THE EFFECTS OF LOCUS OF INSTRUCTIONAL CONTROL AND ORIENTING ACTIVITIES ON LEARNING FACTS AND PROCEDURAL KNOWLEDGE VIA INTERACTIVE VIDEO

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ABSTRACT

The Effects of Locus of Instructional Control and Orienting Activities on Learning Facts and Procedural Knowledge Via Interactive Video

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This study investigated the overall effectiveness of locus of instructional control as well as the effect of orienting activities on learning facts and procedural knowledge using the medium of interactive video. Specifically, it examined three levels of instructional control (linear, designer, and learner) with the presence or absence of an orienting activity. Ninety-one subjects took part in this study. The subjects were made up of 44 male and 47 female undergraduate and graduate university students in the sciences.

Significant main effects were revealed for both locus of instructional control and orienting activity for recall of facts. Subjects in the linear treatment performed significantly better than those in the learner controlled condition. As well, subjects in treatments with orienting activities achieved significantly superior results when compared to those who were exposed to treatments without this learning enhancer. Significant main effects were also noted for orienting activity and time on task (subjects in the orienting treatments took significantly longer to complete the learning task). No significant main effects were noted for learning of procedural knowledge nor were there any significant interaction effects between any of the independent variables.

Recommendations are made for further research in the area of placement of practice activities, and different formats, for interactive video.

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CHAPTER 1

Introduction

Interactive video (microcomputer-controlled interactive videodisc) provides a very flexible yet powerful instructional medium. Interactive videodisc is one of the most recent technologies and offers a wide variety in the types of interactions available to a learner. Its great flexibility in terms of repurposing existing materials makes it a cost effective choice in the training context. But what is it exactly ? It is not just a movie which can be controlled by the computer. Nor is it a computer-based tutorial with pictures added. Palmer & Tovar (1987) provide a general definition: "Essentially, interactive video is the merging of characteristics commonly attributed to computer assisted instruction (CAI) with the visual expository qualities of video" (p. 196). Schwier (1987) is more content design oriented when he suggests that "Interactive video is a program intentionally designed in segments, in which viewer responses to structured opportunities (menus, questions, timed responses) influence the sequence, size, and shape of the program" (p. 36).

Interactive video is exceptionally robust and durable since it is an optical medium and read without physical contact. It permits rapid, seemingly instantaneous, access to various segments, slow motion, and still framing.

Interactive video is a relatively new medium. In the early research there had been a tendency to compare interactive video to already existing media, just as in the 70's classroom teaching was compared to programmed learning, slide-tape presentations and television. This comparative research model is almost no longer recommended and suffers from non-significant results and contradictory findings. Reported learning gains were often attributable to other factors such as better programme design for the competing medium. Research studies of this type have yielded few useful outcomes (Clark, 1983; Reeves, 1986). We no longer want to look at whether medium A is better than medium B but focus more on the instructional strategies and messages conveyed by the medium. Clark (1984) suggests that the wrong questions are being addressed in terms of the effectiveness of interactive video.

Interactive video has been characterized as having three levels of interactivity in the literature based on the Nebraska video Group as reported in Daynes (1984). These levels refer to the players and the videodisc itself. Level I has the least amount of interactivity. The user can control the videodisc player through the keypad. This means that s/he can play the disc, stop it on a frame, search for a chapter, if there are some encoded on the disc, and search for a frame. All this is accomplished through the keypad much like a home VCR.

Level II again uses the keypad for interaction but the difference is that there is a program coded in, which is loaded into the microprocessor of the player. Level II permits branching based on the user's keypad responses.

Level III includes another adaptive control device, usually a computer. A program in the computer controls the discplayer and allows for greater interaction through the keyboard of the computer, a mouse, a touch screen, or even a light pen. The computer also can add graphics and text which can be overlaid onto the video image.

There is another level, level IV, which goes beyond level III and is described in terms of expert systems and artificial intelligence. As this field progresses, examples of these intelligent systems may soon become a reality.

Except for level IV, this taxonomy takes into account only the hardware aspects of the technology. Gayeski (1984-85) proposes a taxonomy which integrates hardware and design levels into seven levels of interactivity. While not limited to interactive video this taxonomy is appropriate for a developers and researchers. This taxonomy has been in use in courses at Ithica College, in professional workshops and used for needs analyses. The first two levels include traditional hardware and are described as having a linear design that can include pausing and self-evaluation. Levels three through six correspond to a branching design that offers feedback for multiple choice questions through to the evaluation of constructed responses and can include microcomputers and specialized peripherals for the evaluation of motor responses. Level seven dubbed "intelligent system" has a recursive design and would include a natural language interface.

In order for interactive video to be an effective medium, applications developed must be instructionally sound, and appropriate for the subject matter, the learners and the educational setting. "There is great need to incorporate instructional strategies into the design of all types of computer-based materials and to try and increase the quality of interactivity within the program" (Cohen, 1984, p. 17)

In the spirit of exploring leading, central issues in interactive video, this study is designed to investigate the overall effectiveness of locus of instructional control as well as the effect of orienting activities in the learning of procedural tasks. Specifically, it will examine three levels of instruction control (linear, designer, and learner) with the presence or absence of an orienting activity.

The historical review, which follows in the next chapter, will focus on the instructional potential of interactive video as it relates to learning outcomes, levels of instructional control, and orienting activities directly relevant to this thesis.

CHAPTER 2

Literature review

Interactive video has been enthusiastically supported (Copeland, 1988; Smith & Jones, 1986; Clark, 1984; Bunderson, Olsen, & Bailio, 1981) as a teaching and training tool, although there are probably as many studies reporting non-significant knowledge gains as those which do report gains. The literature on interactive video has been concentrated in four areas: descriptions of capabilities, descriptions of uses, design considerations and research or evaluation reports.

As with any new medium, especially one as "glamorous" as interactive video, many of the early studies focused on the hardware aspect. Other studies involved comparing interactive video to video or CAI or even classroom teaching. Heinich (1984) argues that the main purpose of media research is to improve rather than prove the media. In this spirit, more and more researchers are looking at instructional variables such as orienting activities, locus of instructional control, time-on-task and the role of practice (Hannafin & Colamaio, 1987; Milheim, 1989, 1988; Goetzfried & Hannafin, 1985; Kinzie *et al.*, 1987; Dalton, 1986; Ho, Savenye & Haas 1986).

Locus of instructional control

One variable of considerable interest is locus of instructional control. Interactive video offers a powerful way to provide access to a very large quantity of information and as such locus of instructional control has become of paramount importance (Hannafin, 1984; Hannafin & Colamaio, 1987; Goetzfried & Hannafin, 1985; Klein 1990; Rieber & Hannafin, 1988) The literature shows some controversy about just how effective designer control is versus learner control in content access and sequencing. Many people equate interactivity with control. Interactivity "has become a catch-all phrase for producers, clients, and consumers who claim they want to use the videodisc because of its unique 'interactivity'" (Cohen, 1984, p. 16). Laurillard (1984) investigated the control of learning and measured how long a student spent in one mode before using an interrupt feature. A student exercising control does not necessarily choose to interrupt. Rather, a student may exercise control by continuing on a particular lesson segment. Locus of instructional control refers to a continuum where, at one end, theoretically, the learner has total control and at the other the designer of the Unit (the computer program actually) has control. Milheim (1986) notes that learner control is most often described as the ability to choose pacing, sequencing or content during an instructional lesson. Interactive video "permits lesson control options ranging along a continuum from fully learner controlled through completely imposed control of lesson activities and sequence" (Hannafin

& Colamaio, 1987, p. 203). Studies examining levels of control reported an increase in learning gain directly related to increased interactivity (Dalton, 1986; Schaffer & Hannafin, 1986). Some studies used two levels: Learner control and program control (Kinzie *et al.*, 1987). Others have looked at three levels of instructional control. Hannafin (1987), for example, used the following levels: Linear, where students followed a predetermined linear path through the lesson; Designer imposed where a predetermined branching path through the lesson was based on the student's performance; and Learner, which is similar to Designer, but where the students made control decisions at each juncture.

Replication of current research studies is difficult and is hindered by different subject matter, instructional strategy, prior knowledge and experience of the learner (Cushall, Havey, Brovey, 1987). Many studies report that individual differences such as ability may affect the efficacy of learner control. It is common sense that someone that we have known to always do well will do well. In information processing, learning is viewed as a continuous cycle where information is received, moves to short term memory, and perhaps to long term memory, and as a learning outcome is exhibited in the form of a response. Learning is organized in long term memory (Gagné, 1985) and because of this a learner is more likely to choose a route through a program consistent with this organization (Laurillard, 1984). As a consequence imposing a structure that is inconsistent with the students' organization may be counterproductive (Hannafin *et al.*, 1985). The cognitivist approach to learning supports the idea of control. It is believed that learners should actively participate in their learning experience. It has also been found that practice is an important instructional variable for recall of facts but relatively unimportant for procedures (Hannafin *et al.*, 1986). Theory relating to motivation is also consistent with learner control. Keller (1983) describes four instructional conditions (interest, relevance, expectancy and satisfaction) that may lead to motivation and learning. Relevance is the student's perceived need during instruction. Being able to control the lesson empowers the student and helps motivate him/her. It is "... mandatory that the software design, itself, build upon this milieu and promote an atmosphere which enhances interactivity, establishing a rich dialogue between the learner and the instructional program" (Cohen, 1984, p. 16). Whether the promotion of this dialogue should be learner or designer controlled is still unclear from the literature. In light of the lack of firm evidence, Cohen (1984) suggested that instructionally sound interactive video programs should be "designed to accommodate many different styles of learning and many different types of responses" (p. 16).

Orienting activities

Findings from computer-based instruction generally point to adequate coaching and advice as important variables. Learners perform better when they have advisement or coaching to help them base their decisions. Orienting activities are "mediators through which new information is presented to the learner ... Properly designed orienting activities promote greater effort during encoding, resulting in more active learning of both factual detail and higher order learning" (Hannafin & Hughes, 1986, p. 244). Keller (1983) describes expectancy as perceived likelihood of success, being greatly influenced by orienting activities which set the tone for upcoming content. Orienting activities can be in one of many forms including title, introductory remarks, summaries, lists, outlines, flowcharts and so on.

Although the use of orienting activities is supported in the literature, findings vary when they are combined with other instructional variables (Hannafin *et al.*, 1987). One could consider that, although a learner has a minimal amount (linear) of control over the learning activity, the orienting activity helps structure the content and thereby improve performance. Thus, although subjects in a linear control situation have no control over the sequencing of the module, the orienting activity is expected to assist subjects in better internalising the material. One would expect that a learner in a full (or learner) control condition given the appropriate orienting activity, would be able to make "intelligent" choices within an instructional unit.

Phillips, Hannafin & Tripp (1986) investigated the effects of orienting activities and levels of practice. In this study the orienting activity consisted of brief introductory statements. The findings revealed significant differences between two levels of practice but no significant results for the orienting activity. In a related study, Hannafin, Phillips & Tripp (1986) looked at orienting activities, time, practice and processing. Subjects in the orienting activity condition performed well under reduced time while those without orienting activities performed better with extended time. Their discussion suggested that the effect of orienting activities is lessened when combined with more powerful variables such as practice, type of learning and prior knowledge. In another study looking at orienting activities and control (Ho *et al.* 1986), found a significant interaction between orienting and control. The orienting activity took the form of behavioral objectives and the control was limited to optional or forced review. The groups with orienting objectives and control performed significantly better than those without.

Practice and access time

In our technologically advanced world of banking machines and video games, time is an important commodity. Interactive video's speed of access is often touted as one of its important characteristics. It was the principal argument in the tape versus disc debate. Although some studies report that the extra time taken for orienting activities did not translate into a gain in achievement (Goetzfried & Hannafin, 1985), earlier research in television and print report that pacing, delays between segments and delayed feedback all contribute to a significant gain in achievement (Schramm, 1967; Kulhavy, 1977). Hannafin & Colomaio (1987) found practice to be a powerful variable in interactive video in the learning of facts and for problem solving skills but not for procedural learning. And Kinzie *et al.* (1987) reported that "students under limited learner control adjust their study behaviours to achieve greater learning in the same amount of time (p.2). Finally, Goetzfried and Hannafin (1985) reported that advisement and control strategies used in their study resulted in increased instructional time, while the linear condition results were comparable with significantly less instructional time.

Research Questions

Based upon the foregoing literature review, the following research questions will be examined in this study:

1. Will levels of locus of instructional control (linear, designer, learner) make a difference in learners' posttest performance ?

2. Does the presence or absence of an orienting activity make a difference on learners' posttest performance ?

3. Will levels of locus of instructional control (linear, designer, learner) make a difference on time spent on task?

4. Does the presence of an orienting activity have an effect on time on task?

5. Is there an interaction effect between the levels of locus of instructional control and the presence or absence of an orienting activity on posttest performance ?

6. Is there an interaction effect between the levels of locus of instructional control and the presence or absence of an orienting activity for time on task ?

Hannafin and Phillips (1987) in a paper on designing interactive video relate that imposed (or linear) control is advisable for procedural and unfamiliar content, while learner control should be most effectual for contextual and higher-order learning. When the material is familiar, as is the case when there is prior knowledge, subjects in a learner control option perform better on posttests (Gay, 1986; Goetzfried & Hannafin, 1985; Hannafin & Colomaio 1987).

Although some studies reported no significant difference for orienting activities, it is speculated that subjects in a learner condition having the possibility to review or redo sections would opt to do so and consequently spend more time on the task. Studies investigating time reported no difference for time on task, for example Kinzie *et al.* (1987) found that subjects in the learner condition selected fewer content reviews. Another study reported less time for the linear condition (Goetzfried & Hannafin, 1985). Although this study reported no significant differences for locus of instructional control, they did report the linear condition as being more efficient (a comparative measure of concepts per minute).

Hannafin *et al.* (1986) reported a marginal interaction for orienting activity and time (time in this case was an independent variable), students under the orienting activity condition performed better under reduced time. Students without an orienting activity performed better with extended time.

In a study investigating practice and orienting activities, Phillips *et al.* (1987) found the effectiveness of orienting activities to be inversely related to the degree to which other instructional variables are utilized in the lesson. Ho *et al.* (1986) conducted a study where subjects in the learner control condition (could choose to review or not) performed better with orienting activities. However, for the program control condition, they found no difference in the presence or absence of an orienting activity. Rieber & Hannafin (1987) actually found in their study that practice hampered the subjects performance but cautioned the reader about the interpretation of this result.

Predictive hypotheses

Based on the preceeding concrete findings, the following predictive hypotheses are advanced.

Main Effects for locus of instructional control

Hypothesis 1. Subjects in the linear treatment will perform significantly better on factual recall than those in the designer or learner treatments.

Hypothesis 2. Subjects in the linear treatment will perform significantly better on procedural knowledge learning than those in the designer or learner treatments.

Hypothesis 3. Subjects in the learner treatment will take significantly less time than those in the designer or linear treatments.

Main effects for orienting activity

Hypothesis 4. Subjects in treatments which include an orienting activity will perform significantly better on factual recall than those in treatments which do not include the orienting activity.

Hypothesis 5. Subjects in treatments which include an orienting activity will perform significantly better on the procedural knowledge learning than those in treatments which do not include the orienting activity.

Hypothesis 6. Subjects in treatments which include an orienting activity will take significantly less time than those in treatments which do not include the orienting activity.

Interactions between locus of instructional control and orienting activity

Hypothesis 7. There will be a significant interaction between locus of instructional control and orienting activity for factual recall.

Hypothesis 8. There will be a significant interaction between locus of instructional control and orienting activity for the procedural knowledge learning.

Hypothesis 9. There will be a significant interaction between locus of instructional control and orienting activity for time on task.

CHAPTER 3

Method

Subjects

Ninety-one subjects took part in this study. The subjects consisted of 44 male and 47 female undergraduate and graduate students in Chemistry, Biology, Bio-Chemistry and Physics at Concordia University in Montreal, Canada. Randomized blocking was used to assign subjects to conditions so as to avoid confusing the conditions and to reduce suspicion among the subjects about the nature of the task.

Materials

An interactive videodisc lesson was developed using the Pixframe authoring system on the Pioneer LDV/S1 system.

Hardware

The hardware of this configuration consists of a UXC-V102 video controller, an LD-V4200 laserdisk player and a TVM-V1300 13 inch colour monitor equipped with a touch screen. All of the equipment is manufactured by

Pioneer of America and can be purchased through any authorized Pioneer dealer.

Videodisc

An existing videodisc (Doiron, 1990) developed for the science laboratories at Concordia University, which is currently in use, was repurposed for use in this study.

Instructional Unit

An interactive videodisc instructional unit was developed to teach the Swipe check method, a radioactive contamination assessment and decontamination procedure. This procedure was chosen because it is an important part of the training required by students who will be working with radioactive materials. They need to know these procedures for their health and safety.

Most of the interaction is via a touch screen. The subjects select choices and respond to questions in a natural manner by touching the appropriate area on the screen. A short module allowing them to practice touching the screen was provided prior to undertaking an instructional treatment.

The instructional unit involves recall and procedural knowledge. It is broken down into three parts which make up the Main menu and consists of an introduction, the actual procedure, and a practice segment (see Figure 1 below).

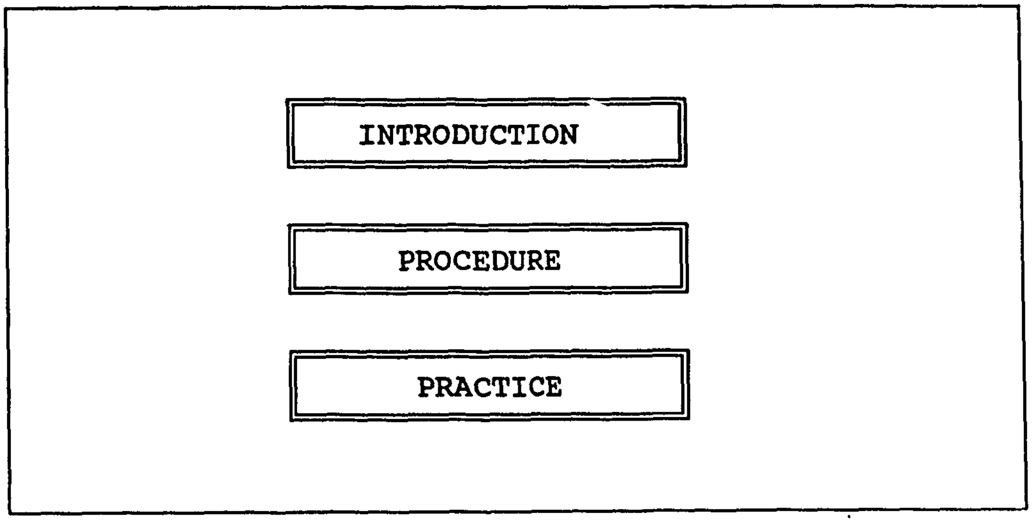

Figure 1. Main Menu

Introduction

The introduction consists of 2 video segments namely, "Why do I use it" and "Introduction". The Introduction includes some motivational aspects and introduces the actors in the video. "Why do I use it" presents factual content about why the Swipe Check is used.

Procedure menu

The Procedure menu (see Figure 2) was organized in six parts. Two of them dealt with the tools and materials. The other four choices offered the student the opportunity to learn about the procedure through viewing a video, accessing a descriptive list, seeing a keyword chart, and controlling a set of step-by-step video segments.

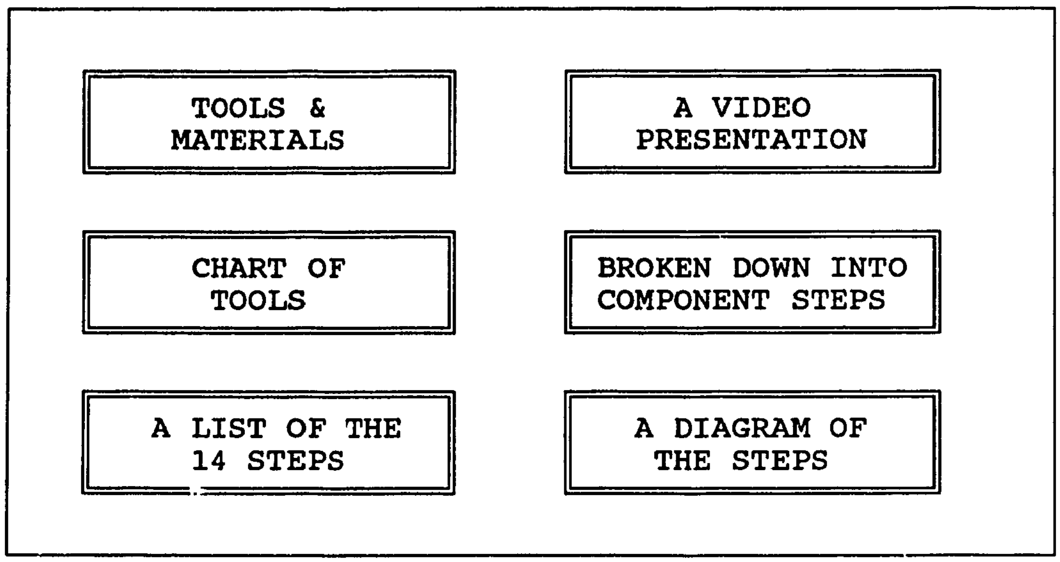

Figure 2. Procedure Menu

1) TOOLS & MATERIALS

This menu selection presented the individual tools in a sequential manner. Each tool was presented as a full-colour still image overlaid with text describing it. Control options included next item, previous item and back to the menu.

2) A VIDEO PRESENTATION

This option offered a full colour live-action video presentation of the Swipe Check procedure. A control option permitted interrupting the video.

3) CHART OF TOOLS

This menu choice offered a colour graphic made up of nine boxes representing the tools. Touching one of the boxes would bring to the screen a still image of the desired tool. Touching again would mean a return to the Chart of tools. A box labelled MENU allowed the subject to return to the Procedure menu.

4) BROKEN DOWN INTO COMPONENT STEPS

In this presentation the Swipe Check procedure is broken down into its component steps. Each step is numbered and described textually; the subject activates the video segment which then plays. The presentation proceeds sequentially under the control of the subject who can choose to play the segment, go back to the previous segment, or return to the Procedure menu. The Control options also include interrupting the video segment.

5) A LIST OF THE 14 STEPS

This option displays the Swipe Check procedure as a textual list.

6) A DIAGRAM OF THE STEPS

This selection displays a full colour graphic. It is made up of a flowchart representation of the Swipe Check procedure. Each step is represented by a Keyword. Touching a keyword activates the corresponding video sequence. Control options include interrupting the video and returning to the Procedure menu.

Practice

The practice section affords learners the opportunity to practice; as well it provides them with feedback. It starts with a two-screen explanation of the control options. Subjects are presented with the steps of the Swipe Check procedure. They must determine if each step is in the correct order and whether it was carried out correctly. If they identify a step as being incorrect they must provide a description of the correct step. Feedback is provided in terms of a performance record which is displayed at the end of the practice or when a subject exits the practice. This record displays the questions correctly answered, incorrectly and those not attempted. The subject can choose to review any of the questions.

Treatments

Linear

In the linear treatment subjects have pacing control, that is to say, they choose when they will proceed to the next section or element. They have no control over sequencing. The instructional unit proceeds in the following order: Introduction, Procedure and ends with Practice. Within the Procedure section the instructional unit proceeds sequentially through the elements of the Procedure Menu (see Figure 2, p. 18). At the end of the practice section, the subjects are given feedback as to their performance and forced to review only those steps which they answered incorrectly. The subject cannot interrupt any portion of the instructional unit.

Learner

In this treatment condition the subject has the freedom to select any item from any menu in any order. The subject can also exit at any point within any portion of the instructional unit and can interrupt video segments. Figure 3 below illustrates the various control features available at the three levels of control.

Designer

The Designer treatment is somewhere in the middle of the continuum between pacing only and total control. The subject can select the order in which s/he wants to proceed within the Main Menu: for example, the subject can choose the Procedure first and then the Introduction and so on. However, within each one of these, the instructional unit proceeds sequentially. There are options built in that permit the subject to exit from some of the sections (see Figure 3).

Control Feature	Learner	Designer	Linear
		Treatments	
interrupt video	Yes	No	No
exit a sequence	Yes	Some	No
go backwards	Yes	No	No
repeat a menu choice	Yes	Yes*	No
menu items available	11	3	1
INTRODUCTION MENU	S	S	P
introduction	SE	P	P
when do I use it	SE	P	P
PROCEDURE MENU	S	S	P
tools & materials	SE	P	P
a video presentation	SE	P	P
chart of tools	SE	P	P
broken down into ...	SE	PE	P
a list of the 14 steps	SE	PE	P
a diagram of the steps	SE	P	P
PRACTICE	SE	SE	A
ability to review practice questions	all in/correct	any incorrect	forced incorrect

S - Selectable directly from a menu
E - Can Exit or be Interrupted
P - Pacing only

Figure 3. Comparison of Control Features for the Three Treatments

* can repeat choices from the Main Menu only.

Orienting Activity

The orienting activity consists of introductory text pages followed by an overview of the Why-When-Where aspects of the swipe check. This is followed by a labelled still image illustrating the tools and materials used. The last element is a flowchart summarizing the steps in the Swipe Check procedure.

Instrumentation

The pre-test ascertained whether the subject had any prior knowledge about the Swipe Check procedure (see Appendix B). The test simply asked whether the student knew the swipe check procedure and if so to describe it.

The posttest consisted of two parts. Questions I through V included questions based on recalling facts and included 24 items relating to the tools and materials used, the areas to be checked and so on (see Appendix C). Question VI dealt strictly with how to carry out the Swipe Check procedure, requiring the subjects to describe the 14 steps of the Swipe Check procedure.

The scoring procedure (see Appendix D) provided the raters with an explicit marking scheme for the post-test and included points allocated for each answer as well as allowable responses and point value for each question. There were a maximum of 25 points allotted for recall of facts, and 28 points for procedural knowledge.

Independent Variables

1. Locus of instructional control.

This variable consisted of 3 levels: Linear, Designer and Learner.

2. Orienting activity.

This variable consisted of 2 levels denoted by the presence or absence of the orienting activity.

Dependent Variables

1. Recall of facts.

2. Procedural knowledge.

3. Time spent (recorded in minutes).

Design

A 2 by 3 factorial design was used (see Figure below). Locus of instructional control had 3 levels: linear, designer, and learner. Orienting activity had 2 levels: orienting, no orienting.

	Linear	Designer	Learner
Orienting	15	15	15
No Orienting	15	15	16

Figure 4. Factorial Design

Procedure

The research assistants were given full instructions from the experimenter on the procedure to be followed for the experiment. To validate this, a pilot test was carried out using 15 students. Based on the pilot test, the method of administering the treatments and the questionnaires were standardized. Problems of a physical nature were revealed and solved. A script was produced for the assistants to follow and they were further instructed to assist the students only if technical support relating to the equipment was required.

Both the subjects and the research assistants collecting and coding the data were kept unaware of the experimental conditions. All subjects in the study were told that they were participating in a programme evaluation study. All testing was carried out during regular class time. Students were logged in by the research assistant and had to sign out. The treatment condition administered was dependent on the order in which students arrived and recorded on the log sheet. No treatment numbers appeared on any of the tests given to the students so as to avoid alerting either the students or the markers about which treatment was administered. Students were asked not to discuss their tests with the others.

Step 1. Upon arrival, students were seated and given a pre-test to determine prior knowledge. At the same sitting, general demographic information was also collected.

Step 2. Upon completing the questionnaires, the students were directed by the research assistants to focus their attention on a demonstration related to the physical equipment used in the study. Specifically, it consisted of a short exercise to familiarize the students with the use of the touch screen.

Step 3. Administration of treatment. The research assistant remained in or near the room in order to respond to any technical difficulty that might have occurred.

Step 4. A distracter was administered. It consisted of the Nelson Denny reading comprehension test questions 17 through 24, and was used to counteract the recency effect of the material on the subjects.

Step 5. The posttest was administered.

Payment for participation Each subject, upon signing out, received a cash payment of $15 for his/her participation.

Scoring

Two raters evaluated the posttest using a standard scoring procedure (see Appendix D). The interrater reliability was .98 and .85 for the recall of facts portion and the Procedural knowledge respectively. If any score diverged by 4 points or more the raters re-evaluated and arrived at a score by consensus.

Data Analysis

A two way analysis of variance was used to determine differences between the treatment groups. The data were analyzed using subprogram ANOVA of SPSS (Statistical Package for the Social Sciences) on a Vax computer. Measures included in the analysis were a) recall measure, b) procedural knowledge measure, and c) time.

CHAPTER 4

Results

The pre-test revealed no prior knowledge among any of the subjects. A two way analysis of variance (ANOVA) was then conducted on the data collected. The dependent variables were recall of facts, procedural knowledge and time spent. The maximum attainable score for recall was 25 points and 28 points for procedural knowledge. The independent variables were locus of instructional control (linear, designer and learner) and orienting activity (presence or absence of the orienting activity).

Recall of facts

It can be seen from the means in Table 1 that the subjects in the linear condition performed better than those in the designer condition and the learner condition respectively As well, subjects in the orienting condition did consistently better than those in the no orienting condition.

The analysis of variance revealed a significant main effect for locus of instructional control for the recall measure with $F(2,90) = 11.46$, $p < .001$ (see Table 2, p. 30). In order to avoid Type I error, the Scheffé was selected for its stringency. *A posteriori* analysis using Scheffé confirmed that the linear and designer groups were significantly different from the learner group at $p = .01$.

However, it also revealed that the linear and designer groups were not significantly different from each other.

A significant main effect for orienting activity was also present for the recall measure with $F(1,90) = 9.36$,

$p < .005$.

No significance was found for two-way interactions on the recall measure.

Table 1

Means and Standard Deviations for Recall of Facts

	Linear	Designer	Learner	
Orienting	21.0 (3.6) n = 15	20.5 (3.4) n = 15	17.1 (3.8) n = 15	19.7 (3.8) n = 45
No Orienting	19.7 (3.7) n = 15	18.1 (4.2) n = 15	13.9 (4.5) n = 16	17.2 (4.8) n = 46
	20.3 (3.7) n = 30	19.3 (4.0) n = 30	15.7 (4.5) n = 31	

Note: The maximum value = 25

Table 2

Analysis of Variance: Recall of Facts Score by Locus of Instructional Control and Orienting Activity

Source of Variation	Sum of Squares	DF	Mean Square	F	*p*
Main Effects	497.601	3	165.867	10.91	.000
CONTROL	348.621	2	174.310	11.47	.000
ORIENTING	142.218	1	142.218	9.36	.003
2-Way Interactions					
CONTROL ORIENTING	24.442	2	12.221	.80	.451
Explained	522.043	5	104.409	6.87	.000
Residual	1292.243	85	15.203		
Total	1814.286	90	20.159		

Procedural knowledge

The maximum score possible was 28. On average, the subjects did well (see Table 3), with means ranging from 22.0 to 24.1 and standard deviations from 2.5 to 4.7.

The analysis of variance, as illustrated in Table 4, did not reveal any significant main effect for either locus of instructional control or orienting activity for the procedural knowledge measure.

No significance was found for two-way interactions on the procedural knowledge measure.

Table 3

Means and Standard Deviations for Procedural Knowledge

	Linear	Designer	Learner	
Orienting	24.1 (4.0) n = 15	23.2 (4.7) n = 15	23.9 (2.5) n = 15	23.7 (3.8) n = 45
No Orienting	23.5 (3.4) n = 15	22.7 (3.0) n = 15	22.0 (3.6) n = 16	22.7 (3.3) n = 46
	23.8 (3.7) n = 30	22.9 (3.9) n = 30	22.9 (3.2) n = 31	

Note: The maximum value = 28

Table 4

Analysis of Variance: Procedural Knowledge Score by Locus of Instructional Control and Orienting Activity

Source of Variation	Sum of Squares	DF	Mean Square	F	*p*
Main Effects	38.263	3	12.754	.98	.405
CONTROL	14.784	2	7.392	.56	.568
ORIENTING	23.196	1	23.196	1.78	.185
2-Way Interactions					
CONTROL ORIENTING	8.674	2	4.337	.33	.717
Explained	46.937	5	9.387	.72	.608
Residual	1103.668	85	12.984		
Total	1150.604	90	12.784		

Time on task

Means and standard deviations are provided in Table 5. In the orienting condition, the time spent seems to increase with control, while conversely in the no orienting condition, time spent seems to decrease with increasing control. In terms of the means, subjects in both the designer and the learner conditions took more time than their no-orienting counterparts. In the linear condition they are about the same.

No significant main effect was present for locus of instructional control for the time spent. However, a significant main effect for orienting activity was noted for the time on task with $F(1,90) = 5.32$, $p < .05$ (see Table 6, p. 35).

No significance was found for two-way interactions on the time on task.

Table 5

Means and Standard Deviations for Time on Task

	Linear	Designer	Learner	
Orienting	96.0 (17.6) n = 15	95.9 (18.2) n = 15	100.8 (30.5) n = 15	97.6 (22.5) n = 45
No Orienting	97.4 (16.8) n = 15	85.9 (15.2) n = 15	81.7 (13.0) n = 16	88.2 (16.2) n = 46
	96.7 (16.9) n = 30	90.9 (17.2) n = 30	90.9 (24.8) n = 31	

Note: Time measured in minutes

Table 6

Analysis of Variance: Time on Task by Locus of Instructional Control and Orienting activity

Source of Variation	Sum of Squares	DF	Mean Square	F	*p*
Main Effects	2653.481	3	884.494	2.37	.076
CONTROL	651.170	2	325.585	.87	.421
ORIENTING	1984.991	1	1984.991	5.32	.023
2-Way Interactions					
CONTROL ORIENTING	1607.742	2	803.871	2.16	.122
Explained	4261.223	5	852.245	2.29	.053
Residual	31699.304	85	372.933		
Total	35960.527	90	399.561		

CHAPTER 5

Discussion

This discussion is organized in accordance with the predictive hypotheses formulated in Chapter 2.

Main Effects

Locus of instructional control

The findings in this study supported the first hypothesis, which stated that students in the linear treatment would perform significantly better on factual recall than those in the learner treatment. Although Kinzie *et al.* (1987) reported findings inconsistent with this thesis, they attributed the learner group's performance to a practice effect. Since they initially forced all groups, including learner, to respond to all practice questions, they suggest that this helped to minimize the possibility of the learner group of missing any needed content. This does not appear to hold in a true learner treatment as in the present study, when learners have the freedom to use or not to use this option.

The findings in this study did not support the second hypothesis, which stated that subjects in the linear treatment would perform significantly better on the procedural knowledge measure than those in the designer or learner treatments. This finding is consistent with those of Hannafin *et al.* (1986). Actually, all of the subjects performed very well regardless of treatment. The mean for the entire sample was 23.2 (80 %) out of a maximum possible score of 28. The fact they did well is probably due in large part to the practice on procedural knowledge and to the robust nature of the instructional design.

The third hypothesis stated that subjects in the learner treatment would take significantly less time than those in the designer or linear treatments. This was not the case; this study did not uncover any significant differences. In fact, in the orienting condition the learner group actually took more time. This is consistent with Kinzie *et al.* (1987) who found that "Learner control subjects took as much time to complete the unit as did program control subjects, even though they selected significantly fewer content reviews" (p.14).

Orienting activity

The fourth hypothesis was supported by the findings in this study. In treatments which included an orienting activity, subjects performed significantly better than those in treatments which did not include an orienting activity. Subjects in the linear treatment with an orienting activity, however, performed significantly better than those in all three of the locus of instructional control conditions without the orienting activity. Hannafin and Hughes (1986) concluded that orienting activities are most effective when there is little pre-requisite knowledge or when instructional unit materials are not fully organized. The instructional unit under study in this thesis was carefully designed and well-organized. Since there was no prior-knowledge as demonstrated by the pre-test, and given that the subjects in the linear condition might have wanted to exercise control over sequence, one could expect a certain level of frustration at not being able to do so. This was not observed; in fact the research assistants reported that most of the students reported enjoying this learning activity, regardless of treatment condition.

The findings in this study did not support the fifth hypothesis which stated that subjects in treatments which included an orienting activity would perform significantly better on the procedural knowledge measure than those in treatments which do not include the orienting activity. All of the groups performed well irrespective of treatment condition.

The findings in this study did not support the sixth hypothesis. Subjects in treatments which included an orienting activity in fact took more (not less) time than those in treatments which did not include one. Perhaps in having the benefit of the orienting activity, subjects in treatments with more control exercised this option and possibly spent more time on specific sections.

Although not substantiated with quantitative data, research assistants reported that many subjects repeated the practice section.

Interactions

There was no significant interaction between locus of instructional control and orienting activity for the recall measure confirming the seventh hypothesis. This finding is inconsistent with another study (Ho *et al.*, 1986) who found a significant interaction. The aforementioned study differed with this thesis in that the orienting activities were instructional objectives and were placed before each instructional segment. Learner decisions are prompted by orienting activities and thus placing them throughout, instead of just at beginning, provides more guidance to the learner enabling him/her to make informed choices about his/her learning.

The findings in this study did not support the eighth hypothesis. There was no significant interaction between locus of instructional control and orienting activity for the procedural knowledge measure.

In examining the means for time on task for locus of instructional control by orienting activity, an interaction could be identified but it did not reach significance. On further inspecting the means for time on task, it seems that in the No Orienting condition time decreases as control is increased. Conversely, in the Orienting condition the time increases as control increases. Despite the fact that this two-way interaction did not reach statistical significance, this writer feels it warrants further investigation. The subjects in the linear condition spent more time on the task and this practice effect might explain the non-significant result obtained for the two-way interaction. Since the subjects in the learner condition did have full control over sequencing and pacing, perhaps the orienting activity could have been designed so as to encourage the subjects to take more advantage of these control opportunities.

Suggestions for further research

More in depth research is needed into the different types of orienting activities such as those in combination with practice. Types of orienting activities for specific types of learner characteristics, and learning styles also warrant attention. The different formats of orienting activities that could be investigated within this research include orienting activities such as instructional objectives, lists, flowcharts, and interactive flowcharts.

Using orienting activities throughout an instructional unit, rather than at the beginning, should be investigated since the placement of the orienting activity may have a significant effect. This study looked at an orienting activity at the beginning of the lesson. Orienting activities could be placed throughout an instructional unit, preceding each segment, or alternately could be available throughout the instructional unit. All these possibilities could be combined with practice.

Summary

This study has provided further evidence of the benefit of linear treatments for recall of facts. As well, the use of orienting activities were shown to have an impact on learning whether or not a subject has the ability to control his/her learning. Additional research is needed to further refine the best type of orienting activity formats and their placement within interactive video instruction in order to maximize learning outcomes.

REFERENCES

Allen, B. S., & Carter, C. D. (1988). Expert systems and interactive video tutorials: Separating strategies from subject matter. *Journal of Computer Based Instruction, 15,* 123-130.

Atkins, M., & Blissett, G. (1989). Learning activities and interactive videodisc: An exploratory study. *British Journal of Educational Technology, 20,* 47-56.

Baggett, P. (1988). The role of practice in videodisc-based procedural instructions. *Educational Technology Reports, 1,* 48p.

Bijlstra, J. P., & Jelsma, O. (1988). Some thoughts on interactive video as a training tool for process operators. *Programmed Learning and Educational Technology, 25,* 28-33.

Bosco, J., & Wagner, J. (1988). A comparison of the effectiveness of interactive laser disc and classroom videotape for safety instruction of General Motors workers. *Educational Technology, 28,* 15-22.

Bunderson, C. V., Olson, J. B., & Baillio, B. (1981). *Proof of concept demonstration and comparative evaluation of a prototype intelligent videodisc system.* Oren, UT: WICAT (ED # 228 989)

Clark, R. E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53,* 445-459.

Clark, R. E., Surgrue, B. M. (1988). Research on instructional media, 1987-88. In D. Ely (Ed.), *Educational Media and Technology Yearbook,* (pp. 19-36). Englewood, CO; Libraries Unlimited.

Cohen, V. B. (1984). Interactive features in the design of videodisc materials. *Educational Technology, 24,* 16-20.

Copeland, P. (1988). Interactive video: What the research says. *Media in Education and Development, 21,* 60-63.

Copeland, P. (1988). Interactive video: Meeting the Ford Challenge. Paper presented at the CBI Fast Forward Conference, May, 1988.

Cushall, M. B., Havey, F. A., Brovey, A. J. (1987). Research from learning from interactive videodiscs: A review of the literature and suggestions for future research activities. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, Atlanta, Georgia.

Dalton, D. W. (1986). How effective is interactive video in improving performance and attitude? *Educational Technology, 26,* 27-29.

Dalton, D. W., & Hannafin, M. J. (1986). The effects of video-only, CAI only, and interactive video instructional systems on learner performance and attitude: An exploratory study. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, Las Vegas, Nevada.

Dalton, D. W., & Hannafin, M. J. (1987). The effects of knowledge - versus context-based design strategies on information and application learning from interactive video. *Journal of Computer Based Instruction, 14,* 138-141.

Doiron, G. (1990). *The Development and Formative Evaluation of an Interactive videodisc program for teaching contamination assessment and decontamination of Radioisotopes.* Masters Thesis, Concordia University.

Gagné, R. M. (1985). *The Conditions of Learning.* New York: Holt, Rinehart & Winston.

Gay, G. (1986). Interaction of learner control and prior understanding in computer assisted video instruction. *Journal of Educational Psychology, 78*(3), 225-227.

Gayeski, D. M. (1985). Interactive video: Integrating design "levels" and hardware "levels". *Journal of Educational Technology Systems, 13,* 145-151.

Gayeski, D. M. (1989). Why information technologies fail. *Educational Technology, 29,* 9-17.

Goetzfried, L. & Hannafin, M. J. (1985). The effect of adaptive, advisement, and linear CAI control strategies on the learning of mathematical rules. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, Anaheim, California.

Goetzfried, L., & Hannafin, M. J. (1985). The effects of the locus of CAI control strategies on the learning of mathematics rules. *American Educational Research Journal, 22,* 273-278.

Hannafin, M. J. (1985). Empirical issues in the study of computer-assisted interactive video. *Educational Communication and Technology, 33,* 235-247.

Hannafin, M. J. (1987). The effects of orienting activities, cuing, and practice on learning of computer based instruction. *Journal of Educational Research, 81,* 48-53.

Hannafin, M. J. & Colamaio, M.E. (1987). The effects of variations in lesson control and practice on learning from interactive video. *Educational Communication and Technology Journal, 35,* 203-212.

Hannafin, M. J., & Hughes, C. W. (1986). A framework for incorporating orienting activities in computer based interactive video. *Instructional Science, 15,* 239-255.

Hannafin, M. J., & Phillips, T. L. (1987). Perspectives in the design of interactive video: Beyond tape versus disc. *Journal of Research and Development in Education, 21,* 44-60.

Hannafin, M. J., Phillips, T. L., Tripp, S. D. (1986). The effects of orienting, processing, and practicing activities on learning from interactive video. *Journal of Computer-Based Instruction, 13,* 134-139.

Hannafin, M. J., Phillips, T. L., Tripp, S. D., Gerhart, W. (1987). The effects of orienting activities and cognitive processing time on factual and inferential learning. *Educational Communication and Technology Journal, 35,* 75-84.

Heinich, R. (1984). The proper study of educational technology. *Educational Communications and Technology, 32*(2), 67-87.

Ho, C. P., Savenye, W., Haas, N. (1986). The effects of orienting objectives and review from learning from interactive video. *Journal of Computer Based Instruction, 13,* 126-129.

Jonassen, D. H. (1985). Interactive lesson designs: A taxonomy. *Educational Technology, 25,* 7-17.

Jones, L. L., & Smith, S. G. (1989). Lights, Camera, Reaction! The interactive videodisc: A toll for teaching chemistry. *Technological Horizons in Education, 16,* 78-85.

Kearsley, G. P. & Frost, J. (1985). Design factors for succesful videodisc-based instruction. *Educational Technology. 25,* 7-13.

Kinzie, M. B., Sullivan, H. J., Beyard, K. C., Berdel, R. L., Haas, N. S. (1987). Learner Versus Program Control in Computer Assisted Instruction. Paper presented at the annual meeting of the American Educational Research Association. Washington, D.C.

Kulhavy, R. (1977). Feedback in written instruction. *Review of Educational Research, 47,* 211-232.

Laurillard, D. M. (1984). Interactive video and the control of learning. *Educational Technology, 24,* 7-15.

Lawrence, P., & Price, R. V. (1987). A project to measure the treatment effects of the use of interactive video on the teaching of language experience approach to reading instruction. Research Report, Texas.

Milheim, W. D. (1989). Perceived attitudinal effects of various types of learner control in an interactive video lesson. In: Proceedings of Selected Research Papers presented at the Annual Meeting of the Association for Educational Communications and Technology, Dallas, Texas.

Milheim, W. D., & Azbell, J. W. (1988). How past research on learner control can aid in the design of interactive video materials. Proceedings of Selected Research Papers presented at the Annual Meeting of the Association for Educational Communications and Technology, New Orleans, LA.

Palmer, M. (1988). *The Formative Evaluation of Interactive Videotape Courseware Teaching Contamination Assesment and Decontamination of Radioisotopes.* Master's Thesis Concordia University, Montreal, QC.

Palmer, M., Tovar, M. (1987). Developing interactive videotape in a university setting. *Canadian Journal of Educational Communication, 16,* 195-204.

Phillips, T. L., Hannafin, M. J., Tripp, S. D. (1988). The effects of practice and orienting activities on learning from interactive video. *Educational Communication and Technology Journal, 36,* 93-102.

Reeves, T. C. (1986). Research and evaluation models for the study of interactive video. *Journal of Computer Based Instruction, 13,* 102-106.

Rieber, L. P., & Hannafin, M. J. (1988). Effects of textual and animated orienting activities and practice on learning from computer-based instruction. *Computers In The Schools, 5,* 77-89.

Russell, A. A., Staskun, M. G., Mitchell, B. L. (1985). The use and evaluation of videodiscs in the chemistry laboratory. *Journal of Chemical Education, 62,* 420-422.

Schaffer, L. C., & Hannafin, M. J. (1986). The effects of progressive interactivity on learning from interactive video. *Educational Communication and Technology, 34,* 89-96.

Schwier, R. (1987). *Interactive Video.* New Jersey: Educational Technology Publications, Inc.

Smith, S. G., & Jones, L. L. (1989). The FIPSE lectures: Images, imagination, and chemical reality. *Journal of Chemical Education, 66,* 8-11.

Sorge, D. H. (1988). PALOS Mathematics: Education by videodisc. ED315042, 6p.

APPENDICES

Appendix A

We are looking for students to participate in a Concordia University Research Project. The project is investigating the effectiveness of an interactive video system in teaching laboratory safety procedures which are to be used when conducting radiation decontamination. This technology combines computers and video to produce multimedia presentations which have the potential to facilitate instruction.

The project will provide you with an opportunity to try out this new technology and to learn procedures which are important in maintaining a safe work environment in the laboratory. As a token of our appreciation we will PAY you $15.00 for your time (no longer that 2 hours), and your name will be entered in a raffle where you have a chance to win $100.00.

If you are interested, or would like further information, please complete the portion below and return it to H549-15 c/o Penelope Nicholson, or phone Penelope (XXX-XXXX) or Mandie (XXX-XXXX). Please note that all information will be kept confidential. Thank you in advance.

Please complete the following information.

NAME ____

PHONE # ____________________________________

BEST TIMES FOR APPOINTMENTS _________________

Appendix B

Name ______________________________

Do you know the steps involved in carrying out the Swipe Check for radio monitoring in a biochemistry lab?

No ___

Yes ___ Please list as many of the steps, in correct chronological order, as you can below. Number each step in consecutive order.

Step #

____

____

____

____

____

____

____

____

____

____

____

____

____

____

Appendix C

Name ______________________________

Post-test (Swipe Check for Radiation Monitoring)

The following questions are designed to provide us with information about the program that you have just seen. We would like to find out how much you can recall from the presentation in order to assess whether the material was clear and comprehensible.

I. What are the **two** most important reasons for performing a swipe check in a bio-chemistry lab?

1) ______________________________

2) ______________________________

II. Name **three** specific times or situations when a swipe check should be carried out.

1) ______________________________

2) ______________________________

3) ______________________________

III. **Seven** specific areas for radiation monitoring in a biochemistry lab were mentioned in the program. Try to identify as many as you can.

1) ______________________________

2) ______________________________

3) ______________________________

4) ______________________________

5) ______________________________

6) ______________________________

7) ______________________________

IV. a. On what level of isotopes would you normally perform a swipe test?

____

b. Name two specific examples of this level of isotope mentioned in the program.

1) ____

2) ____

c. What other type of radiation level monitoring was mentioned?

____

V. In the program, there were **nine** tools/materials required to perform the swipe check. List as many as you can below.

1) ____

2) ____

3) ____

4) ____

5) ____

6) ____

7) ____

8) ____

9) ____

VI. The program that you have just seen contained 14 specific steps or procedures in describing how to carry out the Swipe Check. Please list as many of these steps, in chronological order - or from start to finish - as you can. **Be as precise as possible when describing the steps.**

Step #

1) ____________________

2) ____________________

3) ____________________

4) ____________________

5) ____________________

6) ____________________

7) ____________________

8) ____________________

9) ____________________

10) ____________________

11) ____________________

12) ____________________

13) ____________________

14) ____________________

Appendix D

For questions 1-5 one point should be given to each correct answer. This includes questions which have subtractions (i.e. #4. a,b,c has the potential to be provided with 4 points, and question 5 has the potential to be awarded 9 points). Total up the points for each question and mark them beside the question number. Then total these points to arrive at the total test score. The maximum total score for the test is 53.

#1.

1) Contamination of work surface, clothing and equipment by radioactive substances <u>can be a hazard to health</u>.
2) Contamination can <u>interfere with and invalidate experiments</u>.

#2.

1) Before starting a project.
2) Periodically during work.
3) After significant modifications or dismantling of experimental setup.

#3.

1) Walls of fume hoods
2) Surface of work benches
3) Sinks
4) Floors
5) Walls of work area
6) Clothing
7) Equipment

#4.

a) Low level isotopes
b) Tritium, Sulphur 14
c) Radiation residue from a high level radioisotope

#5.

-filter paper or filters
-tongs or forceps
-50% ethanol
-beaker
-scintillation vials
-scintillation fluid
-waterproof marker or marker or pen
-scintillation vial racks or vial racks or racks
-scintillation counter or counter/machine

#6. Note: List #1 is a description of the 14 steps. This list is not used to score key words. Rather it is provided to help determine if steps are correct, in the correct order, or if steps have been omitted, combined or split. If students answers have the correct key words (refer to list #2) but are incorrect according to list #1 then the step is incorrect and no points are awarded for the correct key words. If steps are in an order which in incorrect then one point will be deducted for every step out of sequence. If steps are omitted then points will be deducted according to which key words are missing. If steps are combined or split no points will be deducted.

Do not be concerned with spelling and grammatical errors (i.e. they are allowed to make these mistakes). However, do not interpret too much; if you are in doubt, do not consider the words to be correct.

List #1

1. Take a piece of filter paper and pinch it with the forceps so that it is held securely.

2. Then over the beaker wet the filter paper with the 50% ethanol solution and allow any excess ethanol to drain off the paper.

3. Before checking the area where the contamination is suspected check for levels of background radiation. Choose are area where you are sure no contamination has taken place. Swipe the paper over approximately 100 square centimetres.

4. Place the filter paper in the scintillation vial.

5. Fill at least half the vial, no less than 10ml, with scintillation fluid.

6. Cap the vial tightly and shake it.

7. With the marker pen cap the vial with the code indicating that this vial is the check for background radiation counts.

8. Place the vial in the scintillation rack.

9. Repeat the same procedure where contamination is suspected.

10. Mark the vial with the code indicating that the area of the lab which has just been checked is the contaminated area.

11. After all of the swipe checks over the area have been completed, the racks holding the vials are taken to the scintillation counter.
Be familiar with the operating instructions of your particular counter, as well as the appropriate input commands to use.

12. The result of the counter operation is a print out do the CPM, or counts per minute, from each vial placed in the counter. These CPM's are noted in the appropriate record book, and a CPM from each vial is compared to the CPM for the background swipe.

13. If reading indicates a higher CPM than that from the background swipe, decontamination procedures are carried out on that area.
Decontamination is repeated until swipe check results over the area are as close as possible to the background CPM.

List #2 (list of Key Words)

Look for the presence of these key words in the student's answers and then assign the points indicated. Partial points will be given if the student includes some key words, but omits others. The acceptable key words for partial points are listed directly below those key words that will earn full points. For example the student may write, "wet the filter paper over a beaker", which would earn one point while the answer "wet the filter paper with ethanol" would earn 2 points. Do not deduct points for interpretable spelling or grammatical errors.

1.	filter paper or filter + tongs or forceps	--- 2 points
	filter paper or filter	--- 1 point
2.	wet filter paper + ethanol	--- 2 points
	wet + ethanol	--- 1 point
	wet + filter paper (or paper)	--- 1 point
3.	background + swipe 100 sq cm	--- 2 points
	area + no contamination + swipe x area	--- 1 point
	background + swipe x area	--- 1 point
4.	filter paper in scintillation vial	--- 2 points
	filter + in vial	--- 1 point
5.	fill at least half + scintillation fluid	--- 2 points
	fill + scintillation fluid	--- 1 point

6.	cap and shake	--- 2 points
7.	mark cap and background code	--- 2 points
	mark cap	--- 1 point
8.	vial and rack	--- 2 points
9.	repeat + contaminated area	--- 2 points
10.	mark cap + area code + scintillation rack	--- 2 points
	mark + rack	--- 1 point
11.	racks and scintillation counter	--- 2 points
	racks + counter/machine/computer	--- 2 points
	counter	--- 1 point
12.	operate counter/machine/computer	--- 2 points
13.	record + log/book + compare +CPM(output) or C/M or printout	--- 2 points
	record	--- 1 point
	compare	--- 1 point
14.	decontaminate	--- 2 points