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LOCUS OF CONTROL AND INSTRUCTIONAL CONTROL IN INTERACTIVE VIDEODISC SCIENCE INSTRUCTION

by

Cyril A. Binette

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NAME OF AUTHOR: Cyril Albert Binette

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Cyril A. Binette

Permanent Address:

5 Brookside Crescent

Spruce Grove Alberta

Canada T7X 1B8

DATE October 8, 1992

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FACULTY OF GRADUATE STUDIES AND RESEARCH

THE UNDERSIGNED CERTIFY THEY HAVE READ, AND RECOMMEND TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH FOR ACCEPTANCE. A THESIS ENTITLED: Locus of Control and Instructional Control in Interactive Videodisc Science Instruction SUBMITTED BY Cyril Albert Binette IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION.

Dr. J. J. La Follette

Dr. A. T. Olson

Dr. P. W. Wright

DATE October 8, 1992

DEDICATION

I respectfully dedicate this thesis to my loving wife Brenda and to my two children Shantelle and Nicholas. I would also like to dedicate this thesis to my parents Ray and Terry Binette and to Nick and Vicky Trefanenko who offered me patience, love and support throughout the development of this work.

ABSTRACT

Many research studies have added to the body of knowledge concerning the effectiveness of learner or program control used in various instructional lessons. Fifty grade seven science students participated in a study to compare instructional control and perception of locus of control of reinforcement in interactive videodisc instruction.

Based on the systematic design of instruction model of Dick and Carey (1990) an instructional prototype was developed on weathering and erosion for grade seven science. Students were assigned to either program control or learner control based on their locus of control of reinforcement (Internals-Externals) as determined by the Nowicki-Strickland Locus of Control (LOC) Scale for Children.

An Analysis of Variance (ANOVA) was performed to determine if there was a significant difference in treatments or attributes due to locus of control.

Results indicated that there was no difference in treatments and no difference attributable to locus of control tendency. Interaction between LOC and control of instruction did occur, however not enough to be significant.

The following conclusions were made based on the evidence found in this research study:

1. An increase in academic achievement in the learner control treatment and the program control treatment supports the research literature on the effectiveness of interactive instruction.

2. Students find the use of new instructional tools exciting and highly motivating. They have a strong desire to finish instruction and to do the best they can to attain curricular objectives.

3. Use of instructional design models was essential in the development of the instructional prototypes.

4. A greater distinction must be made between instructional treatments to effectively evaluate interaction between LOC and treatments.

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INTRODUCTION

Students often have difficulty conceptualizing major concepts throughout certain areas of the science curriculum because the concepts may be too vague or abstract for them to understand. Such concepts as: Volcanism, Plate Tectonics, Continental Drift and Weathering and Erosion are prime examples. Accessibility and convenience to learning resources that allow a strong visual representation to illustrate these concepts are not always available to teachers.

Most human communicative events are significantly influenced by physical and mental images. In view of this, pictorial forms, auditory modalities, text, and graphic effects have always played a vital role in learning and instructional processes. Within virtually all learning situations, perception and cognition are of fundamental importance. So too, is the use of images to promote and amplify these basic processes. Thus, as a result of our ability to analyse complex visual scenes we are able to build up mental images and models of the external world in which we exist. Imagery also plays a major role within many of the cognitive processes associated with communicating, remembering, thinking and action taking.

With the introduction of optical videodisc storage, large data bases of visual images in the form of video segments and still frames allow the teacher and student greater accessibility to vast quantities of information for use in clarifying, and explaining these concepts within their classrooms.

The key to successful implementation of emerging technology into the educational system will be dependent upon the extent to which the student will be actively involved in cognitive activities while interacting with these new technologies. Interaction with well designed new innovative technologies such as laserdisc technology and computer-assisted instruction should lead to a better understanding of major concepts relevant to effective science instruction. Interactivity implies that learners are active participants in the instruction and learning process. The passive aspects of television or film media are compensated for by the activity encouraged by computer control in Interactive Video Instruction (IVI) (Laurillard, 1984). The contention is that any medium encouraging active participation on the part of the learner is better than a purely passive information presentation (D. Clark, 1984; Hon, 1983; La Follette, 1991; Roach, 1984; Smith, Jones and Waugh, 1986). Interactive video is seen to have favorable results in the educational system (Allan, 1986; DeBloois, Maki & Hall, 1984; Hannafin & Schaffer, 1986; Hon, 1983).

In science education, Litchfield and Mattson (1989) support the use of interactive videodisc instruction (IVI) for the following reasons:

> 1. Interactive videodisc instruction allows the opportunity for students to actively interact with materials or participate in inquiry learning. Programs using IVI may be inquiry-based where students are actively involved in decision making and acquisition of knowledge is based on interpretation of data.
>
> 2. IVI provides students with meaningful experiences where they are able to develop problem solving skills and begin to see science as an integral part of their daily lives.
>
> 3. The capability of IVI to present science content may be developed according to logical sequences of problem oriented activities; science subject matter and science processes should be presented simultaneously.

Instructional control refers to the extent to which the learner is allowed the ability to exercise control over the instructional system. Program control is instruction best adapted to individual differences through the instructor's or designer's selection of learner control parameters. These parameters are based upon the goals or objectives of instruction and learner characteristics and needs. Supporters of program control argue that students do not always make effective use of control options in learner control and that they are not always good judges of their own understanding. Learners also differ in the degree to which they prefer control or are able to exercise it effectively. Not all learners know what is best for them at any particular moment in an instructional sequence. (Allen & McDonald, 1966; Carrier, 1984; Fry, 1972; Judd, 1972; Snow, 1980; C. L. Tennyson, R. D. Tennyson & Rothen, 1980).

Learner control can best be described as the degree to which a learner is permitted to direct his/her own learning process. Elements in CAI and IVI that can be controlled by the learner, rather than by the instructional program itself, include sequencing and pacing, display selection, choice of objectives, amount of practice, immediacy of feedback, and review of content for practice items answered incorrectly.

An assumption that has long shaped the design of computer based learning packages is that individual differences in abilities and aptitudes can be accomodated if learners have more control over pace, amount of practice, or style of instruction they receive. There is evidence that increased control of the learning environment enhances feelings of self efficacy and self-determination and helps learners take independent responsibility for their own learning behaviour (Laurillard, 1984; Merrill, 1975). In several studies, students given control over the amount of selection of material tended to stay on the task and learn more (Merrill, 1984; Newkirk, 1973; Milheim, 1990; & Wydra, 1980).

The construct of locus of control is also purported to have strong implications for learning (Rotter, 1966). Locus of control relates to individual's perceptions of whether successes and failures in their own lives are the result of their own actions or the result of other factors or person's actions. Despite an extensive body of research on locus of control, its implications for instruction need to be examined experimentally.

It is the main purpose of this study:

1. To develop interactive videodisc instruction that will enhance learning of difficult concepts in secondary science education.

2. To increase academic achievement and student motivation by using new instructional tools.

3. To research instructional control and locus of control as important design variables in interactive videodisc instruction.

CHAPTER II.

RELATED RESEARCH

INTERACTIVE INSTRUCTION:

Interaction in a very broad sense would be a mutual or reciprocal action or influence on someone or something. For countless decades humanity has seen interaction as a key concept in the communicative process. The mutual, reciprocal action or influence of man's environment has lead to discoveries and inventions that astound each and everyone of us. It is very apparent that interaction between people within our society is influencing everyone on this planet.

Selnow (1988) proposes three features as critical in characterizing interpersonal communication and therefore interaction:

> 1. Messages must be receiver specific. The source must tailor his or her communication for each receiver (this implies, but goes beyond, recognition of the partner).
>
> 2. Message exchanges in the event must follow the pattern of a response contingent progression. Message exchanges are contingent on sequential feedback information (this acknowledges communicative interdependence and flexibility, but also suggests activity and structure).
>
> 3. The channel must provide for a two-way flow of information to accommodate the essential feedback component. (p. 127)

Berlo (1960) indicates that communication between the source and receiver are interdependent. The source affects the receiver and the receiver affects the source. Interaction is seen as one of four levels of interdependence. Interaction according to Berlo is, "*if two individuals make inferences about their own roles and* *take the role of the other at the same time, and if their communication behavior depends on the reciprocal taking of roles, then they are communicating by interacting with each other.*" (1960 p. 130). Berlo goes on to say "When two people interact, they put themselves into each other's shoes, try to perceive the world as the other person perceives it, and try to predict how the other will respond." (1960, p. 131). Good computer-assisted instruction fits this category.

With reference to students that do not bring previous knowledge to a lesson, Borsook (1991) suggests guidance in the instructional process. Computer guided branching is seen to enhance interaction because without it, the computer either follows a predetermined path (low interaction), branches contingent on the learner's answers (moderate interaction), or turns over full control of branching to the learner (moderate interaction because the computer is not influencing [i.e. communicating] it's recommendations)--it is simply reacting to the learner's input. Computer-guided branching maintains the spirit of true interaction which involves receiver specific and influenced messages, and a reciprocal give and take.

INTERACTIVE VIDEO:

DeBloois, Maki and Hall, (1984) define interactive video instruction as:

> " a form of instruction based upon random accessibility of a very large textual, visual and audio database. A population of predesigned instructional motion, and still images, audio and visual reinforcement and feedback segments are retrieved from this base in a pattern which is determined by each learner. Continued and frequent learner intervention, alters the course of instruction in a way that is relevant to each learner's needs."(p.5)

In an instructional sense interactive video is "any video program in which the sequence and selection of messages is determined by the user's response to the material" (Floyd & Floyd, 1982, p. 2). Combining the capabilities of computers with the capacity of videodiscs to store and retrieve information from extremely large data bases allows the learner to follow pre-designed patterns of instruction. Whether this is accomplished through program control or learner control, an individualized interactive program of instruction may be developed to meet individual learning differences.

According to DeBloois, interactive videodisc instruction (IVI):

> "...is seen as the function of the software to store pre-planned instructional strategies, visual images (motion and still) audio signals, selection menus, quiz items, simulations, diagnostic routines etc. The player functions to retrieve information from the disc as commanded by the computer program or as intitiated by the user. The monitor serves as the display screen for both computer and videodisc images, although occasionally two screens, a CRT showing computer text, and a video monitor, showing images from the videodisc are used in tandem. The computer provides the system with it's "intelligence" -- the instructional programming and search algorithm created by the instructional design team."(1982 p. 6)

The interactive instructional system has the ability to focus learner attention on important information and provide information in the form of query and feedback. When instructional designer, subject matter expert, computer and videodisc equipment, and learner all come together it is said to form "a configuration allowing these resources to interact in completely new ways to improve the outcomes of training and instruction" (DeBloois, Maki, & Hall, 1984, p. 10). La Follette, (1989) with reference to the work of (Hannafin, Garhart, Rieber & Philips,1985) supports the proposition that research into interactive video instruction (IVI) must look beyond a "technocentric" perspective toward developing a context for integrating presentation technologies and instructional design and information processing principles.

Hannafin & Schaffer (1986) support this divergence from a "technocentric" perspective by noting:

> "...interactive video appears to effectively focus attention on intended learning by isolating important information, querying learners, and providing feedback and remediation as needed. In many regards this may be more closely akin to sound instructional practice than to an inherent capability of the technology." (p.94)

EFFECTIVENESS OF INTERACTIVE VIDEO INSTRUCTION:

DeBloois, Maki & Hall, (1984) summarize in three statements what the research literature claims are the reasons for the effectiveness of interactive videodisc instruction:

> 1. Interactive videodisc instruction which is thoughtfully and systematically developed, and shows creative new instructional strategies is beginning to demonstrate consistent positive results.
>
> 2. Typically learners who use interactive systems are achieving scores which are significantly higher than learners using other approaches. They often do this although they spend less time in instruction. Uniformly, these learners report they enjoy and prefer working with interactive videodisc systems over conventional mediated approaches.
>
> 3. The concept has been proven, interactive videodisc lessons can be created, the equipment can be successfully integrated, and it stands up, under thousands of hours of use.
>
> (DeBloois, Maki & Hall p. 53)

The substantial advantages to educators claimed by proponents of interactive videodisc instruction are increasingly being supported by empirical evidence. Therefore, it is appropriate to analyze what the research literature says to support or refute the claims as to the effectiveness of interactive videodisc science instruction. In the last few years sound qualitative and quantitative research is beginning to appear on interactive videodisc technology within science education.

Smith, Jones & Waugh (1986) studied interactive videodisc in a chemistry setting. Interactive computer-assisted videodisc laboratory simulations combined microcomputer graphics and text with video images from a laser videodisc player on one screen in a predesigned tutorial. The lessons were evaluated as prelaboratory instruction and as laboratory replacement for 47 students in a group of 103 students enrolled in a general chemistry course. Student performance on laboratory reports was significantly better for students who used the videodisc lessons before laboratory work. Students who used the videodisc lessons as a laboratory replacement achieved significantly higher test scores than students who performed a traditional laboratory experiment on the same content material.

Stevens, Zech & Katkanant (1987) focused on the implementation of an Interactive Videodisc Science Lesson on Titration in a high school chemistry class. Although data were collected by the usual types of achievement and attitude instruments, it was the observational data and practical information that surfaced as important for classroom teachers, administrators, teacher educators, instructional designers and evaluators of instructional technology.

The purpose of the study was to conduct a formative evaluation of a federally funded interactive videodisc instruction high school science project (Stevens, Zech & Katkanant, 1987):

1. to refine interactive videodisc science lessons,

2. to evaluate the effect of an instructional application procedure on student outcomes, and

3. to investigate a specific classroom application.

The specific application in this case was to integrate one of four interactive videodiscs designed for high school science students. This study focused on the implementation of a lesson on titration in a science classroom with the traditional laboratory approach in a traditional setting. The emphasis was to investigate the effect that sequencing the lab activities would have on achievement, attitude scores and general classroom activities of students and the instructor in a secondary chemistry class. The titration lesson required correlating the volume of titrant used (computer code) with the speed of the video portion on the disc. Each lesson utilized a videodisc, two microcomputer disks, and print support materials (student and teacher manuals).

Students had a positive attitude toward using the lesson and more students appeared to prefer the interactive videodisc simulation to conducting the actual lab experiment; however they were not quite as sure of the effectiveness of the interactive videodisc lesson over the lab experience. Student ratings clearly showed a positive feeling about using the interactive videodisc system as an instructional tool. Almost all of the students indicated that they enjoyed learning with the interactive videodisc system and suggested more interactive videodisc lessons be made available.

There was no significant difference between achievement or attitude scores of the two groups. It did not make any difference in achievement whether the students used the interactive videodisc lesson before conducting the experiment or reversed the process. This finding is important to classroom teachers when trying to manage two modes of lab instruction with limited equipment and lab stations.

The main advantage of the use of interactive videodisc was that students who completed the titration process spent much less time setting up equipment and conducting the experiment than students beginning their experience in the lab. Interactive videodisc lab students required only the prescribed amount of solutions to conduct the experiment, knew the data to be looked for and were more accurate in determining the end point.

According to the instructor the teaching role changed dramatically. The instructor worked with the students individually or with small groups by responding directly to learning needs. The teacher commented on several occassions that standing back and watching students learn was exciting and expressed satisfaction at having the time to work with students with special needs. Less teaching time was offset by more planning and preparation time and working directly in class with students one on one.

The following recommendations were made with regard to using interactive videodisc instruction within the science classroom:

1. Classroom application of technology research needs to include written information and quantifiable observational data.

2. A variety of systematic teaching applications need to be studied to provide teachers with teaching alternatives in integrating IVI science lessons into the curriculum.

3. Findings in this study support the use of IVI lessons in traditional classrooms; however, careful planning and preparation is necessary for successful implementation.

4. Teachers need to network to share teaching ideas and interactive videodisc experiences to maximize the educational benefits to students.

(Stevens, Zech & Katkanant, 1987)

In physics instruction, Zollman & Fuller (1982) used an interactive videodisc program on the puzzle of the Tacoma Narrows

Bridge collapse. This was used to explain the phenomena of wave motions and oscillations to physics students at various levels of instruction. The main strength of using interactive videodisc technology was that this program provided physics teachers with a valuable resource in which students were highly motivated to interact with instruction. Gautreau (1986) states that an important concept in the study of motion is the understanding of how the position of an object varies with time. Interactive videodisc is especially suited for motion analysis in that the frame number indicator acts as a built in clock, since the frames are separated from each other by 1/30 second. Further, the numbers are also convenient to use, since every three frames corresponds to a time passage of 0.1 seconds. This allows students to time the position of an object as it varies through time by using the videodisc in a unique fashion. Using a transparent calibrated grid placed on the monitor of the videodisc machine, students may combine the overlayed calibrated grid with the video frame number indicator providing a basic setup for any videodisc player to be used for analyzing motion.

In biological science, Bunderson (1984) and WICAT systems Inc., produced a "proof of concept" videodisc in college biology with the support of the National Science Foundation. The project involved simultaneous development of content design, instructional strategies, software design, and software and hardware with a principal focus on evaluation of the instructional videodisc in the classroom. Videodisc development proceeded through three phases of increasing sophistication and evaluations performed at each phase, including several comparisons of student learning with videodisc instruction and traditional lecture learning which were conducted at three different colleges. Results indicate that videodisc students consistently displayed greater learning and retention gains, reduced study times, and higher productivity ratios.

Biological science, health sciences and, biomedical education, especially physiology, traditionally have used live animal experimentation to teach biological principles and problem solving skills. Branch, Ledford, Robertson & Robison (1987) found the use of interactive videodisc instruction to be effective as an alternative to traditional techniques in teaching auscultation of the canine heart. This study revealed a more humane approach to the study of physiology.

Applied to the health sciences, interactive videodisc instruction is becoming increasingly useful. The strength of interactive instruction lies in the ability to offer individualized instruction within the health sciences (Allan, 1986; Bove, 1986). An analysis of a widely recognized study by David Hon, (D. Clark 1984) found that students in biomedicine using a videodisc-based simulation learned the technique of Cardiopulmonary Resuscitation (CPR) in one-third the time required in a conventional teacher/student situation. As well, retention rate doubled. Persaud (1986) used interactive video and simulated case studies to promote critical thinking in clinical practice. Harless (1986) developed a prototype interactive health drama whereby a fictitious patient, Frank Hall, complains of weakness and abdominal pain following an episode of vomiting blood. The simulated patient illustrates the medical content and sociological issues related to a variety of gastroenterology problems confounded by alcoholism. Three main strengths of this interactive drama were: 1) an engaging and relevant context for teaching cogent points; 2) the opportunity to participate actively in making decisions about important situations relevant to educational goals, observing the results of interventions, and discussing the implications with instructors and peers; and 3) the opportunity for students and instructors to engage in true discovery learning since the course of events and outcomes of a drama are not predictable–even by the instructor. At this point in time, research in biomedicine and science, indicates that interactive videodisc has already become an effective method of instruction.

One of the primary principles of curriculum design set forth by the authors of videodisc courses in earth science is to show how seemingly unrelated phenomena can be unified through a common set of rules. Learning a small set of related rules that then make sense out of dozens of facts is easier than learning those same facts as unrelated bits of information. Englemann and Carnine (1989) suggest that the videodisc would help to identify and teach those concepts necessary to understand the underlying principles of a discipline. The underlying principles are presented and then used to explain various facts. For example, in earth science, convection can be used to explain many of the phenomena found in the earth, atmosphere, and oceans. In short, students first learn the prerequisite concepts needed to understand convection. Convection then serves as the underlying principle for many of the natural phenomena found in the earth, oceans and atmosphere. These phenomena are not unrelated facts, but part of a lawful, comprehensible system.

Mashiter (1988) lists the following reasons for interactive videodisc being particularly applicable in science education. The currently popular movement away from "content" towards "process" in science education is upheld by the use of IVI. Particularly well received are those processes impossible to demonstrate in the school laboratory, whether due to time, apparatus, staff availability, or for reasons of safety, expense or practicality. Interactive experiments demonstrate to the user the consequences of their actions and decisions, and the opportunity to adjust or recover the situation if necessary and appropriate.

Farragher (1992), sees the applications of interactive video to science teaching as very promising. Quoting Reif (1985), he states that ample opportunities exist for further exploration of interactive video in science education. He recommends basic research on cognitive issues including thought and learning processes, the structure of knowledge, mental models, relevant artificial intelligence research, and evaluation relevant to learning theory. There is also a need to examine relevant applications of the technology such as simulated laboratory environments and intelligent tutoring. Interactive video may prove to be especially useful in science education as a vehicle for teaching laboratory skills through individualized tutoring.

INSTRUCTIONAL CONTROL

Learner Control versus Program Control

Instructional control refers to the extent to which the learner is allowed control over his or her learning. Sequencing, pacing and feedback are strategies which influence the instructional process, and the degree to which these are regulated by the designer determines where instructional control resides. In interactive instruction, learner control and program control are important design variables.

> "A crucial aspect of interactive instruction which relates to the learner's processing of the media within a complex instructional system is the manner in which the system permits control during learning. Under learner control, adaptive instructional decisions are made by the student, in contrast to system control where instructional decisions (adaptive or linear) are made for the student. Design decisions along this dimension, in interplay with the learner and the medium would seem to determine the true nature and quality of the interaction involved." (La Follette, 1990 p. 7)

A strong case may be made that instruction can best be adapted to individual differences through the instructor's or designer's selection of learner control parameters. These parameters are based upon the goals or objectives of instruction and learner characteristics and needs (Allen & McDonald, 1966; Fry, 1972; Judd, 1972; Snow,1980; C. L. Tennyson, R. D. Tennyson & Rothen,1980).

An alternative view suggests that this is too constrictive and that students should have the ability to choose their own control of sequence, pace of instruction, display selection, choice of objectives, amount of practice, type and immediacy of feedback and review of content. Allowing the learner a great deal of control over these variables would be to a large extent exercising a high degree of learner control (Laurillard, 1984; Merrill, 1975; Merrill, 1984; Milheim, 1990; Newkirk, 1973; Wydra, 1980).

Despite the anticipated potential advantage for greater learner control, research to date has yielded mixed results on the effects of learner control (Carrier, Davidson & Williams, 1985).

In theory, learner control could include student choices at the curriculum level, the opportunity for a student to study a given unit as long as needed, or the ability of the student to select and sequence a variety of internal processing strategies (Merrill, 1984). Utilization of a great deal of learner control is seen as important for the development of improved learning strategies, improved attitude and an improved sense of responsibility on the part of the learner (Fine,1972; Ross, Morrison & O'Dell, 1988; Newkirk, 1973). An added benefit is the ability to allow the learner to organize and control learning.

Laurillard (1984) investigated how students would operate within a complex learning medium that gave them maximum control over the learning process. The results showed conclusively that students can indeed make use of maximum control. In research on sequencing of material, Newkirk (1973) discovered that students under learner control learned as much as students using a program control strategy; they also appeared to retain most of what they learned, whereas students taking the program controlled strategy sequence forgot significantly more after two weeks. (Ross, Morrison and O'Dell 1988) found that subjects under more learner control had a high degree of task persistence as demonstrated in their pacing rates. Results also indicated that instructional designers might consider selective uses of low density narrative to reduce length and time in learner control situations.

David Merrill (1984), one of the more prominent researchers on instructional control argues that all instruction involves some learner control. The challenge is not whether or not learner control should be made available, but rather how to maximize the student's ability to use the learner control available. Given a system which allows content selection and display selection, the important question is how to maximize his/her choices and match them with appropriate cognitive processing activities in order to maximize performance. Research indicates that learner control with some form of coaching has been consistently superior to unassisted learner control (Hannafin, 1985).

It has been suggested that program control can be a powerful management strategy for computer-based instruction when the learner is sufficiently advised of specific learning needs (Carrier, 1984). Although there is a strong, intuitive appeal for allowing students to choose the type of instruction, too much learner control may lead to skipping of essential concepts in instruction. In general, research results suggest that allowing a moderate amount of learner control over instruction yields better achievement than permitting a higher degree of learner control (Lopez and Harper, 1989).

Within the research literature a distinction is made between program control with branching and linear program control. Program control with branching offers a wide variety of branching options, all of which are executed under fixed lesson, rather than learner control. In such designs, contingencies are typically established which control the need for, or selection of, systematic branching. This branching allows students to branch throughout the lesson. As they experience difficulty, the lesson will adapt and branch the learner to appropriate lesson segments as needed. In each case movement through the lesson is dictated by the designer based upon predetermined needs and characteristics of the learner (Hannafin, 1984). Thus program decisions are made based on the learner's response.

In a linear program control treatment such as that used in a study by Goetzfried and Hannafin (1985), the learners received the same sequence of instructional material but no advisement as to progress. There were neither externally generated program decisions nor learner control over the pace of the lesson, other than the ability to determine when to start. Learners did not have the opportunity to respond to problems. They were merely given the problem, and then were allowed to view the solution on the next screen. Each lesson had to be completed prior to proceeding to the next lesson. Results from the basic linear control strategy yielded comparable learning, coupled with significantly less instructional time.

R. E. Clark (1983) notes that measurement of learning efficiency as a result of program or learner control may give spurious results. Learning may be more inefficient when the learner is given more control, especially with more difficult material and larger instructional units, but the learner may as a result be able to synthesize and adapt the knowledge to new situations. He states that this is a largely unexplored hypothesis.

Milheim and Azbell (1988) sum up the research on learner control studies in the following eight points:

> 1. Learner control is as effective as program control in terms of achievement scores for students using this control strategy.
>
> 2. Attitudinally, learner control is rated equal to (or better than) program control by students using these strategies.
>
> 3. Some type of learner control may be appropriate in many different interactive video learning situations.
>
> 4. Training in how to use learner control options is important.
>
> 5. Learner control of content is often not appropriate since some students may skip important material or quit the lesson too soon.
>
> 6. The adaptation of interactive video material for each learner, although potentially difficult is very important.
>
> 7. Advising a student during instruction as to sequence and pace should help increase retention, therefore guided learner control is very important to affective instruction.

8. Learner control may be most effective with higher ability learners or those with some prior knowledge of the content.

LOCUS OF CONTROL

Internal-external locus of control as a psychological construct refers to the extent to which persons perceive contingency relationships between their actions and their outcomes. People who believe they have some control over their destinies are called "Internals"; that is they believe that at least some control resides within themselves. "Externals", on the other hand, believe that their outcomes are determined by agents or factors extrinsic to themselves, for example, by fate, luck, chance, powerful others, or the unpredictable.

Social scientist and psychologist John Rotter (1966) defined internal-external locus of control in the following way:

> "an event regarded by some persons as a reward or reinforcement may be differently perceived and reacted to by others. One of the determinants of this reaction is the degree to which the individual perceives that the reward follows from, or is contingent upon, his own behavior or attributes versus the degree to which he feels the reward is controlled by forces outside of himself and may occur independently of his own actions. ....a perception on causal relationship need not be all or none but can vary in degree. When a reinforcement is perceived by the subject as following some action of his own but not being entirely contingent upon his action, then, in our culture, it is typically perceived as a result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexity of the forces surrounding him. When the event is interpreted in this way by an individual, we have labeled this a belief in *external control*. If the person perceives that the event is contingent upon his own behavior or his own relatively permanent characteristics, we have termed this a belief in *internal control*."
>
> In Robinson and Shaver (1973, p. 169)

Rotter developed an internal-external locus of control scale consisting of 23 question pairs, using a forced choice format, plus six filler questions. Internal statements were paired with external statements. One point was given for each external statement selected. Scores can range from zero (most internal) to 23 (most external).

Although this scale was developed to determine locus of control for adults other psychologists: Bialer; V. C. Crandall, Katkovsky and V. J. Crandall; and Nowicki and Strickland (Lefcourt, 1982) have developed scales more suitable to determine locus of control for children.

The Nowicki-Strickland locus of control scale (Appendix A) has been used by researchers such as J. L. Louie, Luick and S. Louie (1985-86), Nowicki and Strickland (1973) and Nowicki and Roundtree (1971) to determine the LOC orientation of students. Nowicki and Strickland (1973) reported reliability was based on statistical measures with previous LOC scales. Nowicki and Strickland (1973) reported test-retest reliabilities for a six week period of 0.67 for an eight to eleven year old group and 0.75 for those in a twelve to fifteen year old group. Based on the acceptance for use of the Nowicki-Strickland as a reliable test in previous research studies it was used in this research study. Lefcourt (1982) supports the use of the Nowicki and Strickland as a valid test measurement of LOC for children in the age category under consideration.

POTENTIAL INTERACTION

According to social learning theory, a person's reinforcement responses from the past will influence perception of educational objects and expectations of success in the present educational environment. It is expected that this perception will vary in degree from person to person and will vary within an individual over time. Clearly, there is a need to evaluate reinforcement and LOC in the application of educational technologies in the classroom.

Wesley, Krockover and Hicks (1985) attempted to determine the effects of computer-assisted instruction versus a text mode of programmed instruction, and locus of control, on preservice elementary teachers' achievement of computer literacy. They found that the main effects were not significant. However, a significant trait by treatment interaction was found. Differences in adjusted posttest cognitive computer literacy scores of externally controlled individuals favored the CAI mode. There were no differences between treatments when internally controlled subjects were considered.

Nishikawa (1988) studied LOC and feedback strategies in computer assisted instruction using junior high students. She presented three treatments of feedback: immediate (IFB), delayed (DFB) and no feedback (NFB). The results indicated that Internals performed significantly better than the Externals on DFB on the test for recall. No other significant differences or interaction was found.

H. Gozali, Clearly, Walster & J. Gozali, (1973) determined that the LOC is informative in predicting time utilization; internals use time in a manner more appropriate to the test taking situation than do externals. Internals were more variable than externals in the amount of time spent on items.

In interaction of LOC and pacing procedures in a personalized system of instruction (PSI) course, Reiser (1980) examined final examination performance in a PSI course. College students identified by the Rotter Internal-External Locus of Control Scale as expecting external reinforcement performed better under the reward and control condition, and those identified as expecting internal reinforcement did better under the penalty condition. Student anxiety was postulated as having been a factor affecting performance.

Very few studies at the present time have considered the potential interaction of LOC and instructional control in interactive videodisc instruction. Previous research has suggested that internals normally demonstrate higher academic achievement than externals. However, the findings of recent studies, for example, Lopez & Harper (1989) question whether LOC is as significant a factor in achievement as has previously been supposed.

PURPOSE OF THE STUDY AND HYPOTHESES

It was the purpose of this research study to develop interactive videodisc instruction to enhance learning of difficult concepts and increase academic achievement and student motivation in secondary science education, by using new instructional tools.

In order to research locus of control and instructional control as important design variables in interactive videodisc instruction the following null hypotheses were stated:

1. There will be no significant difference between the learner control and program control group.

2. There will be no significant difference between groups identified as internals or externals on a Locus of Control Scale.

3. There will be no interaction as a result of the effects of Locus of Control and Instructional Control:

a. There will be no significant difference between internals and externals as a result of using a learner control treatment.
b. There will be no significant difference between internals and externals as a result of using a program control treatment.

CHAPTER III.

INSTRUCTIONAL DESIGN

This section will focus on the design phase of this research study. With copyright permission (Appendix B) the "Systematic Design of Instruction Model" (Dick and Carey, 1990) (Figure 1) based on the work of Robert Gagné and Leslie Briggs, most recently documented in Gagné, Briggs and Wager (1992), was used to design instructional material suitable for science instruction. A description of ten components will illustrate the interconnections which make up the systems approach model of instructional design:

The first step in the model is to *identify an instructional goal* to determine what it is that students will be able to do when they have completed the instruction.

Conduct an instructional analysis – Here it is necessary to determine what type of learning is required of the student. The goal will be analyzed to identify subordinate skills and procedural steps that must be learned to accomplish a particular process. This analysis results in a chart or diagram that depicts these skills and shows the relationship among them.

Identify entry behaviors and characteristics – In addition to identifying the subordinate skills and procedural steps that must be included in the instruction, it is necessary to identify the specific skills that students must have prior to beginning instruction. This is not a listing of all the things learners can do, but the identification of the specific skills they must be able to do in order to begin. It is also important to identify any specific characteristics of the learners that may be important to consider in the design of the instructional activities.

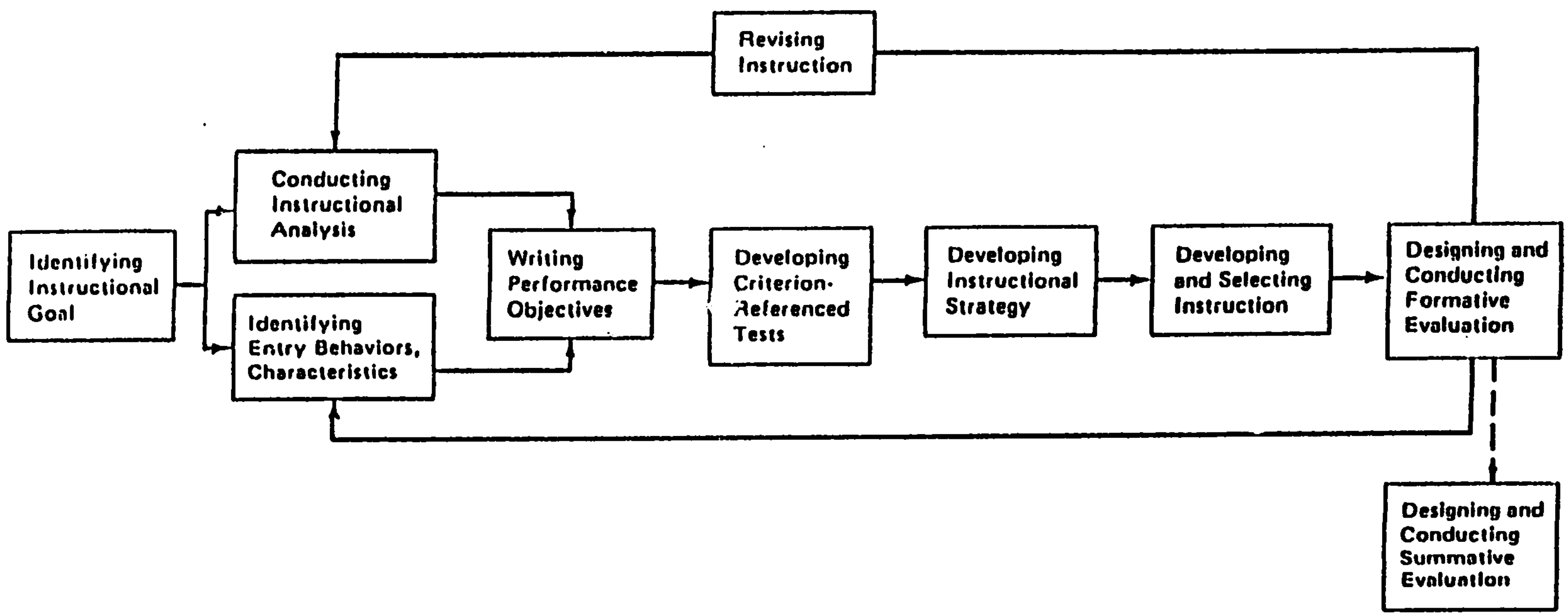

Figure 1. Systems Approach Model for Designing Instruction

Write performance objectives – Based on the instructional analysis and the statement of entry behaviors, specific statements are written about what it is the learners will be able to do when they complete the instruction. These statements, which are derived from the skills identified in the instructional analysis, identify the skills to be learned, the conditions under which the skills must be performed, and the criteria for successful performance.

Develop criterion-referenced test items – Based on the objectives written, assessment items will be developed that are parallel to and will measure the learner's ability to achieve what has been described in the objectives.

Develop an instructional strategy – Given information from the five preceding steps, identify the strategy that will be used in instruction to achieve the terminal objective. The strategy should include sections on preinstructional activities, presentation of information, practice and feedback, testing, and follow through activities. The strategy is normally based upon current outcomes of learning research, current knowledge of the learning process, content to be taught, and the characteristics of the learners who will receive the instruction.

Develop and/or select instruction – In this step the instructional strategy is used to produce instruction. This typically includes a learner's manual, instructional materials, tests, and an instructor's guide. The decision to develop original materials depends upon the type of learning to be taught, the availability of existing relevant materials, and developmental resources.

Design and conduct a formative evaluation – Following completion of a draft of the instruction, a series of evaluations is conducted to collect data that are used to identify how to improve it. The three types of formative evaluation are referred to as one-to-one evaluation, small group evaluation, and field evaluation. Each type of evaluation provides the instructional designer with a different type of information that can be used to improve the instruction.

Revise instruction – The final step (and the first step in a repeat cycle) is revising the instruction. Data from the formative evaluation are summarized and interpreted to attempt to identify difficulties experienced by learners in achieving the objectives, and to relate these difficulties to specific deficiencies in the instruction. Review the validity of the instructional analysis and the assumptions about the entry behaviors and characteristics of learners. It is also necessary to reexamine statements of performance objectives and test items in light of collected data. The instructional strategy is reviewed and finally all this is incorporated into revisions of the instruction to make it a more effective instructional tool.

Conduct summative evaluation – Although summative evalution is the culminating evaluation of the effectiveness of instruction, it generally is not part of the design process. It is an evaluation of the absolute and/or relative value or worth of the instruction, and occurs only after the instruction has been formatively evaluated and sufficiently revised to meet standards of the designer.

These ten basic steps represent the procedures that one employs when the systems approach is used to design instruction.

There are two main reasons why this approach was used in this study:

1. The main focus of the systematic design of instruction approach is at the outset on what the learner is to know or will be able to do when the instruction is concluded. Without this precise statement, subsequent planning and implementation steps can become unclear and ineffective.

2. There is a careful linkage between all components, especially the relationship between the instructional strategy and the desired learning outcomes. Instruction is specifically targeted on the skills and knowledge to be taught and supplies the appropriate conditions for the learning of these outcomes. Instruction is designed not to be used only once, but is to be evaluated and revised. This all relates to matching the appropriate form of instruction to the needs of the learners and educational objectives.

A productive approach to model building for interactive videodisc instruction may be found in the efforts of Gagné, Briggs and Wager (1992). Nine events of instruction for any desired learning were postulated for completion of the learning process:

1. Gaining attention
2. Informing the learner of the lesson objective
3. Stimulating recall of prior learning
4. Presenting the stimulus material with distinctive features
5. Providing learning guidance
6. Eliciting performance
7. Providing informative feedback
8. Assessing performance
9. Enhancing retention and learning transfer

(1992, p. 190)

Gagné, et al. (1992) assert that for computer based instruction (and by extension, interactive video) to be effective in a tutorial model, all nine events must be included or accounted for by other factors. It is important to realize that these nine different events must always be considered as potential ways of providing external support for the internal act of learning. Furthermore, they propose that the nature of the instruction of an event should differ depending on the category of learned capability expected as the outcome of the instruction. For example, learning intellectual skills requires different design of instructional events than those required for learning verbal information or a psychomotor skill.

Milheim (1990) suggests three different theoretical frameworks, each with a different perspective to understand the potential effectiveness of learner control. These perspectives which are detailed below, may offer important insight into why the use of learner control may be beneficial for some learners.

Information Processing

The first theory base for the potential effectiveness of learner control comes from an information processing perspective as described by Gagné, et al. (1990). This model sees the process of learning as a continuous cycle, with information moving from sensory receptors, through short term memory, perhaps into long-term memory. and finally into a learner response. One of the results of the long-term encoding of information is the development of a schema, described by Gagné as the way knowledge is organized in long-term memory. Within this framework, learner control would greatly benefit the learning process, since choice by a learner (compared to choice by a program) is much more likely to match that learner's existent internal organization of knowledge.

Motivation Theory

A second potential framework as described by Milheim (1990) and based on the work of Keller analyzes motivation and the characteristics of instruction that help to motivate students to learn. Motivation is defined as both the magnitude and direction of a student's behavior. This theory focuses on the choices that people often make concerning their goals and the degree of effort they will expend to reach them.

Within this model, Keller described four instructional conditions (interest, relevance, expectancy and satisfication) that may lead to increased motivation and learning. Two of these categories, relevance and expectancy, are particularly important to the issue of learner control in the instructional process. Motivation theory, therefore, implies that the use of learner control will increase both the relevance of the instruction and the learner's expectancy for success.

Attribution Theory

A third theory that relates the use of learner control to potential positive effects is attribution theory. Attributions can be defined as inferences or perceptions that an individual has concerning the causes of behavior, whether one's own or someone else's. Using this definition, learner control can be seen as student's perceptions that they are controlling (or causing) their own behaviour, with program control seen as control by something outside their influence.

Milheim (1990) notes the existence of attribution theory as an effect of the learner control variable. Attribution refers to the perception that the learner has of the causes of his/her learning behaviour. Milheim refers to several researchers who have noted learner's inabilities to identify the lack of their own effort as a cause of failure; rather they blame external causes outside their control for their failure to learn. He notes that learner control may overcome this tendency, as learning behaviour may be perceived as being directed by the learner. Even the perception of learner control may contribute toward increased success under this theory, he argues.

Internals in perceiving that they are in control of their own educational experience may strive to succeed since their academic success or failure is based on their own decisions and effort. The similarities between attribution theory and locus of control of reinforcement may lead to the possibility that internals under learner control may do better than internals in program control. Learner control would allow the internals greater control over the instructional process which may be attributed to greater satisfaction, motivation and success.

Weiner and Kukla (1970) discussed this idea in a summary of six related experiments. They suggest that those individuals who ascribe success to themselves are also more likely to approach achievement-related activities, be higher in achievement motivation, and experience greater reward for goal attainment. Since learner control in this context may be associated with attributing success to oneself, students using this option may also be more likely to show higher achievement scores.

Portions of all three theoretical frameworks were used in the development of instructional material in this research.

The following guidelines and cautions as proposed by Hannafin, Garhart, Rieber & Philips (1985) in the design of interactive video instruction were also considered in the development of interactive instruction for this unit:

1. Criterion-based interactivity should be used to direct learner processing and to monitor on-going comprehension of intended learning.

2. Video stimuli should provide the primary instruction; the computer should manage and control instructional sequence decisions.

3. The fundamentals of good instruction are more likely to be appropriate to the design of interactive video than not; the processes included are more important than the technology, per se.

4. The level of difficulty of the video-based lesson should be perceived by learners as challenging and as requiring considerable effort.

The instructional design model of Dick and Carey (1990) is not a linear process, however it is necessary to show the model that way. The following developmental sequences were followed in this research study:

1. Instructional Goal:

"What is it that the pupils should be able to do when they have completed the instruction?" To be able to answer this question the designer consulted the grade seven science curriculum as established by Alberta Education.

The following statement was the instructional goal for this unit on weathering and erosion:

> **Students will be able to discriminate, identify, or classify statements relating to geological change, specifically, weathering and erosion.**

2. Instructional Analysis:

The instructional goal was analyzed to determine what type of learning was required of the student. Subordinate skills were analyzed and an instructional analysis chart was completed to depict necessary skills and the relationship among them.

The topic chosen relates to the study of earth science in the new science, technology, and society curriculum of grade seven science. More specifically, weathering and erosion. This topic is so extensive that part of the challenge of designing this lesson was to determine what level will be understood, while at the same time allowing sufficient complexity to allow the learner to build upon these concepts. Much of the subject content relating to weathering and erosion uses new terminology unfamiliar to most students, therefore, it is important to address these carefully and methodically one concept at a time. Emphasis was placed on the use of visual images to enhance the learning environment of the target population.

Throughout this unit students were introduced to the Earth Sciences with major program emphasis on the nature of science through geological change, weathering and erosion.

In the first of the three sub-units, "Geological Change" students were instructed on how geological processes change the earth and how scientists study and explain these changes. It was organized in a repeated sequence; evidence of changes to the earth's surface was presented and then students were asked to examine this evidence. This sequence communicated to students that science is a way to explain natural events and objects. Students were to examine visual representations of geological processes in order to observe gradual or sudden geological change. As the visual information was presented, they were to become more familiar with such scientific processes as observing, inferring, relating evidence to inference, and comprehension of scientific information.

In the second sub-unit,"Weathering" students were introduced to the concepts of physical, chemical and biological weathering. Weathering was seen as the process of breaking down rocks into smaller pieces. Examples were given throughout this sub-unit allowing for understanding such concepts as the formation of stalactites and stalagmites.

In the third sub-unit, "Erosion", students were informed that erosion is the wearing away and movement of sediments (rock materials) from place to place. Erosion and the deposition of sediments based on size and shape cause tremendous changes to the course of rivers. Water was seen as a major force in erosion.

3. General Characteristics and Entry Behaviors:

Most grade seven students are between the ages of twelve and thirteen and are extremely enthusiastic, if properly motivated. However, they are well known for being distracted easily. Attention span is also an important characteristic, but experience with grade seven students suggests that length of attention span varies depending on the method of presentation, type of content and the time of day of the class. Students at this age level can be extremely motivated when presented with instructional material in new and unique ways, however, it must be highly structured. Explanations and directions must be easy to understand, clear, concise, and to the point in order for students not to be confused. It was the intent of this instructional unit to sufficiently motivate students to enjoy science instruction by designing interesting and meaningful lessons. Thus, the only prerequisite skill with regard to motivation for this module was that students would participate to the best of their ability.

Throughout the school year students had been expected to learn many new scientific terms and concepts, through traditional instructional techniques. Although they may be familiar with use of the computer, very few, if any of the students were familiar with interactive videodisc instruction. Most students in this research study were already familiar with basic principles of computer use by having been exposed to programs such as "Mouse Paint" and "Mouse Write" on the "Apple" computer. It would seem appropriate that a desirable prerequisite skill be that students have some of these basic computer skills.

Since sequence of instruction is not critical, there was no entry prerequisite relating to content.

4. Formulating Performance Objectives:

Performance objectives were developed based on the instructional analysis, and entry behaviors. Specific statements were written as to what the learners were to be able to do when they complete instruction. These performance objectives identified the skills to be learned, the conditions under which the skill must be performed and the criteria to be successful.

5. Criterion-Referenced Test Items:

In conjunction with a subject matter expert (certificated science teacher at the grade seven level) and based on specific objectives developed for the unit, the designer developed test items (Appendix C). It was assumed that this process would provide representative content validity for the module. Practice items were developed for each segment of learning materials. After many of the practice items in the module, learners were shown correct printed feedback on the computer screen, which they could compare with their own answers.

The designer developed criterion-referenced test items following the goals and general objectives for grade seven science as stipulated by Alberta Education. Then the designer developed specific performance objectives in juxtaposition to the learning skills analyzed from curricular general subskills.

Based on exam questions found in the traditional instructional material, multiple choice, short answer, true or false, and fill in the blanks test items were developed. Test items were developed from recommended textbooks and teacher resources as supported by Alberta Education. The criterion-referenced test items were developed to be used for both the pretest and posttest.

6. Instructional Strategy:

Using information from the five preceding steps, the designer developed an instructional strategy. The strategy required pupils to interact with instruction through textual, graphic and visual information. Where required, students were given correct feedback to practice questions in the lesson. In anticipation of the experimental component, two versions of feedback control were designed. When receiving feedback from practice questions, students in the program control group were given appropriate feedback and automatically went to the next sequence of instruction. The learner control group had the option of continuing with instruction or could review the practice question and instructional materials as many times as desired.

7. Develop and/or Select Instruction:

Using the instructional design model of Dick and Carey (1990), two prototype individualized lessons were developed that consisted of the same instructional material. By reading text and interpreting graphic information on the computer and by pressing icons (buttons), the computer allowed the students to progress through the instructional program. The videodisc acted as a large data base of images and motion sequences. From this large visual data base on earth science, the developer selected images and motion sequences most appropriate for understanding concepts about geological change, weathering and erosion. Motion sequences and still frames were presented to students based on the format of instructional control presented.

One form of instruction was program control, the other was learner control. The learner control instructional prototype was developed first allowing for control of pacing, sequence, review and feedback. Some icons which were essential for the instructional material were removed from learner control to develop the program control treatment. Removal of these icons disallowed review, and choice of sequencing, forcing the student to follow a linear path through instruction. The program control group and learner control groups both had control of pacing with identical content.

The instructional material was developed using HyperCard 1.2.1. Goodman (1988) served as a reference for learning HyperCard. The instructional prototypes were developed based on the systems approach model and suggested guidelines refered to earlier in the instructional design process. The research study utilized the following software and hardware:

1. HyperCard 1.2.1 as an authoring tool.

2. Voyageur Videostack 2.0.

3. A Macintosh SE computer interfaced with a Sony 1000A videodisc player.

4. The videodisc "Windows on Science-Earth Science" developed by Optical Data Corporation, along with supplementary resource material.

Instructional material was derived from the following textbooks:

McFadden, Morrison, Armour, Hammond, Hayson, Moore, Nicoll, Smyth,(1989) Science Plus Technology & Society 7, Toronto: Harcourt Brace Jovanovich.

Durword, Grace, G. Krupa, M.Krupa, Hirsch, Spalding, Bradly, Wohl, Jean, (1989) Science Directions 7, Edmonton: Arnold Publishing.

Included for the teachers and supervisor was an Instructor's Manual with directions for implementation, and appropriate instructional material.

8. Formative Evaluation:

The prototypes were assessed by an expert (professor) in instructional design. One suggestion was to limit the amount of textual information in each instructional segment. The instructional designer also recommended that the learner control group be allowed as much time as necessary to complete the lesson. This would allow for review of instructional material in the lesson if desired.

In respect to criticisms and suggestions for improvement by the instructional designer and the students involved in the study, the designer made the necessary revisions in the study materials.

One to One:

The researcher observed (one to one) two subjects as they proceeded through the instructional unit. One subject received learner control, the other program control. It was found through the one to one evaluation that directions for use of the program would have to be revised to clarify instructions on the use of the software. It appeared that students had to have the directions explained and needed to be shown one or two examples before they felt confident proceeding with instruction. Based on observations made on the one to one instruction, necessary revisions were completed before proceeding to the small-group evaluation.

Small-Group Evaluation:

The main purpose of using this small-group evaluation was to evaluate overall design, instructional content, and all phases of software and hardware functioning. Therefore it was used to assess the appropriateness of the materials for the learner, the readability of directions, overall time considerations, and other relevant details.

The small-group evaluation was used to determine the effectiveness of the stimulus materials. The major goal was to observe the students as they progressed through each form of instruction.

Subjects for the small-group evaluation were eight grade seven students from Neil M. Ross Elementary School in St. Albert, Alberta, School District No. 3. The designer used only students who showed an interest on the assumption that they would take the experience more seriously than reluctant participants. Parental consent was obtained before any research was conducted. The Nowicki-Strickland Locus of Control Scale for Children, (Appendix A) a forty question forced-choice (yes/no) test, was administered via pencil and paper by a certified teacher at the research site. The items on the test involve reinforcement situations dealing with interpersonal and motivational areas. Although the test was written for a fifth-grade level, it involved many choices for older children. The time allocation of forty-five minutes was ample time for the subjects to complete the Locus of Control Scale.

A written criterion-referenced pretest using true and false, multiple choice, matching, and fill in the blank items, was administered before formal instruction, to determine previous knowledge on weathering and erosion. The identical test was administered as a posttest following individual instruction. The main purpose for testing students was to compare test scores before and after instruction, enabling the researcher to compare prior knowledge with acquired knowledge.

The researcher placed the videodisc into the videodisc player and briefly checked the proper functioning of the instructional system before allowing the subjects to enter the research site.

Students in the program control group were informed that they would only be allowed to go through the program once; therefore they should proceed very carefully through the instructional material. The program control treatment allowed the student to progress through the program linearly without the capability of branching and no opportunity for reviewing a sequence of instruction. Although the sequence of instruction was to be controlled by the program, students would be able to control pacing. Students were given written and verbal directions on the proper functioning of the system and were allowed to begin. Since students had no chance of reviewing the material it was noted that less time for instruction was required for program control than learner control. On average, forty five minutes was required for completion of instruction for the program control group.

The learner control treatment permitted selection from a main menu, as well as the opportunity to branch and review instruction as often as necessary. The learner was able to control sequencing and pacing with the added capability of as much review as was necessary. Subjects were instructed that when they felt that they had mastered as many of the concepts as possible and if they had completed all of the instructional material, they were to see the supervisor immediately. On average, sixty minutes was required for completion of instruction via the learner control treatment.

The technology (hardware and software) worked efficiently throughout the small group evaluation and was determined to be sufficiently reliable for the experimental study.

An examination of the means of the pretest and posttest scores (Table 1) shows a marked increase in scores after formal instruction. An increase of 29 % in the mean score in the small-group evaluation shows an increase in academic achievement using interactive videodisc instruction.

Table 1.

Small-Group Evaluation: Pretest-Posttest Scores

		Mean Score out of 90	
VARIABLE	N	MEAN	PERCENTAGE %
Pretest	8	44.62	50 %
Posttest	8	70.75	79 %
Increase		26.13	29 %

The small-group evaluation provided insight into what to include or correct in the instructional material, and helped to determine the suitability of the material for the grade level of students.

9. Revise Instruction:

Based on observations made by the designer and student's suggestions, the designer made some changes. Aside from minor spelling mistakes, the major change which had to be made consisted of one wrong instructional sequence appearing when a certain button was pressed. This occurred near the end of the last sub unit and caused the student to completely miss the last two sequences (cards) of instructional material. This was corrected on both programs and the programs ran properly. In some cases textual information was made more concise and graphic material was added to clarify the concept. No corrections were made on the pretest and posttest as it would affect the validation and reliability of the test measurement. All necessary revisions were made to the instructional prototype after the small-group evaluation and it was judged to be suitable for use with the experimental study group.

VALIDITY AND RELIABILITY OF MEASURING INSTRUMENTS;

Content validity:

The designer developed criterion-referenced test items following the goals and general objectives for grade seven science as stipulated by Alberta Education. Then the designer developed specific objectives in juxtaposition to the learning skills analyzed from curricular general subskills.

Multiple choice, short answer, true or false and fill in the blank test items were used. These were based on exam questions found in the traditional instructional material. Test items from teacher resources as supported by Alberta Education were used. It was assumed that by following the instructional design model, chances of obtaining reasonable content validity were increased.

Reliability:

Twenty three grade eight students from Vincent J. Maloney Junior High School in St. Albert, Alberta were selected for the purpose of determining the reliability of the test instrument. These students had already completed the instructional material through traditional classroom instruction in grade seven the previous year. The designer used a test-retest model with an interval of three weeks between tests. The designer avoided letting the students know that he would come back to their school, lest they prepare themselves for retesting. The results were then analysed using the Pearson *r* correlation statistical test (Moor, 1983). Table 2 shows the Pearson *r* Correlation Coefficients:

Table 2.

Pearson *r* Correlation Coefficients on the Reliability of Measuring Instruments.

VARIABLE	CASES	MEAN	STD	CORR	P
Test 1	23	52.69	10.29		
				0.839	.000
Test 2	23	56.26	09.92		

The results from Table 2 show that the correlation between the first and second test was high r =.83. Based on this high correlation, one can conclude that the measuring items were consistent over time when corrected by attenuation. However, Wiersma (1975), argues that reliability of a test is relative. He contends that an achievement test with a reliability of .65 might be undesireable if existing tests in the academic discipline have reliabilities in the .90's. Dyer (1979) suggests that a reliability coefficient of .75 should be the minimum level except when using a small sample size of less than 50 students, as in this study, where tests with reliabilities as low as .50 may still be acceptable.

CHAPTER IV
METHOD

EXPERIMENTAL DESIGN

Most students in this study had received instruction only through the traditional lecture method of presentation, where there is little individual feedback. Since there is little feedback with the lecture method, students may think that they understand concepts, only to discover that they don't understand them on the exam. The interactive instruction approach used in this research study was intended to provide more individual feedback to help alleviate this problem. The initial system was designed as a stand alone interactive system where students were able to progress at their own pace. For purposes of the experimental study two treatments of interactive videodisc instruction were developed. The instructional design model of Dick and Carey (1990) provided the basis for design and development.

The study focused on the use of interactive videodisc instruction, using weathering and erosion for grade seven students. It makes no attempt to analyze other disciplines or other grade levels. For that reason, the findings and conclusions are delimited to one discipline at one grade level only. Further, the investigation involved only two schools in one school district. Due to the diversity of students in other districts, the study could provide different results in other settings.

The following limitations of this study may effect the degree to which the results might be generalized to a larger population and are a threat to the external validity of the experiment:

1. A larger sample would indeed have increased the power of the study. The size of the sample population is relatively small in comparison to what may have been most desirable for statistical analysis in this research study.

2. The sample for the in-school study was not selected at random from the population. The sample was taken from intact classes at an elementary/junior high school.

3. The use of interfaced multimedia systems was a new approach to the schools where the study was carried out. This could possibly have caused a novelty effect for some pupils.

4. Since instruction was not part of the classroom curriculum to be assessed for grades, obvious signs of relief were observed. This in turn may have affected attitude towards instruction.

SUBJECTS

Subjects for the experimental study were fifty grade seven students from Vital Grandin Elementary School, an urban K-7 school, which has a population of approximately 637 students during the regular school year.

EXPERIMENTAL PROCEDURE

One week prior to formal individual interactive instruction the students wrote the Nowicki-Strickland Locus of Control Scale for Children as a large group in a formal classroom setting. Based on the results from the Nowicki-Strickland Locus of Control Scale for Children, those scoring high on the LOC scale were determined to have an external orientation, and those scoring low were deemed to have an internal orientation. Students were ranked from highest to lowest on the LOC scale. The median score derived as 17 was used as a reference point to designate the LOC orientation. Students with a score greater than 16 were designated as having an external LOC, and those with less than 17 were designated as having an internal LOC. Twenty-five subjects were externals, and twenty-five subjects were internals. The externals were randomly assigned to the learner control or program control treatment and the internals were randomly assigned to either the learner control or program control treatment. Table 3 outlines the research design.

Table 3: Research Design

Method of Instructional Control

Locus of Control	Program Control	Learner Control	
Internals	13	12	Number of Subjects
Externals	12	13	

PARENTAL CONSENT FORM

Two weeks prior to formal interactive instruction, classroom teachers provided the students with a parental consent form notifying the parents of the purpose of the research study and requesting permission to allow their son/daughter to participate in this research study (Appendix D).

PRELIMINARY ARRANGEMENTS

Two days prior to formal instruction, students wrote the pencil and paper pretest to determine prior knowledge of instructional material on weathering and erosion. This was again presented to the large group in a formal classroom setting. No formal time limit was set, however most students completed the pretest in approximately forty five minutes.

The interactive instructional system consisted of:

1. One individualized interactive work station using a Mac SE computer (4mb RAM 40mb ROM) interfaced with a Sony 1000A videodisc player via an RS-232 cable: a standard VHF cable; and a 20 inch television monitor.

2. Two floppy discs, one utilizing program control; the other learner control. The videodisc "Windows on Science-Earth Science" and appropriate guides and references for use of the equipment.

ADMINISTRATION OF STIMULUS MATERIALS

The study was conducted during January, February, and March, 1992. On each day when the study was conducted, three students participated. When students were scheduled to participate in the study they were to go to the designated work area. Two students were tested in the morning and one in the afternoon. In order to assure adequate supervision of instruction a supervisor (a certified special education teacher) was appointed to make sure students were operating the equipment satisfactorily and to help the student should any mechanical difficulties arise. The investigator would place the videodisc in the player, and turn the power on to both the videodisc player and the computer.

Before each student began formal instruction, the investigator was present to explain the instructions from an instruction sheet placed beside the student for convenient reference. The investigator would then select one of the two treatments on the computer and would open the application for the student by 'double clicking' on the folder icon entitled Weathering and Erosion (P) for program control, or Weathering and Erosion (L) for learner control. The investigator would inform the student how to use the mouse to operate the program successfully. Briefly the investigator would explain how the program worked and would review the directions with the student.

In the program control treatment students were informed that they would only be allowed to go through the program once, and therefore should read all the material carefully. They were requested to contact the supervisor immediately after they had completed the instruction.

In the learner control treatment students were informed that they were allowed to take as much time as necessary to complete the instruction. They were advised that they should attempt to complete all three units. When the students felt confident that they had learned the material to the best of their ability they were to see the supervisor immediately after instruction.

Out of fifty students presented with computer-assisted instruction, the computer failed to function only once and had to be restarted. The investigator was called. He brought the student back to the same instructional sequence and the student continued through the program.

ADMINISTRATION OF THE POSTTEST

After completion of the individual interactive instructional unit via either of the two treatments, students were administered the posttest by the supervisor. No time limit was specified for either group. For each treatment, average time for completion of the posttest was approximately forty minutes.

CHAPTER V.

RESULTS AND DISCUSSION

RESTATEMENT OF PURPOSE AND NULL HYPOTHESES:

The main goals of this research study were: to develop interactive videodisc instruction that would enhance learning of difficult concepts in secondary science education; and to increase academic achievement and student motivation by using new instructional tools. Instructional control was seen as an essential psychological trait and locus of control was seen as an important design variable. In order to research instructional control and locus of control as important variables related to interactive videodisc instruction, the following null hypotheses were stated:

1. There will be no significant difference between the learner control and program control group.

2. There will be no significant difference between groups identified as internals or externals on a locus of control scale.

3. There will be no interaction as a result of the effects of Instructional Control and Locus of Control:

a. There will be no significant difference between internals and externals as a result of using a learner control treatment.

b. There will be no significant difference between internals and externals as a result of using a program control treatment.

The main purpose of this research study was to support the use of interactive videodisc instruction in science education. Based on an instructional design model (Figure 1.) as proposed by Dick and Carey (1990), students were actively engaged in instructional material with positive results.

It was also found that the instructional design process was important for the development of interactive videodisc instruction. The design process was seen as a productive way of integrating the development of instruction with curricular objectives. Through the utilization of instructional design processes the instructional program was found to enhance the learning of difficult concepts by junior high science students. This research study confirms an increase in academic achievement for all experimental study groups. The program control treatment and learner control treatment were found to be effective methods for instruction in science education.

ANALYSIS OF ACHIEVEMENT

The following table indicates the Means of the pretest and posttest for the experimental study groups.

TABLE 4. Experimental Study Group-Pretest-Posttest Mean and Percentage Scores

		Method of Individual Instruction	
Locus of Control		Program Control	Learner Control
Internals	Pretest	37.6 = 42 %	27.7 = 31 %
	Posttest	61.0 = 68 %	54.1 = 60 %
	Increase	= 23.4 = 26 %	Increase= 26.4 = 29 %
Externals	Pretest	35.0 = 38 %	32.7 = 36%
	Posttest	58.2 = 64 %	58.4 = 64 %
	Increase	= 23.2 = 26 %	Increase= 25.7 = 28 %

Raw Score out of 90

The data from table 4 indicates that there may be an interaction between LOC and instructional control. From the Mean scores presented results show that there may be a tendency for internals to prefer learner control, (29 % increase) to program control (26 % increase). It is interesting to note, that both learner control groups had a greater increase in achievement, although this is probably not significant. However, it could be an indication that the program control groups suffered from being unable to review. For externals, results appear to be consistent with both treatments.

ANALYSIS OF VARIANCE:

The null hypotheses were developed to determine the extent to which instructional control (Program Control-Learner Control) was seen as an important instructional design variable, and locus of control (Internals-Externals) might be considered an important psychological trait influencing instructional outcomes. An analysis of variance (ANOVA) was performed on the scores to see if the differences across groups were large enough to be statistically significant beyond the 0.05 level. The results of the analysis of variance indicated a failure to reject the null hypotheses.

TABLE 5. Test results by LOC and Instructional Control - Analysis of Variance (ANOVA)

SOURCE OF VAR.	SUM OF SQUARES	DF	F	SIG OF F
Program vs Learner Control	121.376	2	1.041	.313
Internal vs External	11.616	1	.099	.754
Interaction	138.418	1	1.186	.282

When assessing the motivational aspect of interactive videodisc instruction students involved in this research study stated that they should do more coursework this way. Students were asked if they preferred this form of instruction to traditional teaching methods and if they found it motivating. Most said they liked both traditional and interactive videodisc instruction, however, interactive videodisc instruction was viewed more positively. The majority of students indicated that they were quite interested and motivated to finish instruction once they began. Others commented that they liked the ability to access both visual and graphic information. When asked if they had any problems with the instructions or the equipment most said the equipment was easy to use and the directions were easy to follow. Students felt that they had learned a lot about weathering and erosion from the instruction presented to them. They also commented that they would like to do other similar units using interactive videodisc technology. The information found in this research study supports strongly the philosophy for developing interactive videodisc science instruction:

1. The increase in academic achievement supports the research literature on the effectiveness of interactive instruction.

2. Students find the use of new instructional tools exciting and highly motivating. They have a strong desire to finish instruction and to do the best they can to attain curricular objectives.

DISCUSSION

Drawing conclusions regarding locus of control and instructional control during interactive instruction from this study or any study must be done cautiously. It is the contention of researchers that in addition to flaws in research design and procedure, there are other variables such as socioeconomic conditions, (V. C. Crandall, Katkovsky & V. J. Crandall, 1965), and sex (Louie, et al., 1985-86) which confound any set of data. Major limitations such as sample size may have contributed to confounding the data. A larger sample would have increased the power of the study and indeed the results may have been considerably different.

Other areas of concern may have been the length of the instructional program. The researcher observed that students using program control required less time to finish (approximately 45 minutes) the instructional material. Learner control required considerably more time for instruction (approximately 60 minutes).

Since the instructional unit included three topics out of a possible six in the unit on geological change, this amount of information may have been too comprehensive. Limiting the amount of instruction to one or two topics may have produced less fatigue for the learner. It was the intent of the pretest-posttest (90 items) to be comprehensive. However, this may have been too long and may have lead to learner fatigue. Learner fatigue associated with the length of instruction may have negatively affected the results of the posttest. Achievement results may have improved if less information was presented.

Having observed students going through the instructional process it was noted that under the learner control treatment some students proceeded through the instruction by first doing sub unit one-geological change, then sub unit two-weathering, and finally sub unit three-erosion. They did not exercise the option to use a great deal of learner control. This resulted in some of the learner control group following virtually the same instructional process as the program control group. Some students from the learner control group missed icons that would have given them valuable information. These factors may have affected results in this research study.

The results indicated a failure to reject the null hypotheses. Although this conclusion was found by the researcher in this particular study, caution must be exercised when generalizing this information. With sample size a major limitation it would seem most appropriate to consider the results as inconclusive at this point in time.

Although the Nowicki-Strickland LOC scale was determined as the most appropriate for assessing students of this age and grade level, difficulties may have arisen as to the datedness (1973) of the LOC test measurement. There is always the possibility that the Nowicki-Strickland scale may be too generalized and may not consider educational and societal factors that are present for students in the nineties. The use of other LOC test measurements such as Bialer's Locus of Control Questionnaire or Crandall's Intellectual Achievement Responsibility Questionaire (Lefcourt 1982) may have produced different results.

A larger sample size may have helped to increase the accuracy of determining student's locus of control orientation. Also a large group sample could be divided into three groups based on their locus of control (high-external, middle, low-internal). Thus more distinction between internals and externals on the Nowicki-Strickland would indicate closer proximity to the individual's true locus of control.

R. E. Clark (1983) noted that measurement of learning efficiency as a result of program or learner control may give spurious results. Learning may be more inefficient when the learner is given more control, especially with more difficult material and larger instructional units, but the learner may as a result be able to synthesize and adapt the knowledge to new situations. Clark severely criticizes studies carried out with video, CBI and IVI. He argues that uncontrolled confounding factors (e.g. different instructional methods or content between treatments) could explain observed performance improvements in virtually all published research.

Reeves (1986) suggests inadequate treatment definition and incomplete specification of treatment dimension may have an effect on IVI. He enumerates several inadequacies with comparative research models:

> a. Inadequate treatment definition-differences in the forms and functions of videodiscs in the studies prohibit any generalization of a particular study's results.

b. Incomplete specification of treatment dimensions- instructional characteristics comprising the treatment and control modes of instruction are assumed to be constant or dicohotomous. In reality, these may vary as much as other major elements involved in the studies (e. g. individual differences of learner, educational contexts, and instructional outcomes) and also have many characteristics in common.

c. Insufficient relevance to practical decision making by instructional developers. Research should have the potential to suggest directions for creative and effective instructional development and application.

Merrill (1984), refers to the question of learner-control versus program control as an insufficiently constrained research question. The exact degree of learner control must be specified, isolated and studied, as the two treatments are not distinct, but merely polar opposites on a long continuum. Even when content, sequence, and display-selection are under program control, giving the learner control of the number of examples studied, for instance, allows the learner to maximize his/her learning effectiveness. This, he implies, is perhaps the type of program control mix which will provide the most efficient and effective learning environment.

Locatis, Letourneau & Banvard (1989) also support Reeves as they note that instructional design issues and concomitant impacts on learner control also impact hypermedia software development and program capabilities. Although instructional control may be envisioned as a primarily learner-controlled medium, learner control is reduced because the author must still anticipate branch points which may be inappropriate at some times and for some learners. This tendency to provide links (and thus some sort of structure to the subject matter) results in associations being made by designers that may be quite arbitrary. These associations, though practical, may bear little relationship to how people assimilate the subject matter.

Hannafin (1985) states that program control may impose non-trivial external structure which will conflict with the internal schema of previous high achievers.

In a recent study (Milheim 1990), pacing was merely controlling time that the display was on the screen. Milheim's study supported learner control over pacing. Milheim also suggested that students in the learner control group may have had limited sequencing choices in this study. In the present study, the buttons on the starting page were probably (but there is no data) selected in sequential rather than random order. If some students did select them in different orders, the results indicate that it didn't affect the outcome. The perceived linearity of the HyperCard stack may have discouraged browsing and prompted the learner control group to follow essentially the same path as the program control group. La Follette (1990) refers to Merrill (1984), stating that students not used to having learner control over individual displays apparently settle for a rather simple adaptive method of display selection, rather than carefully assessing the need for the next display. Without specific time on task data, ability to make inferences is limited.

A final statement tends to support the proposition that not enough distinction was made between treatments in the present study. Merrill (1984) points out that even in situations where the presentations are selected for, sequenced for, and paced for, the student can still exercise a considerable amount of learner control.

> "Those students who have developed effective internal processing strategies may be able to compensate for a wide amount of variance in the instructional displays presented to them; those students who have less effective internal processing strategies may be more subject to performance decrements as a result of inadequate presentations. Internal control of cognitive processing may enable students to perform much more adequately than would be expected and probably accounts for the limited effect that the manipulation of stimulus materials seems to have in many instructional situations." (p. 222)

CHAPTER VI.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY:

Most of the research on interactive video addresses the question of interactive video as an effective instructional delivery system. Results from this study support the use of interactive videodisc instruction in science education. Although instructional control and locus of control were seen as important variables for the researcher to pursue, the research data indicates a failure to reject the null hypotheses. It must be emphasized that the conclusions drawn regarding these variables must be viewed cautiously as there were major limitations that may have confounded the data. Sample size, lack of distinction between treatments, and the locus of control test measurement are variables that may have to be adjusted in future studies in this area.

The instructional design process was found to be an integral part of the development of educational material for students. It is without hesitation that the researcher recommends the use of instructional design models. The design phase is seen as a continuous cycle of revision and evaluation. Each and every step of the process was important to the development of curriculum material.

Instructional control as a variable in interactive instruction must be considered further. To what extent do we call one form of instruction learner control and the other program control? In this study the extent to which subjects in the learner control group had control of their own instructional process was limited to the order in which they chose to proceed through the program. It was interesting to note that most students proceeded through the instructional program as it was laid out (linearly) and proceeded cautiously. This resulted in the possibility of the same instructional process for those using learner control as those receiving program control. It was observed by the researcher that many students in the learner control group did not exercise the option of using sequencing, pacing and review as much as may have been required to affect posttest results. When observed carefully a few students using learner control missed icons that would have brought them to important scientific concepts in the instructional process. This may have occurred as a result of program design rather than student error. Junior high school students may need more guidance built into the instructional program to enable them to use learner control more effectively.

Program control students on the other hand, had no choice as to the selection of sequences, and therefore were exposed to all the interactive instruction. In learner control situations students may have missed exposure to valuable scientific concepts. Although this was witnessed by the researcher, stringent observations were not recorded. It was interesting to note that although this was observed, students using learner control still had about the same or higher scores on posttest results as the program control group. Had the learner control group exercised more of the review capabilities of the instructional program a possibility existed for even higher academic achievement.

Time required to complete instruction, although not monitored stringently throughout this experimental study, indicated that students using learner control require more time to complete the instructional process than students using program control. On average, learner control required fifteen more minutes to complete.

One issue that has not been addressed in this study is financial considerations. The researcher fully realizes the budgetary restraints that are occurring within the present day educational system. However, if one were to consider the benefits to students for this form of instruction, it would not be long before educators would see interactive videodisc instruction as an economically viable means of instruction. The hardware and software developed in this research study could be used by science teachers to supplement and in many cases, replace textual material. The technology was found to be reliable, practical and easy to use.

When one considers the number of students that could benefit from this form of instruction, cost becomes a smaller issue.

CONCLUSIONS:

Null hypotheses were proposed in order to investigate locus of control as an important psychological trait and instructional control as an important design variable affecting interactive videodisc instruction. Results from this research study show that there were no significant differences in instructional treatments (program control versus learner control), and no significant differences attributable to locus of control (internals versus externals). Further, there was no significant interaction between locus of control and instructional control.

We may conclude the following from this research study:

1. Interactive videodisc instruction is an effective method of increasing academic achievement of difficult concepts in science education. Instructional development of interactive instruction provides teachers with exceptional opportunities to allow students to utilize new technologies in new and unique ways. The implementation of this new technology should become more prominent throughout science education.

2. Careful observation and questioning of students, although not stringent in this research study, indicates that students within our educational systems are interested and motivated when using new technologies. Many teachers see the use of these new instructional systems as a step toward enabling students to control their own instructional process. Some teachers like the ability of the program to guide students through the instructional process.

3. Instructional design models are useful for the development of interactive videodisc instruction. By following the philosophy and guidance of instructional design models and principles, the researcher was allowed the opportunity to develop instruction which was beneficial to all students in this study. Continuous revision of the instructional material was seen as an intregal part of the development process. Further revisions in the instructional material may enhance further academic achievement from the approximately 65% level found in this research study to even better results with future groups receiving the instruction.

RECOMMENDATIONS:

Further research on locus of control and instructional control as variables in interactive videodisc instruction could utilize this developed program as a prototype for refining other treatment approaches.

More distinction between learner control and program control treatments should be implemented in further studies on instructional control in interactive videodisc instruction.

Bosco (1986) recommends use of careful, structured observations, rather than more rigorous (but less useful) statistical tests to determine the efficacy of CBI and IVI. Closer observation of student responses and time on task may lead to more conclusive results in future studies.

Future research using this instructional prototype could use pretest results or previous achievement tests, as variables in comparing learner control to program control. Feedback strategies could be interspersed within the instructional prototype and analyzed using program and learner control strategies. Pacing and sequencing procedures could also be analyzed using program control and learner control strategies.

Reeves (1986) suggests the following research and evaluation approaches for IVI:

a. Controlled correlation: It is proposed to measure differences in four domains-initial learner characteristics, environmental variables, instructional treatments, and outcomes. Analysis of variance techniques could then be used to predict the relative importance of each measure, as well as interaction between the various predictors, and thus produce more meaningful results.

b. The instructional events model as used in this research study could be usefully adapted to accomodate the type of information necessary to answer research questions. For instance, the number and length of instructional events required by each learner could be easily captured. As a result, the relative effects of the nine events of instruction could be better assessed.

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APPENDICES

APPENDIX A.

NOWICKI STRICKLAND LOCUS OF CONTROL SCALE

Locus of Control Measurement Instrument

The Nowicki-Strickland Locus of Control Scale for Children is a forty question forced-choice (yes/no) test that will be administered by paper and pencil. The items involve reinforcement situations dealing with interpersonal and motivational areas. The test was written for a fifth-grade level but involves choices appropriate for older children.

Nowicki and Strickland have reported test-retest reliabilities for a six week period of 0.67 for the eight to eleven year old children and 0.75 for those in the twelve to fifteen year old group. The LOC scale will be administered by certified teaching staff at the research site on an individual basis.

The Nowicki-Strickland Locus of Control Scale for Children

NAME ______________

Please place a check mark next to the answer you believe most strongly in and please answer every question.

Yes ___ No ___ 1. Do you believe that most problems will solve themselves, if you just don't fool with them?

Yes ___ No ___ 2. Do you believe that you can stop yourself from catching a cold?

Yes ___ No ___ 3. Are some kids just born lucky?

Yes ___ No ___ 4. Most of the time do you feel that getting good grades means a great deal to you?

Yes ___ No ___ 5. Are you often blamed for things that just aren't your fault?

Yes ___ No ___ 6. Do you believe that if somebody studies hard enough he or she can pass any subject?

Yes ___ No ___ 7. Do you feel that most of the time it doesn't pay to try hard because things never turn out right anyway?

Yes ___ No ___ 8. Do you feel that if things start out well in the morning that it's going to be a good day no matter what you do?

Yes ___ No ___ 9. Do you feel that most of the time parents listen to what their children have to say?

Yes ___ No ___ 10. Do you believe that wishing can make good things happen?

Yes ___ No ___ 11. When you get punished does it seem it's for no good reason at all?

Yes ___ No ___ 12. Most of the time do you find it hard to change a friend's (mind) opinion?

Yes ___ No ___ 13. Do you think that cheering more than luck helps a team to win?

Yes ___ No ___ 14. Do you feel that it's nearly impossible to change your parents' mind about anything?

Yes ___ No ___ 15. Do you believe that your parents should allow you to make most of your decisions?

Yes ___ No ___ 16. Do you feel that when you do something wrong there's very little you can do to make it right?

Yes ___ No ___ 17. Do you believe that most kids are just born good at sports?

Yes ___ No ___ 18. Are most of the other kids your age stronger than you are?

Yes ___ No ___ 19. Do you feel that one of the best ways to handle problems is just not to think of them?

Yes ___ No ___ 20. Do you feel that you have a lot of choice in deciding who your friends are?

Yes ___ No ___ 21. If you find a four leaf clover do you believe that it might bring you good luck?

Yes ___ No ___ 22. Do you often feel that whether you do your homework has much to do with what kind of grades you get?

Yes ___ No ___ 23. Do you feel that when a kid your age decides to hit you, there's little you can do to stop them?

Yes ___ No ___ 24. Have you ever had a good luck charm?

Yes ___ No ___ 25. Do you believe that whether or not people like you depends on how you act?

Yes ___ No ___ 26. Will your parents usually help you if you ask them?

Yes ___ No ___ 27. Have you felt that when people were mean to you it was usually for no reason at all?

Yes ___ No ___ 28. Most of the time, do you feel that you can change what might happen tomorrow by what you do today?

Yes ___ No ___ 29. Do you believe that when bad things happen they just are going to happen no matter what you try to do to stop them?

Yes ___ No ___ 30. Do you think kids can get their own way if they just keep trying?

Yes ___ No ___ 31. Most of the time do you find it useless to try to get your own way?

Yes ___ No ___ 32. Do you feel that when good things happen they happen because of hard work?

Yes ___ No ___ 33. Do you feel that when somebody your own age wants to be your enemy there's little you can do to change matters?

Yes ___ No ___ 34. Do you feel that it's easy to get friends to do what you want them to do?

Yes ___ No ___ 35. Do you usually feel that you have little to say what you get to eat at home?

Yes ___ No ___ 36. Do you feel that when someone doesn't like you there's little you can do about it?

Yes ___ No ___ 37. Do you usually feel that it's almost useless to try in school because most other children are just plain smarter than you?

Yes ___ No ___ 38. Are you the kind of person who believes that planning ahead makes things turn out better?

Yes ___ No ___ 39. Most of the time, do you feel that you have little to say about what your family does?

Yes ___ No ___ 40. Do you think it's better to be smart than lucky?

APPENDIX B.

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Mrs. Barbara Bartolotta
Scott, Foresman
1900 East Lake Ave.
Glenview, Illinois
60025
Fax 708-486-3938

Dear Mrs. Bartolotta:

Please accept this as a request for permission to reprint twelve copies of the model of The Dick and Carey Systems Approach for Designing Instruction.This information is on pages 2 and 3 of The Systematic Design of Instruction (3 rd ed.) by Walter, Dick and Lou Carey.(copyright 1990 Dick and Carey 1985 Scott, Foresman and Company) This model was used in the development of material used in a thesis entitled Locus of Control and Instructional Control in Interactive Videodisc Science Instruction. Reprinting this systematic design of instruction model would help to clarify the instructional design process.

It would be greatly appreciated if written permission could be sent as soon as possible via fax number 403-962-4505 and addressed c/o Mr. Cyril Binette.

Thank you very much for your consideration.

Mr. Cyril A. Binette
5 Brookside Crescent
Spruce Grove, Alberta.
T7X1B8

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To CYRIL BINETTE	From B. BARTOLOTTA
Co.	Co. HARPER/SCOTT
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7.6.92

Date Barbara Bartolotta
HarperCollins Publishers
1900 E. Lake Ave.
Glenview, IL 60025

APPENDIX C.

INSTRUCTIONAL DESIGN

PRETEST/POSTTEST

Answer Key

NAME____________________

CRITERION-REFERENCED TEST ITEMS

PreTest/PostTest

A. True/False

For each of the following, circle the T if the statement is true. If the statement is false, circle the F, and rewrite the statement to make it true on the line beneath. (* = correct answer)

1. T* F Weathered rock in mountainous regions, erosion in river valleys and glaciated mountains are all examples of on going processes of change on earth.

____

____

2. T F* Weathering carries away rock fragments from the land.

____

Erosion carries away rock, weathering breaks rock down

3. T* F Larger rock materials can be separated from other particles in a river.

____

____

4. T F* Volcanism and avalanches are examples of gradual geological change.

Volcanism and avalanches are examples of rapid

geological change.

5. T F* Falling rock is sufficient evidence to show that changes on the mountain are gradual and not sudden.

No, the mountain would have to be observed for many years to see gradual geological change.

6. T F* Water freezing in cracks in rocks and splitting the rocks represents chemical weathering.

Water freezing in cracks in rocks and splitting the rock represents physical weathering.

7. T* F A meandering river will gradually cut a valley in rock.

8. T F* Volcanism and avalanches usually may occur gradually with drastic consequences to the land.

Volcanism and avalanches usually occur suddenly with drastic consequences.

9. T F* The making of a natural land bridge is an example of a man made change.

The making of a natural land bridge is an example of a natural change.

B. Matching

10. In the space to the left, write the letter of the description that best describes the words. (You will have to use all the descriptions.)

	TERM	DESCRIPTION
B	gravity	A. tiny plants growing directly on rocks.
A	lichens	B. a force behind every kind of erosion.
D	erosion	C. fallen rock at the base of a mountain.
		D. gradual wearing away.
G	floodplain	E. formed by the chemical reaction of acid with limestone.
J	rivers and streams	F. dissolves rock.
		G. flat area covered with fertile sediments from a river.
H	silt	H. very fine pieces of rock.
I	volcanoe	I. drastically change the land.
E	cave	J. erode land by carrying boulders, pebbles, sand, gravel and silt.
C	talus	
F	Carbonic Acid	

11. State three kinds of weathering agents that result in change and describe how these may change the lay of the land over a long period of time.

Weathering Agent	Change in the lay of the land
1. a. ice, wind	1. b. wearing away (frost wedging)
2. a. water, wind	2. b. acid rain, breaking apart by chemicals
3. a. plants	3. b. breaking apart by roots

12. Place the letter next to the weathering agent that would have the greatest effect on the landform.

D	Tombstone	A.	wind, dust
A	Pyramid and Sphinxes	B.	acid rain, frost wedging
B	Sidewalks	C.	glaciation, lichens, wind
C	Mountains	D.	acid rain, lichens

13. Write the word **natural** before the following landforms that are naturally occuring and **man made** before those that are made by man:

natural	glacial moraine	natural	avalanche
man made	retaining wall	man made	road through a mountain
natural	glacier	man made	hydrodam

C. Completion

14. In each of the following, fill in the blank with the word that correctly, completes the sentence. Use words from this list: runoff, delta, tributary. (You will need to use all the words.)

i. When a large river carrying sediment enters a standing body of water, the
feature that will form is a _delta___.

ii If water cannot soak into the soil fast enough after a rain, it becomes
___run off__ .

iii. When a __tributary_ flows into a river, the amount of water in the river increases.

D. Multiple choice

In each of the following questions, circle the letter of the best answer. Circle only one answer in each question.

15. Which of these rock fragments are the finest?

A. pebbles
B. sand
C. gravel
*D. silt

16. Which of the following is an example of biological weathering?

*A. A tree's roots extend into the cracks of a rock and eventually split it apart.
B. Water seeps into the cracks of a rock, freezes, and eventually splits the rock.
C. Acid rain damages the surface of an ancient stone building.
D. The movement of a glacier scrapes the surface of an area.

17. Some distinctively shaped lakes are formed by changing river meanders. What are these lakes called?

A. deposits
B. deltas
*C. ox-bows
D. tributaries

18. Each of these substances was dropped into a container of hydrochloric acid solution. Which one would show the most chemical weathering?

A. granite
*B. limestone
C. sand
D. gravel

19. On which of the following is erosion from runoff likely to be the most serious?

A. gentle well-treed slopes

B. steep well-treed slopes

C. gentle, poorly-treed slopes

*D. steep, poorly-treed slopes

20. Which of the following is an example of physical weathering:

*A. water seeps into the cracks of a rock and eventually splits it apart.

B. acid rain damages the surface of an ancient building.

C. a tree's roots extend into the cracks of a rock and it eventually splits.

D. a rodent such as a gopher decides to burrow into the ground.

21. The amount and rate of weathering is determined by all of the following except:

A. rain

B. gravity

C. wind

*D. force

Fill in the Blank:

22. In each of the following, fill in the blank with the word that correctly, completes the sentence. Use words from this list:

Water, contraction, avalanche, mudslide, carbonic acid, runoff, tributary, flooding, and expansion.

i. An agent of erosion water.

ii. When deep snow builds up on a mountain there is a danger of a (an) _avalanche_. When mud builds up a (an) _mudslide_ may occur.

iii. Weak acids in the air such as carbon-dioxide combine with moisture in the air or with rainwater to form _carbonic acid_.

iv. If water cannot sink into the soil fast enough after a rain it becomes _runoff_.

v. When a _tributary_ flows into a river, the amount of water in the river increases.

vi. When snow melts at the end of winter or when there are heavy rainstorms runoff becomes heavier which may cause flooding.

vii. In the first step of weathering expansion and contraction will cause rocks to crack over a long period of time.

23. Number the following geological materials in order from those that would weather fastest to those that would weather slowest:

1= fastest ..... 4= slowest

_4_ granite _1_ limestone _2_ calcite _3_ marble

24. Classify the following rock types from largest to smallest:

1. largest 6. smallest.

_3_ pebbles _2_ gravel _5_ clay _4_ sand

_1_ boulders _6_ silt

25. Which of the following rocks would resist weathering by acid rain better than the other?

Marble or Quartzite?

Quartzite .

26. Circle the material that will take longer to show the effects of weathering.

*Granite or limestone.

Granite

27. In the space to the left, write the letter of the description that best describes the words.

TERM	DESCRIPTION
__G__ stalagmite	A. causes small craters and erosion.
__H__ weathering	B. natural sorting by streams.
__J__ downslope movements	C. landforms that indicate gradual geological change.
__K__ flooding	D. usually cracked by weather and lichens.
__I__ tides	E. hang from the roof of a cave.
__C__ hoodoos and canyons	F. carry boulders, pebbles, sand and silt.
__E__ stalactite	G. formed at the bottom of limestone caves.
__A__ raindrops	H. a crack in the sidewalk.
__D__ weathered tombstone	I. coastlines are shaped by these.
__B__ gold prospecting	J. avalanches and mudslides are called this.
__L__ clay	K. excessive runoff may cause this.
__F__ erosion and deposition by water.	L. low porosity.

Write a sentence or two to answer the following questions:

28. In what type of rock might you usually find caves? Why?

Usually in a limestone mountain where HCL and Carbonic Acid dissolves the rock forming a cave

29. Why does the land in a floodplain make especially good farmland?

The water carries very rich nutrients from the surface making the mixture that the water deposits rich in nutrients making it it very fertile

APPENDIX D.

ETHICAL CONSIDERATIONS

ETHICAL CONSIDERATIONS

Ethical considerations were evaluated and approved for this research. Participants in both the small group evaluation and the experimental study were fully informed and voluntary consent to participate was necessary. Students had the option of participating in this study only with written consent from their legal guardians. Legal guardians were fully informed of the purpose of this research study (see text of letter which follows).

All students participating were guaranteed anonymity and their responses were treated confidentially. Participants were informed that they had the right to withdraw from the study without any penalty or risk. No one involved in this study exercised this option. No information from the results of this study was used to the detriment of any person involved.

The researcher requested official permission at different administrative levels. The Director of Curriculum approved the research study at district level and the administration and staff also offered their cooperation.

The University of Alberta Secondary Education Ethics Committee approved the application and confirmed that it conforms with the provisions contained in the University Policy Related to Ethics in Human Research document.

Dear Parents:

I am presently doing research at the University of Alberta on Locus of Control and Instructional Control in Interactive Videodisc Instruction in Junior High Science.

There are three main purposes for conducting this research study:

1. To develop interactive videodisc instruction that will enhance learning of difficult concepts in secondary science education.
2. To increase academic achievement and student motivation by using new instructional tools.
3. To research locus of control and instructional control as important design variables in interactive videodisc instruction.

The research study to be conducted in January, February and March, will be during class time and will consist of filling out a questionnaire, approximately one hour of individualized instruction and adequate testing. The lesson will be on weathering and erosion which follows the grade seven science curriculum. The benefits to your son/daughter will be that they will aready have covered some of the major concepts of weathering and erosion before the formal class presentation of the unit later on in the year. This should help students increase their science marks for the unit. Your son/daughter will have the right to withdraw from this study without any penalty or risk.

This letter is written for permission to use your son/daughter in my research study. All information will be confidential and will be used solely for the research study.

Thank you very much for your consideration.

Mr. C. A. Binette (Teacher-Vital Grandin
Elementary School)

I give my son/daughter ________________ (full name) permission to participate in this research study.

Parents Signature ____________________

I do not give my son/ daughter________________ (full name) permission to participate in this research study.

Parents Signature

____