 1: Content</strong></td>
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<td></td>
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</tr>
<tr>
<td>The Loess Hills program was interesting.</td>
<td>5.7</td>
<td>4.4</td>
<td>9.1</td>
<td>30.3</td>
<td>38.2</td>
<td>12.3</td>
<td>80.8</td>
<td>4.3</td>
<td>1.3</td>
<td>317</td>
</tr>
<tr>
<td>The program made me more interested in science.</td>
<td>8.8</td>
<td>14.2</td>
<td>18.6</td>
<td>32.8</td>
<td>18.9</td>
<td>6.6</td>
<td>58.4</td>
<td>3.6</td>
<td>1.4</td>
<td>317</td>
</tr>
<tr>
<td>The program helped me understand the importance of preserving the Loess Hills.</td>
<td>3.8</td>
<td>5.0</td>
<td>10.7</td>
<td>21.5</td>
<td>33.4</td>
<td>25.6</td>
<td>80.4</td>
<td>4.5</td>
<td>1.3</td>
<td>317</td>
</tr>
<tr>
<td><strong>Construct 2: Quality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>---</td>
</tr>
<tr>
<td>The graphics and animations looked professional.</td>
<td>4.4</td>
<td>5.4</td>
<td>7.9</td>
<td>22.8</td>
<td>36.1</td>
<td>23.4</td>
<td>82.3</td>
<td>4.5</td>
<td>1.2</td>
<td>316</td>
</tr>
<tr>
<td>The video segments looked professional.</td>
<td>4.1</td>
<td>3.8</td>
<td>7.6</td>
<td>19.2</td>
<td>38.2</td>
<td>27.1</td>
<td>84.5</td>
<td>4.7</td>
<td>1.3</td>
<td>317</td>
</tr>
<tr>
<td><strong>Construct 3: Ease</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>---</td>
</tr>
<tr>
<td>The Loess Hills program was easy to use.</td>
<td>8.5</td>
<td>6.6</td>
<td>14.5</td>
<td>23.7</td>
<td>22.1</td>
<td>24.6</td>
<td>70.3</td>
<td>4.2</td>
<td>1.5</td>
<td>317</td>
</tr>
<tr>
<td>The remote control was easy to use.</td>
<td>12.3</td>
<td>9.5</td>
<td>12.6</td>
<td>18.0</td>
<td>19.6</td>
<td>28.1</td>
<td>65.6</td>
<td>4.1</td>
<td>1.7</td>
<td>317</td>
</tr>
<tr>
<td>The icons (symbols) were easy to understand.</td>
<td>3.5</td>
<td>3.2</td>
<td>6.9</td>
<td>23.0</td>
<td>32.8</td>
<td>30.6</td>
<td>86.4</td>
<td>4.7</td>
<td>1.3</td>
<td>317</td>
</tr>
<tr>
<td>The screens were easy to understand.</td>
<td>2.8</td>
<td>2.5</td>
<td>5.7</td>
<td>20.5</td>
<td>35.3</td>
<td>33.1</td>
<td>89.0</td>
<td>4.8</td>
<td>1.2</td>
<td>317</td>
</tr>
<tr>
<td>The text on the screen was large enough and clear enough to read.</td>
<td>1.6</td>
<td>1.3</td>
<td>1.6</td>
<td>12.9</td>
<td>32.2</td>
<td>50.5</td>
<td>95.6</td>
<td>5.2</td>
<td>1.0</td>
<td>317</td>
</tr>
<tr>
<td><strong>Construct 4: Design</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td>---</td>
</tr>
<tr>
<td>The host, &quot;Justin,&quot; helped me understand the program.</td>
<td>12.3</td>
<td>6.6</td>
<td>12.6</td>
<td>26.3</td>
<td>24.3</td>
<td>18.0</td>
<td>68.5</td>
<td>4.0</td>
<td>1.6</td>
<td>317</td>
</tr>
<tr>
<td>The worksheets were helpful.</td>
<td>9.5</td>
<td>10.2</td>
<td>17.5</td>
<td>24.1</td>
<td>28.9</td>
<td>9.8</td>
<td>62.9</td>
<td>3.8</td>
<td>1.4</td>
<td>315</td>
</tr>
<tr>
<td>There were enough video segments to choose from.</td>
<td>4.7</td>
<td>4.7</td>
<td>9.1</td>
<td>20.8</td>
<td>33.4</td>
<td>27.1</td>
<td>81.4</td>
<td>4.5</td>
<td>1.3</td>
<td>317</td>
</tr>
<tr>
<td>The dictionaries were helpful.</td>
<td>9.1</td>
<td>8.8</td>
<td>12.9</td>
<td>27.8</td>
<td>23.7</td>
<td>17.7</td>
<td>69.1</td>
<td>4.0</td>
<td>1.5</td>
<td>317</td>
</tr>
<tr>
<td>The video segments were too long.</td>
<td>14.5</td>
<td>19.2</td>
<td>25.9</td>
<td>24.0</td>
<td>8.5</td>
<td>7.9</td>
<td>40.4</td>
<td>3.8</td>
<td>1.4</td>
<td>317</td>
</tr>
<tr>
<td>The maps were helpful.</td>
<td>8.5</td>
<td>5.0</td>
<td>12.6</td>
<td>26.5</td>
<td>31.2</td>
<td>16.1</td>
<td>73.8</td>
<td>4.2</td>
<td>1.4</td>
<td>317</td>
</tr>
<tr>
<td>Doing the project helped me learn more.</td>
<td>7.3</td>
<td>3.5</td>
<td>8.8</td>
<td>20.8</td>
<td>35.0</td>
<td>24.6</td>
<td>80.4</td>
<td>4.5</td>
<td>1.4</td>
<td>317</td>
</tr>
<tr>
<td>The feedback after answering the questions was helpful.</td>
<td>6.6</td>
<td>3.2</td>
<td>8.5</td>
<td>25.6</td>
<td>37.2</td>
<td>18.9</td>
<td>81.7</td>
<td>4.4</td>
<td>1.3</td>
<td>317</td>
</tr>
<tr>
<td>The library was a good way to organize and display options.</td>
<td>4.7</td>
<td>3.2</td>
<td>8.5</td>
<td>21.1</td>
<td>32.5</td>
<td>30.0</td>
<td>83.6</td>
<td>4.6</td>
<td>1.3</td>
<td>317</td>
</tr>
<tr>
<td>I could find the information I needed in the program</td>
<td>4.7</td>
<td>4.1</td>
<td>7.6</td>
<td>28.1</td>
<td>34.4</td>
<td>21.1</td>
<td>83.6</td>
<td>4.5</td>
<td>1.3</td>
<td>317</td>
</tr>
</tbody>
</table>

**Construct 5: Satisfaction**                                                       |      |     |      |      |     |      |               |      |      |---|
| The Loess Hills program was a worthwhile activity.                                  | 7.6  | 4.1 | 10.4 | 18.6 | 27.8| 31.5 | 77.9          | 4.5  | 1.4  | 317|
| Overall, I was satisfied with the Loess Hills program.                              | 7.3  | 6.0 | 11.0 | 18.6 | 30.6| 26.5 | 75.7          | 4.4  | 1.5  | 317|
| The Loess Hills program was a good way to learn.                                    | 6.0  | 4.7 | 7.6  | 18.9 | 28.4| 34.4 | 81.7          | 4.6  | 1.4  | 317|

Scale: SD= strongly disagree; D= disagree; MD= moderately disagree; MA= moderately agree; A= agree; SA= strongly agree; total % agree= percent of students indicating moderately agree, agree, or strongly agree for each item.
Focus Group Results and Discussion

Learning with interactive multimedia

Motivation (the degree to which the program stimulated student interest). Students were highly positive toward learning with interactive multimedia. Students mentioned that it seemed easier to focus on learning activities with multimedia. They seemed very motivated to use such programs with other subjects as well.

Just thinking of using multimedia interactive makes you...think it's going to be a lot of fun, and they are a lot of fun to use. School B

I think it is [a good way to learn] because I learn better when I see a picture instead of just seeing words and stuff. School A

It holds your attention more than a book would and just the teacher standing up in front of the room talking. I mean it gets really boring and you kinda tune them out...but if...the teacher isn't there, you know, it kind of makes a difference, and then you can go...at your own pace and...then go back if you didn't understand it. School A

And sometimes while reading a book you get distracted and can't focus. It's easy to focus on this. School B

Three students from School A explored the potential of using interactive multimedia for learning a variety of other subjects:

I think it would be really cool if you could just, like, come down here in your little group, like, one day a week, and you just did your whole day down here, and you did your whole class like that.

For every class.

That'd be cool. You could have, like, math and science and stuff.

A few students noted that it might be the novel character of the learning activities which account for some of the positive anticipation.

I think...maybe if they get used a lot though, they would maybe become...I don't know if this would necessarily happen, but maybe a little monotonous...if people would start going back to books. School B

Learner control over path and pace of learning (the degree to which the program allowed users to decide their direction and speed). Students welcomed the opportunity to determine what they wanted to learn and how long to spend on each media segment. They
liked the fact that they could work independently of their teacher—that they could go back to
review or skip ahead. They seemed to find it easy to navigate through the program.

I also liked how you could, if you missed parts of the movie, you could always go back instead of, like, you only get one chance to look at it. School C

And really you learn it at your own pace specific things because I mean a lot of teachers they'll go really fast...but on this you get to pick what you want to do and then you can go back through it...and there's really nobody to tell you how to do it. School A

It's pretty cool because you can learn at your own pace, instead of having to just go like 90 miles an hour like some teachers do. School A

And you can go any direction instead of having to do each thing over and over again. School C

I liked how they had the...library thing, and how you could choose where you wanted to go and do. School D

Educational usefulness and content

A number of students indicated that they learned a great deal from the program. This was the first time most of them studied the Loess Hills.

I thought it was pretty useful because I didn't know anything about the Loess Hills. School A

Well, I thought I really learned a lot about the Loess Hills, and I liked the pelican video because it had cool music. School B

I liked the little videos, like the fauna and the preservation and everything, and I thought they showed the different animals on the tapes. I thought it was pretty neat. School B

It's a good way to learn about some really neat spots in our state of Iowa. It's a pretty nice program. School B

However, students had some suggestions for future modifications of the program. These included more substantive "animal clips," a larger dictionary, and more detailed maps.

You should just type in whatever the word is, and it should have all kinds of words instead of just certain words. School A

I think the maps should show more, because we got a map, and it only showed...just one part of Iowa with the red part, and then it showed just the counties. I think it should show a little bit more than that. School A
You need the "animal clips" to be longer because they give just limited amounts of information about the different animals. School A

...the animal clips—have more of them, and go into more detail about 'em than they did. School D

Some students thought that the on-line questions were too easily answered, while some indicated that answers to some of the workbook questions were not easily located.

[The quizzes] were pretty easy, 'cause, since the video things were so short, and then after that you went to the questions,...you could remember them pretty easy. 'School D

I didn’t really like the questions, but the questions were probably just for the report 'cause our group...had a hard time finding them. School D

And some of the questions were too obvious on there like ‘What are s’mores made of?’ School A

Hardware and software

Technical reliability (the perceived freedom of the program from glitches).

Intermittent technical problems with delivery of the program to students was a factor in how much time they got on-line to work through the program and earn enough points to finish their presentations.

I’d say the only thing bad about it is when it froze once in a while. School B

It was just kind of easy to use once you got into it, but sometimes getting into it was a problem. School D

Our group didn’t get to do a whole lot on it because it kept breaking down. School D

Well, it got like, it got really annoying when after you’ve punched in all the password over and then it’d freeze. School A

Because we were supposed to have...three hours on it or something and we were lucky if we got an hour on it 'cause by the time we got it going and it froze up or something we didn’t have time to do anything and we didn’t get to very many questions because it took too long. School A

At the same time, students indicated that they sometimes had trouble navigating, or getting to where they wanted to go within the videos.

The one part I didn’t like about one of the videos is when you have only one part that you needed to go back and see...at the end and you had to go though and watch the whole video over. School A
If you, like, hit the button too many times, it keeps rewinding clear back to the beginning, and you have to do the whole thing again. School D

Remote control (student attitude toward the hand-held device used to move the cursor). The remote control was deemed by many students to be a weak input device. Buttons were judged to be too small and, in the case of non-functioning buttons, superfluous. Students expressed a preference for a mouse or similar device. Coloring criticism of the remote control was the inconvenience of the log-on user interface (see “logging on,” below).

...and make the remote control different and easier to use. School D

If there was an easier way to do it, it would be a lot better to deal with. School A

I think it would be, like, better if you...somehow fixed it up so you could, like, have it on a mouse and then you could go through the code stuff faster than with the remote. School A

The other thing is, what are all, what are all the buttons on there used for? School A

It’s not that we don’t like the remote control, it just took forever. School A

I think they should have just a regular keyboard, so it would be faster and easier.... School C

I think that you should still have...a controller...just, like, differently made, like, bigger buttons, and everything, and easier to push down, ’cause they’re like, these itty-bitty buttons that you could barely push. So, like, just bigger buttons on the controller. School C

Logging on (student attitude toward the process of entering a group name and password at the beginning of each session). Logging on was a major area of complaint with the students, who cited the awkwardness and time-consuming nature of the process. They were critical of the user interface (an on-screen keyboard), and of the remote control used to enter names and passwords (see “remote control,” above).

When you want to go a direction and pick your password you know, and you push the arrow one way it goes the other way. School A

You can’t use up or down, either. School A

Yeah, like if you write above or below your number...you can’t go up or down, you have to go sideways. School A
'Cause you spent, like, our group spent five to ten minutes just getting our code and password. It would be much faster just typing. School C

And every time it froze, it took another five to ten minutes, so it took about half your time...just typing your name. School C

Program design

Humor (the perceived amusing nature of the content). Students found humor in several aspects of the program: in some of the quiz answer choices, the student interviews in the geology video, and especially the animated frog. Students seemed to enjoy imitating the frog: "[slurp] You got it."

I like the frog after the 'quiz me's.' It told you if you got it right or not. School B

A lot of them [quiz questions] were pretty funny, too, like 'How do you make s'mores?' School B

The Loess Hills Interactive interviews conducted by children appealed to some of the students, as reflected in the following exchange among students from School A:

I kinda liked the surveys the kids did on there, the people who didn't know about the Loess Hills.

Yeah, that was cool.

That was funny.

Justin (student attitude toward the young video host of the program). Opinions about Justin seem to be divided by age of student, with younger students expressing more positive attitudes. Students tended to agree, however, that Justin could become tiresome with repetition. Some students suggested that it would be more effective if the host were closer to the age of the students using the program.

Justin was pretty cool.... School B

And the first time it was kinda confusing what that guy was saying. School A

Have kids that know what they're talking about put it in their own words so we can understand them better. School A

That guy talked too long in the very beginning. School A

The host was kinda annoying after awhile. School A
I kind of thought Justin was a dork. I didn't like him. School D

Justin really didn't do all that much. School D

That host person. He's helpful...but then every time he came back, he said the same thing. That got annoying. School C

Earning points (student attitude toward the process of accumulating points by correctly answering on-screen questions). Students had some problems figuring out where to earn points. Even though directions were given in the User Guide, not all students apparently read it.

It's hard to score points on it, 'cause when you got all the 'quiz me's' done on it and got all the points, then I couldn't hardly score any more points on it until I went to the main section. And when I was done with that, then I really couldn't get any more. School A

There's this part where we'd always go to 'quiz me' to get our points, and then it wouldn't let us go any more, and we just kinda stumbled onto that. That's the main thing, 'cause we didn't know where the questions were. And so, I think the explanation at the beginning, like, should tell where everything is. School A

I went to the book and it said that you could get points off the main section of the videos. That's where I got some of the points, but I wish you could've got more points. School A

One student suggested that it would be more convenient to have the group's score displayed in the library.

I thought that to...see your points, you shouldn't have to...go click on the host and then click on something else. It should have just been in the main room, like, always up there somewhere to see where your points are at. School C

Cooperative groups

Students enjoyed working in their groups, for the most part, although they indicated that they would like to be able to choose with whom they worked. Some groups evidently had to work through problems that arose during their time together. Most students seemed to like having the interaction with each other as well as the interaction with the program. Students seemed to think three to four students per group was a good size.

I like it better than working alone because you share your ideas out loud.... School B
It was easier. Like on different quizzes and stuff if you didn’t know it hopefully somebody else in the group would know it. School B

I liked them [groups] because you got to...assign jobs and stuff, so you didn’t have to do everything by yourself. School C

We worked pretty good together but on some parts it got kinda bad because people that wanted to be by themselves kinda just took the remote...but we all ended up working together. School A

There were a few students who would have preferred to work alone or with only one other person.

I would have rather worked maybe alone or with just one other person cause like one person in our group...or a couple people had their own ideas about what they wanted to do and I mean I don’t have a problem with compromising but it set us back a little bit. School B

A further discussion of these results is presented in the section Summary and Suggestions on page 23.

Teacher Interview Results and Discussion

Learning with interactive multimedia

Motivation (the degree to which the program stimulated student interest). Teachers had a very positive attitude toward learning with interactive multimedia.

Well, that was the nice thing about the program, because even my...students who always do really well, found the program exciting and interesting and challenging and the students who have a lot of learning problems still found the program exciting and fun and interesting. So, it worked with all of the kids. Teacher 1

Considering they weren’t getting grades, nothing is on the report card, probably the least accountable thing they’ve done all year, it was probably the one they were most motivated to do. Teacher 2

Learner control over path and pace of learning (the degree to which the program allowed students to decide their direction and speed). Teachers thought that giving students control over their learning was a positive feature of the program.

Anytime you get the kids where they kind of have control, they like it. Teacher 5
They felt they were in control...you know, and for kids this age they really need that. And that was part of it and it was visually stimulating and it's kind of a game. And...they're learning all the way through it in spite of themselves. It's great. Teacher 1

The students feel that they have some control over what they're learning. It forces them to have some responsibility as to what they're learning, and that they end up with a product. And I think that is really good. Teacher 1

The kids were...eager to learn that way and being able to choose where they wanted to go in the program, I thought that gave them a sense of power. Teacher 4

I just know my own students with 3D atlas, and Grolier's and all these interactive things that they have at home, like we do, kids really use them, and I think to be able to give this to everybody at school and make it really accessible for all the students is really motivating. Teacher 3

Educational usefulness and content

Teachers found the content of the program to be educationally relevant and interesting, even though they might not have had the opportunity to integrate it into their curriculum at the time of the pilot test.

Not just Iowa students, but, I think, midwestern students. Because I think the Loess Hills go down to St. Joe. And I know...when we study about glaciers...and actually we do that everywhere in the United States. And that's just something else important that comes out of the glacier age. And I would think the Loess Hills is an important feature as an uplifted mountain or a volcano or anything else. So I think it's part of social studies, science.... Teacher 3

I've done a prairie burn before, and so I thought that was real accurate, too, and even how they were dropping the fire down with the can and everything, was how we did it, and I thought that was real interesting. Teacher 3

Because I look at it as being able to take a field trip. There's no better way to learn than to immerse kids in the...environment you want to study. And there's so many things...when we're studying I wish we could hop on a plane and go there. Teacher 4

Maybe something like this could actually advance earth science in middle schools. Teacher 2

It's very relevant to kids in Iowa. Teacher 1

Teachers saw the program as an opportunity to give their students experience working with multimedia.

And that's something else we're moving towards is having the students do, you know,...more media-type presentations. Teacher 3
The kids wanted to do the project, and show their video. So, to me it's another form of visual aid. And visual aids always make things more interesting. Teacher 3

It was noted that a few spelling errors needed to be corrected.

I didn't find anything that I didn't think was accurate. There are some spelling errors. 'Prairie' is misspelled. Some things like that that need to be changed. Teacher 1

Hardware and software

Technical reliability (the perceived freedom of the program from glitches). Teachers were aware of minor technical problems which needed attention. They also reported that students did get frustrated when the program froze while they were working.

At the very end of each one of the videos, though, they need to go back in and fix those because it stops and then starts over again, so it's kind of like a little...error in there that they need to fix. Teacher 1

There were some glitches where Justin would repeat. Teacher 2

The only time I ever really heard anything negative was when it froze up on them. Teacher 5

Oh, I think it has great potential, especially if the technology bugs get worked out so that it can be a little more dependable. I think [the students] just got frustrated...when it would freeze up all the time, and then their momentum kind of died. Teacher 4

Remote control (student attitude toward the hand-held device used to move the cursor). Like the students, teachers were critical of the remote control. They were clear in support of a different input device, especially a mouse.

I think there needs to be a mouse. I think a mouse would work a lot better. Teacher 1

The way [the remote control] was designed, the little buttons were very, very small. And if you sit at the program for any length of time you really get a bruised thumb. That was part of it, but...also it worked really slow, and I think...all of our students are familiar with using a mouse. I mean, they can use remotes, too, but, but there was a lot of stuff on there that they couldn't use on that remote, so it was a waste of, of remote and then, also, I think with a mouse they can, they know how to move it, and then click and then move and click. I think it will move a little faster. You don't...have to follow a certain pattern. Teacher 1
I think...there has to be a better way. I think the students maneuvered in and out of the program very well. They understood what to do and when they didn't know, they shut it off and started over again. They weren't afraid of it. They weren't afraid of the technology. It was just not fast enough for them. That's how much they are prepared for technology. Most kids are used to having things go a lot faster when they are working the computer. Teacher 2

Once you get used to it, it's okay. It works. The first few times I used it, [I had to] figure out which button to push. But I don't see anything wrong with it. It's nothing different pushing a, you know, mouse. You just gotta get used to it. I think if they designed a remote just for that with a little bigger buttons.... 'Cause some of the kids said they'd be going through it and they'd accidentally push the wrong button and take 'em where they didn't want to go, or freeze up on them. If you don't look where your thumb is, you're gonna do that. Teacher 5

Logging on (student attitude toward the process of entering a group name and password at the beginning of each session). The teachers echoed the students' dim view of the log-on procedure. The awkward user-interface, combined with the problematic remote-control, slowed the log-on procedure. When frequent system breakdowns required that the program be rebooted (and the log-on repeated), frustration resulted.

When that thing is broken down and you have to type your name in 15 times in one hour using that method, it tries the patience of Job. Teacher 2

Just the fact that it wouldn't work all the time. Just the technical glitches. Other than that, I didn't see anything really wrong with it. Or bad about it. It was frustrating. You know, you go through the menu and then you go through your name and then the password, and that takes some time. You use that remote, that takes some time to do that. And then it freezes up on you. It was frustrating. Teacher 5

Program design

Humor (the perceived amusing nature of the content). Teachers recognized the humor in the program and acknowledged that their students seemed to enjoy it.

So they appreciated the humor, I think, and they loved the frog. They make the sounds. Teacher 2

We know humor is a good thing to teach with. Teacher 2

I didn't particularly find it amusing. I think some of the kids did. Back to the frog—that's the thing they kept talking about. Teacher 5

It wasn't too mature for them which it could have been. It was just right. Teacher 1
Justin (student attitude toward the young video host of the program). Teachers were aware of their students' reactions to Justin.

They talked back to him. They got tired of him at the end of the week saying the same things. Teacher 2

He was dressed cool. They did want to ask Luiz when he was here what his life was like...what he did for a living. Teacher 2

Maybe a girl in there too so...he would have a partner that he was working with. Teacher 1

Quality of videos, graphics, and animation (the perceived professionalism of the program). Teachers felt highly positive about the professional quality of the videos, graphics, and animation of the program.

I thought for the most part it was pretty good. High quality, I'd say. It came through clear. What I did, I don't remember any problems with it. Teacher 1

They were really good. It's a lot better than a quick-time movie on the videos and even the stills, they were really good. Teacher 1

Oh excellent. It's way above expectations, I think. Teacher 2

Icons (the perceived quality of the on-screen icons). For the most part, teachers were satisfied with the icon design.

Oh, they worked really well. There was nothing wrong with those. Teacher 1

No, I don't think the kids found any confusing.... They're used to using a lot of different kinds of video games and...computer games, so they didn't find the icons confusing. Teacher 1

I thought they were excellent and they matched the icons in science.... I was totally surprised. It had the same format. Teacher 2

The first couple times you see them, some of those are real small....I really had to look hard to see which one was which. You know, you click on it and it goes somewhere, so you know what it's for. Teacher 5

Text and reading level (the perceived quality of the text and appropriateness of the vocabulary). The text and reading level were acceptable to teachers.

Yeah, the font was large enough, and the vocabulary was...excellent, the reading level was fine. It was okay. Teacher 1
Well, none had a problem reading it. The only text that they read in front of other people were in their presentations. The reading level must have been okay. I even thought at first for sixth-graders it could be [too] elementary. The level was too low, possibly. But I don't know if the reading part of it was geared toward sixth grade. My first thought was that this could be a fourth, fifth-grader type program, too. Teacher 2

One teacher noted some confusion about the meaning of the term “graphic.”

The only comment was that when they bought a slide or graphic we were all surprised that a graphic was text. We didn't think that should...be called that. Teacher 2

Earning points (student attitude toward the process of accumulating points by correctly answering on-screen questions). Teachers recognized that earning points fostered enthusiastic competition among the students.

There were great discussions down in our halls from group to group. 'How many points does your group have?' 'How many points does your group have?' There was a lot of discussion on that and that was very important. Teacher 2

Cooperative groups

Teachers were very supportive of the cooperative aspect of Loess Hills Interactive. Most students were familiar with cooperative learning in other aspects of their class work. Teachers reported that students seemed actively engaged in discussion and participation while using this program. Teachers also reported that most groups worked out their interpersonal problems and were successful in getting along.

I thought it was just another excellent way for the students to [interact]. Teacher 3

There'll be some kids who would have enjoyed it to do it by themselves, that would have loved to have done it by themselves, and maybe would have gotten more done.... Teacher 3

Supporting materials

Teachers were generally positive about the quality and usability of the User Guide which contained written directions and suggestions and the worksheet questions for the “main” videos. One teacher made some suggestions for supplemental hands-on activities.

...[I] thought that blue manual, direction manual, was very good. Teacher 4
They didn't have any trouble finding the questions, and I thought [the User Guide was] real usable. Teacher 3

We talked about it at the very beginning how you could do that but they used the manual to walk themselves through....The manuals were really helpful for that. Teacher 1

It would need a teacher's guide with hands-on experiments to go with it, for a teacher, because I don't teach any geology or earth science so I don't...have a repertoire of hands-on projects. So I would need a guide, a teacher’s guide that would have that, with good successful ideas. Teacher 2

I thought they were excellent....The only thing I would like as a teacher would be hands-on ideas or other videos they could have watched....They needed to be more specific. We had to call down to Tom and ask what kind of pelican....Then we could start our research but just pelican was just a little bit too vague. Teacher 2

Teachers considered the questions on the worksheets important to the learning process. One teacher noted that the worksheets included in the User Guide might include more application type questions for the students.

But I think if there hadn’t been questions there they wouldn’t have been on task near like they were. Teacher 5

I think that with that there should have been some application, okay? And maybe they could have created some scenarios and the kids made some decisions based on the scenarios. But...it was very literal....We never got into the higher order thinking skills. Teacher 1

Some of the teachers initially seemed confused over the development of the project. They would have preferred a more definitive description of the student project development process.

The presentation directions were too open-ended....The presentation was too open-ended. I wanted more things on that, so I could help the children. Teacher 2

I was still kind of at a loss as to what the project [was about]. They were supposed to do this project at the end....It was real vague. Teacher 5

Access to the program

Because all of the teachers had to leave their classrooms (and in one case, their building) to use Loess Hills Interactive, access to the program was a concern.
That one week was a nightmare. And I have an excellent student teacher. I would have gone insane. I would have had to rely on her and that would have been totally unfair. I don't know how I would have done it. And I wasn't up here that much. But I was just so far. If they could have brought it to the room, that would have been okay. That was my first choice. Teacher 2

'Access' is the big word. Our ICN room is quite busy, so it couldn't be tied down. [Programs] would have to come in [on separate]lines like this. Teacher 2

...especially if it was right there, you know, if we hadn't had to worry about it being covered and everything, boy, if it was right there, and you could see it anytime, anywhere.... Teacher 3
Summary and Suggestions

The following section revisits each theme, summarizing the data from the survey, focus groups, and interviews. Suggestions are made based upon the data.

Learning with interactive multimedia

Data from all three sources overwhelmingly reflected student and teacher support for using interactive multimedia in the classroom. Students expressed a desire to use similar programs with additional topics in other curricular areas. They perceived using interactive multimedia as a very positive learning experience.

Motivation (the degree to which the program stimulated student interest). There was a high motivation factor for most teachers and students. Of course, the participating teachers were those who had agreed to test the program with their students and their initial interest would be a factor in their agreeing to participate. Students were also motivated, though. Some of that motivation was almost certainly due to novelty—something different from what they usually used in their classrooms. Leaving the regular classroom and being aware of participating in a special event (a four-school pilot study) may also have heightened student motivation, as well.

Learner control over path and pace of learning (the degree to which the program allowed the students to decide their direction and speed). Both teachers and students liked the aspect of learner control that students had while working with the program. Teachers saw learner control as a motivating factor for students. Students saw learner control as a welcome opportunity to determine both what they wanted to focus on and how fast they wanted to go. The number of options for students seemed appropriate; students did not complain of getting lost in the "hyperspace" of the program, nor dissatisfied with the number of available options.

Educational usefulness and content

Overall, participants indicated that they learned a lot from the program, because they did not know very much about the Loess Hills before they used the program. The relevance of the content for Iowa students was noted. The program may provide a way for schools that do not have earth science as part of their curriculum to offer students a resource that fills this need. The flexibility of this program is that it may be used in several ways in the curriculum. It could be used as part of Iowa history, preservation of the environment, geology, or ecosystems.
Teachers should be given suggestions about how to use the program. A survey could be made to determine potential niches in the existing curricula.

Many participants made suggestions of subjects that may lend themselves to interactive learning. These subjects included social studies, science, math, and history. Participants seemed eager to have more programs with a variety of topics.

Hardware and software

Technical reliability (the perceived freedom of the program from glitches). Both the data from the survey, focus groups, and interviews reflected the technical problems which plagued the program during the time it was on-line to the schools. All students experienced times when the program would freeze or even would not permit access. Considering the extent of these problems, which interfered with many students even completing their projects, students still seemed able to differentiate between the potential of the program and their actual experience.

Remote control and logging on (respectively, the hand-held device used to move the cursor and the process of entering a group name and password at the beginning of each session). The remote control that was provided for students to use with the TV monitor was considered by most participants to be awkward. Students are accustomed to the ease of a mouse to move a cursor around a screen. Because of programming problems, the cursor would only scroll through the screen and students found it laborious to do so, especially as they went through the logging-on process which involved picking letters from a diagram of a keyboard for both the group name and the password. Because of the high number of technical problems, students were required to go through this logging-on process many more times than should have been necessary. Adding to the frustration was the number of small buttons on the remote control.

Program design

Humor (the perceived amusing nature of the content). Overall, the teachers seemed to like the humorous aspects of the program. Students and teachers alike expressed fondness for the frog and his slurp, followed by “You got it.” It was the one thing mentioned repeatedly in response to the question, “What did you like best about the program?”

Quality of the videos, graphics, icons, animation, and text (the perceived professionalism of the videos, graphics, icons, and text of the program). All participants seemed satisfied overall with the professional quality of the videos, graphics, icons, animation, and text. The use of the word “graphic” in reference to written transcripts when students were choosing project elements was confusing to a number of participants. The student
attitudinal survey indicated some dissatisfaction with the length of the videos, but this may have been a reflection on the “alternative” videos which did not have worksheet or on-screen questions to stimulate interaction among the students. There was some indication that some students would like more information in the “animal clips.” This information could take the form of factual data about each species, which might help students develop their presentations.

**Justin (student attitude toward the young video host of the program).** Data from the students indicated that many of them were dissatisfied with how Justin was presented on-screen. It seems that most of the comments from the younger, 6th-grade students, were positive: “He’s cool.” But the older students seemed unhappy with the fact that he repeated the same message every time they logged on and they did not seem to relate to him as the younger students seemed to. Teachers noted their students’ annoyance with him. Some suggestions were to include more than one host or make the host younger (or older).

**On-screen questions (the perceived appropriateness of the on-screen questions posed to students by the program).** There was some difference of opinion about the content of the on-screen questions in the videos and the “quiz-me” section. Some students felt that a few of the questions were too easy. One teacher noted the dilemma of making it challenging while allowing most students to succeed.

**Cooperative groups**

Teachers and students alike seemed to appreciate the use of cooperative groups with this program. Teachers reported that students seemed actively engaged while using the program. Teachers indicated that their students were used to working in small groups with other learning activities. Students liked that fact that they worked together, helping each other. Students expressed a desire, though, to be able to choose their groupmates instead of being assigned by the teacher.

**Supporting materials**

Most of the teachers found the User Guide satisfactory. However, one teacher suggested a hands-on kit be created for teachers and students to enrich student learning. This kit might include soil samples and suggested experiments and projects. There was some initial confusion about the development of the student projects in conjunction with the program. The term “multimedia presentation” may more accurately reflect what the students are expected to do after they work with the program.
Although the students were not very positive about the worksheets, teachers thought that the worksheets helped the students by giving them a focus while they were exploring the program. Several teachers thought more worksheets—over other areas of the program—would be helpful. Also, one teacher thought that the level of questions on the worksheets should include application type thinking, so students would be required to give more than just factual information.

Access to the program

Several teachers expressed a concern that the program, in order to be integrated into the curriculum, needs to be easily accessible for both them and their students. In order to allow groups of students access to the program over the high-density phone line, four of the five teachers had to arrange for outside supervision of the their students at a location distant from the regular classroom. In the other case the teacher moved her whole class to be near the room where the groups of students were working. Several teachers mentioned the fact that ease of access is very important. If the program is too hard to schedule, it will not be used.

Conclusion

Several factors challenged full teacher and student enjoyment of Loess Hills Interactive during the pilot test conducted in the spring of 1996. Delays in making the program available to the schools limited student participation and prevented greater integration of the program into the curriculum. Interruptions in delivery frustrated students as well as teachers. Less seriously, a flawed log-on procedure was aggravated by an awkward remote control. Finally, the inconvenience of getting students from the classroom to the program delivery site was a major concern of the teachers.

And yet, the survey, focus groups, and interviews leave little doubt that the Loess Hills Interactive pilot test was successful. Participants were overwhelmingly positive about the program, as well as the potential of the technology as a learning tool. Teachers and students noted the program’s high-quality video, graphics, and screen design, and the high level of student interest the program created. Students liked learning with Loess Hills Interactive and expressed a desire to use similar programs. So did their teachers—if those programs are easily accessible.
Appendix A

Loess Hills Interactive Student Survey
You have recently been working in small groups with an interactive multimedia program called *Loess Hills Interactive*. We would like to ask you for your opinion about the program and the group learning experience.

**Section 1** Think about the Loess Hills program you have been using and respond to statements 1 through 23. Circle the number that best represents your views. Use the following scale:

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th>D</th>
<th>MD</th>
<th>MA</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Loess Hills program was interesting.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2. The program made me more interested in science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3. The program helped me understand the importance of preserving the Loess Hills.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>4. The graphics and animations looked professional.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>5. The video segments looked professional.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6. The Loess Hills program was easy to use.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7. The remote control was easy to use.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>8. The icons (symbols) were easy to understand.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9. The screens were easy to understand.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>10. The text on the screen was large enough and clear enough to read.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>11. The host, &quot;Justin,&quot; helped me understand the program.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>12. The worksheets were helpful.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>13. There were enough video segments to choose from.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>14. The dictionaries were helpful.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>15. The video segments were too long.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
16. The maps were helpful. 1 2 3 4 5 6
17. Doing the project helped me learn more. 1 2 3 4 5 6
18. The feedback after answering the questions was helpful. 1 2 3 4 5 6
19. The library was a good way to organize and display options. 1 2 3 4 5 6
20. I could find the information I needed in the program to answer the questions. 1 2 3 4 5 6
21. The Loess Hills program was a worthwhile activity. 1 2 3 4 5 6
22. Overall, I was satisfied with the Loess Hills program. 1 2 3 4 5 6
23. The Loess Hills program was a good way to learn. 1 2 3 4 5 6

Section 2 In the previous section, we asked your opinion about the Loess Hills program. The Loess Hills program is an example of an interactive multimedia computer program. Now think about your experience with other programs similar to the Loess Hills program and respond to the following statements. Circle the number that best represents your views. Use the following scale:

1 = strongly disagree  2 = disagree  3 = moderately disagree  4 = moderately agree  5 = agree  6 = strongly agree

When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

24. ...I learn better. 1 2 3 4 5 6
25. ...I don't learn much because the lessons are so mixed up. 1 2 3 4 5 6
26. ...I think exploring and searching for information is a good way to learn. 1 2 3 4 5 6
27. ...I learn things better when I can see and hear them. 1 2 3 4 5 6
28. ...I think I can learn better from a videotape than from an interactive multimedia computer program. 1 2 3 4 5 6
29. ...I think it is a good way to learn. 1 2 3 4 5 6
30. ...I like to explore and search for information. 1 2 3 4 5 6
31. ...I think I learn as much as in a regular class. 1 2 3 4 5 6
32. ...I feel I have control of my own learning. 1 2 3 4 5 6
33. ...It is more interesting than regular classroom instruction. 1 2 3 4 5 6
34. ...I think I can learn better from books. 1 2 3 4 5 6
When I use interactive multimedia computer programs with text, video, photographs, drawings and sound...

35. ...I would rather learn in a different way. 1 2 3 4 5 6
36. ...The choice of text, video, photographs, drawings, and sound make learning more fun. 1 2 3 4 5 6
37. ...I like to set the pace of my own learning. 1 2 3 4 5 6
38. ...I'm not sure what I'm supposed to be learning. 1 2 3 4 5 6
39. ...I like it because I don't have to watch parts I don't want to watch. 1 2 3 4 5 6
40. ...I like it because it lets me learn on my own. 1 2 3 4 5 6
41. ...It is a waste of time because there is no clear purpose. 1 2 3 4 5 6
42. ...It lets me learn the way I learn best. 1 2 3 4 5 6
43. ...It is confusing. 1 2 3 4 5 6
44. ...I would like to try other interactive multimedia programs. 1 2 3 4 5 6
45. ...Exploring and searching for information is a waste of time. 1 2 3 4 5 6
46. ...It is a good way to learn because it does not have to be used the same way every time. 1 2 3 4 5 6
47. ...Choices between text, video, photographs, drawings, and sound are confusing. 1 2 3 4 5 6

Section 3 Now think about your experience working in your group with the Loess Hills program and answer the following questions. Circle the number that best represents your views. Use the following scale:

1=strongly disagree  2=disagree  3=moderately disagree  4=moderately agree  5=agree  6=strongly agree

48. Working in small groups makes learning fun. 1 2 3 4 5 6
49. I usually prefer to work by myself. 1 2 3 4 5 6
50. Working in small groups helps me learn better. 1 2 3 4 5 6
51. I liked working with my group. 1 2 3 4 5 6
52. I would have been more comfortable working alone. 1 2 3 4 5 6
53. I would choose to work in this group again. 1 2 3 4 5 6
54. My group worked too slowly for me. 1 2 3 4 5 6
55. Group members helped each other complete the lesson. 1 2 3 4 5 6
56. My group learned a lot from the program. 1 2 3 4 5 6
57. I could have accomplished more working alone. 1 2 3 4 5 6
58. Everybody in my group got to participate. 1 2 3 4 5 6
59. The group listened to everyone's ideas. 1 2 3 4 5 6
60. Everyone in the group helped each other. 1 2 3 4 5 6
61. My suggestions and explanations helped other group members with the lesson. 1 2 3 4 5 6
62. I helped group members when they had questions about the lesson. 1 2 3 4 5 6
63. I did not help answer questions in my group. 1 2 3 4 5 6
64. I helped my group make decisions during the lesson. 1 2 3 4 5 6
65. My group members were helpful to me. 1 2 3 4 5 6
66. When I asked a question, my group members did not help me. 1 2 3 4 5 6
67. Members of my group explained what I did not understand. 1 2 3 4 5 6

Section 4 Please circle the response that best describes how much you knew about the Loess Hills before you used the Loess Hills program.

1 = Nothing 2 = A little 3 = A lot

Now, we'd like you tell us a little about yourself. Please mark the appropriate response.

I am male female
My ethnic origin is Caucasian Black American Asian/Pacific Islander
Hispanic Native American Other

I am in grade 5 6 7 8 9

How many boys _____ and how many girls _____ were in your group (including yourself)?
Appendix B

Student Focus Group Questions
Loess Hills Interactive
Student Focus Group Questions

1. What do you think of the *Loess Hills Interactive* program?

2. What did you like best about the program?

3. What didn’t you like about the program?

4. If you could change the program, what changes would you make?

5. How did the cooperative groups work out?

6. What would you say is the ideal group size for working on the program?

7. Is interactive television like *Loess Hills Interactive* a good way to learn? (Why or why not?)

8. What kind of students do you think would learn best from this kind of program?
Appendix C

Teacher Interview Questions
Loess Hills Interactive
Teacher Interview Questions

1. What do you think of the Loess Hills Interactive program?
2. What do you like best about the Loess Hills Interactive program?
3. What do you like least about the Loess Hills Interactive program?
4. If you could, how would you redesign the Loess Hills Interactive program?
5. Was the remote control easy to use?
6. Did the students find the program easy to use?
7. Were the icons easy to understand?
8. Were the screens easy to understand?
9. Was the text easy to read?
10. How would you rate the accessibility and usefulness of the help?
11. How would you rate the quality of the manuals and documentation?
12. How would you rate the quality of the graphics and animation?
13. How would you rate the clarity of the video?
14. How would you rate the clarity and volume of the audio?
15. How accurate was the content of the program?
16. Do you think the program is a motivating instructional product?
17. Do you think the program is a meaningful instructional product?
18. Did the program support the existing curriculum?
19. Did the program and supporting material help you prepare a unit on the Loess Hills?
20. How effective was the collaborative learning aspect of the program?
21. Were students actively engaged in discussion and participation while using the program?
22. For what types of learners was the program best suited?
23. What types of learners seemed to enjoy the program most?
24. What was your opinion of the program's library metaphor?
25. How adequate was the level of user control over the program?
26. Did you find the program amusing?
Appendix D

Iowa Public Television
*Loess Hills Interactive* Development Team
Iowa Public Television *Loess Hills Interactive* Development Team

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