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The Formative Evaluation Of Interactive Videotape Courseware Teaching Contamination Assessment And Decontamination Of Radioisotopes

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ABSTRACT

The Formative Evaluation Of Interactive Videotape Courseware Teaching Contamination Assesment And Decontamination Of Radioisotopes

Michael Palmer

This thesis discusses the formative evaluation of the prototype of a self-instructional, interactive videotape. The courseware was designed to teach biochemistry students at Concordia University the appropriate Contamination Assessment and Decontamination Procedures for the Safe Handling of Radioisotopes.

The formative evaluation of the prototype was considered necessary to obtain feedback which could be used to improve the instructional effectiveness of the product. Since developing interactive video courseware was a new endeavor for all involved, conducting formative evaluation was considered important for the valuable feedback it would provide the team for future projects.

Six categories were defined for evaluation : Content, instructional design, instructional format, learner outcomes, learner attitudes, and technical quality. To obtain feedback a number of evaluation methods were used. These include self-evaluation, expert review, and learner review. The rationale for using these evaluation methods is explained in the thesis as well as the details and results of their application. The helpfulness of the evaluation is revealed in the revision section where recommendations were made for each courseware section.

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Gille Doiron	Magda Hechema	Ken Todd
Chris Boer	Miriam Posner	Paul Taslini

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INTRODUCTION

Undergraduate and graduate students studying biochemistry at Concordia University often carry out laboratory experiments involving the use of radioactive isotopes as part of their curriculum. Important concerns to the teaching staff of these students are the risk of radioactive contamination as well as the potential damage to the sensitive equipment used to detect radioactivity.

Traditionally, a series of manuals, slide-tape presentations, and in-class discussions were used to train students in the correct laboratory procedures. Upon evaluating the effects of these instructional strategies, technicians in both the Chemistry and Biology Departments were not entirely satisfied with the results of the training. In an attempt to improve the transfer of learned procedures from the classroom to the laboratory as well as to minimize potential dangers while students are learning these procedures, a unique training program was developed through the cooperative efforts of Concordia's Chemistry, Biology, Education and Audio-Visual Departments.

The training program consists of a self-instructional, interactive videotape. Which teaches the appropriate contamination assessment and decontamination procedures for

the safe handling of radioisotopes. In order to ensure that this type of training provided a satisfactory amount of control for the students and their learning, the unique capabilities of a microcomputer/video system accompanied with a CAI (computer assisted instruction) package were exploited.

The actual design and production of the "interactive video" courseware was carried out by a team of faculty and students from the Graduate Programme in Educational Technology at Concordia University. Within this group, the author served as the instructional designer and producer.

Developing interactive video courseware was a new and complex endeavor for all involved. This was further complicated by the limited amount of interactive video research available when important design decisions had to be made. Due to these factors, it was decided that the project would be developed as a prototype which would then be formatively evaluated.

The prototype was produced using videotape. This was done since the hardware and resources to produce and run videotape were relatively inexpensive and accessible within the university. Formative evaluation was conducted on the prototype in order to a) solicit information concerning the products instructional effectiveness, b) obtain valuable

feedback for the design and production team on their first interactive video project, c) suggest recommendations which would be implemented within the final version of the courseware. This thesis equivelent describes the process of the courseware's development and details the procedures and results of the formative evaluation.

LITERATURE REVIEW

A. Interactive Video

Interactive video as defined by Floyd (Floyd et al., 1982) is "any video program in which the sequence and selection of messages is determined by the users response to the material" (p.2). Although this is a good general definition of the medium, it encompasses a number of types [levels] of interaction which should be clarified. The Nebraska Video Group (cited in Daynes, 1982) developed a model which for many years had been the accepted means used to define the various levels of interactivity. A working definition of these four levels has been drawn from the model:

1) At the first level, the video playback unit is usually manually controlled and the learner has access to conventional playback mechanisms such as fast-forward, slow motion, still frames and reverse. Learners can manually branch to various locations on the videodisc and access information on the two audio channels. Most level one videodiscs are accompanied by workbooks or are used by instructors (Gayeski & Williams, 1984-85).

2) The second level is defined by a " videodisc with computer programming "dump" recorded on it which is

read by an on-board computer located in the disc player" (Gayeski & Williams, 1984-85, p. 145). At this level, basic branching is possible for answer sequences or menu selections. However, the amount of memory available is very small thus limiting the amount of interaction possible.

3) At the third level, a video playback mechanism (videodisc or videotape) " is linked to an external microprocessor; the programming information is contained on a floppy disc and users interact with the computer keyboard or peripherals" (Gayeski & Williams, 1984-85, p. 145). Level three systems also have the capability of storing learner responses, generating and overlaying graphics, as well as allowing for sophisticated feedback and remediation processes.

4) As the field of interactive video progresses there is beginning to be more and more discussion pertaining to what is becoming known as levels four and five interactivity. These levels tend to apply to expert systems and artificial intelligence systems. Although these future applications are very exciting for the field of educational technology, they do fall beyond the scope of this thesis equivilent.

Essentially, interactive video is the merging of

characteristics commonly attributed to computer assisted instruction (CAI) with the visual expository qualities of video (Palmer & Tovar, 1987). This combination opens up a number of instructional possibilities which were previously impossible to exploit when CAI and video were used on their own. Some of the characteristics which are commonly associated with CAI include, (i.e. embedded questions, branching, feedback, remediation, graphics, key word checks, learner control options, and management components). Once these characteristics are merged with a rapid access visual medium which can store high quality video, graphics, as well as textual and audio information, we then have at our disposal a powerful instructional tool.

Jon Baggaley (1973) suggests that there are four teaching functions which instructional media should attempt to simulate if the medium is to be successful. They are:

> 1- The ability to present logically developing sequences of information.
>
> 2- Awareness of the need to reinforce information either by repetition or by presenting the materials in alternative forms.
>
> 3- The capacity to establish a relationship with the class [student]..
>
> 4- A capacity to cope with the problems of individual students. (Baggaley, 1973, p.140)

Interactive video delivery systems can be exploited to simulate these functions through the consideration of the mediums unique capabilities. However, if the instructional event is to be appropriately directed and controlled, it must be based on the consideration of sound instructional design principles and how these can be translated into interactive video courseware.

Although the instructional potential of the medium has been enthusiastically endorsed, (Butcher, 1986; Clark, 1984; Howe, 1985; Manning, Ebner, Brooks & Balson, 1983a; Pawley, 1983; Wilson, 1983), it has also been suggested that empirical evidence supporting the mediums instructional effectiveness is lacking (Hannafin, 1985).

This lack of empirical evidence can be attributed to a number of factors. First, in the early stages of the medium's development, individuals working within the field were mostly interested in the nuts and bolts of the technology (i.e. disc players, peripherals, monitors). For example, until recently, taxonomies used to define the levels of interactivity were classified in terms of hardware configurations without acknowledging that it is ultimately the pedagogical design of the program which determines interactivity (Palmer & Tovar, 1987, p.202).

There are signs however, that this largely unnecessary emphasis on hardware is changing. Gayeski & Williams (1984-1985) have developed a seven level taxonomy which integrates levels of interactivity with hardware and design characteristics. With these considerations, their taxonomy is clearly more appropriate for instructional designers and researchers. The taxonomy is not limited to interactive video, but provides a wide range of options for interactivity from traditional methods (i.e. self-evaluation, pause, use of workbooks) to more sophisticated systems with touch screens and computer control (Palmer & Tovar, 1987). This taxonomy, therefore, facilitates the definition of design strategies to be developed and researched.

Secondly, many designers are coming to the realization that if interactive video is to have a viable future as an instructional tool, enthusiastic endorsement of the medium will have to be based on its instructional effectiveness and not on visual glitter. Hawthorne (1986) writes " Cooler heads are prevailing now, people seem more interested in real results than in whiz-bang demonstrations" (p. 18). This need to substantiate the technology has gone a long way to stimulate research interest.

A third phenomenon related to the lack of empirical evidence stems from the relative youth of the technology. Since

interactive video is so popular within educational technology, it is easy to forget that " the first videodisc players [interfaced with a computer] reached the [consumer] market at the end of 1978 and by late 1979 [only] a dozen organizations were experimenting with its use as an educational device" (Brandt, 1986, p. 3). Given the average two to three year lag-time between the planning of an experiment and the publication of its results in a journal, we are then, only now beginning to obtain interesting research results. (This time frame may be even longer in the case of interactive video research since any experiment on the technology must first begin with the production of courseware).

Kearsley & Frost (1985) conducted a review of results relating to the effectiveness of interactive video instruction. While we are cautioned that many of the studies mentioned are less then methodologically rigorous, the review is useful in providing general information concerning early overall trends on the effects of interactive video instruction.

A number of U.S. military studies (Manning, Balson, Ebner & Brooks, 1983b; Ketner; Kimberlin (cited in Kearsley & Frost, 1985) reported significant reductions in training time when comparing students learning with interactive video to

students learning through other means of instruction. In another study, trainees learning officer leadership and counselling skills with interactive video showed significant differences in test scores when compared to trainees who learned through program text and role playing (Schroeder, cited in Kearsley & Frost, 1985).

In an educational context at the university level, Bunderson, Olsen, & Baillio, (1981) reported significantly higher post-test scores as well as a 30% reduction in study time when comparing students who learned biology with an interactive videodisc compared to those who learned through classroom instruction. In a similar comparison, Boen (1983) compared classroom instruction to a videodisc for teaching test-taking skills to university students and found videodisc instruction to be superior.

In another study conducted by Hon (1983) fifty students received CPR training from an instructor and fifty students received training from a videodisc. Hon reports that three times as many students who received videodisc training passed as those who had the instructor based training. In addition, significant reductions in training time were also noted.

In a field test conducted with a health education videodisc for elementary children, 94% of pupils indicated that they "learned a lot" from using the videodisc (Kirchner, Martyn, Johnson, 1983). Similar outcomes were also reported with a gymnastics videodisc used by elementary level physical education teachers (Daynes & Butler, 1984). In a study conducted by American Bell, results indicated that the videodisc was more effective than classroom instruction, text based instruction, slide or videotape training (Goldberg, 1983). Another study compared videodisc instruction to instructor-led courses teaching word processing indicated that the videodisc students performed better on the posttest than students in the instructor-led course (Duelfer, cited in Kearsley & Frost, 1985).

These reported findings, however flawed or limited in number, seemed to indicate preliminary results supporting learning effectiveness, reductions in training time as well as positive acceptance of the medium by users when comparing interactive video to other methods of instruction.

As the medium has begun to mature, so have some of the available research results. In 1985 when this project was begun, the vast majority of available research were comparative studies which overwhelmingly confirmed the effectiveness of the medium. Since then a few studies have

surfaced which have shown no significant difference in learning when comparing interactive video to stand up training (Lyness, 1985; Young and Tosti, cited in Young and Schlieve, 1984) or when comparing interactive video to a computer assisted instruction course (Dalton, 1986).

Although these findings may serve to subdue over-enthusiastic support of the medium, they also raise an important issue concerning the worth of comparitive studies for interactive video designers. This is not to say that comparative studies do not have a place within the spectrum of interactive video research. However, an important weekness of comparative studies involves the data's inability to offer clues concerning the strategies, the design elements or the particular qualities of the medium which should be applied in order to develop effective courseware.

Solomon & Gardner, (1986) suggested an alternative to posing what they consider to be naive questions (i.e. does interactive video teach better than...). They explain that the role of research within instructional technologies should attempt to understand how mind and technology interact. Although their argument was originally directed towards early research into computer assisted instruction (CAI) their rationale seems to apply equally well to research with interactive video. They write " One needs to begin with as

thorough an analysis as possible of the critical features of the medium or technology-by standard use, design, or potential realization. Then one needs an equally refined picture of a particular user's mind to study how critical attributes of the former map onto corresponding attributes of the latter" (p. 14).

Along the same lines, Brody (1984) defined two branches of interactive video research which would help "researchers begin to undertake a thorough and systematic analysis of the medium" (p.1). Brody proposed what he calls 'research on' and 'research with' interactive video. 'Research on interactive video' would be directed towards determining theoretical and empirically substantiated instructional characteristics of the medium. Results from this type of research would be used to develop a design model for the medium. 'Research with interactive video' would focus on the attributes of the medium. Results from this type of research would define the role of interactive video in relation to other delivery systems.

The increased need to understand the medium has begun to stimulate research aimed at explaining interactive video's instructional characteristics rather than simply comparing the medium to other forms of instruction.

Presently, comparative studies are becoming less prominent as researchers are beginning to examine design elements such as the use of orienting objectives and review strategies (Ho, Sovenye & Hass, 1986), the structuring of courseware information (Hannafin & Phillips, 1987), the effect of utility questions on knowledge acquisition (Dalton & Hannafin, 1987) or as they begin to examine some of the mediums critical features such as, the use of varied lesson access time (Hannafin, Phillips & Tripp, 1986).

Although research into the medium is now becoming more and more refined and rigourous, still to this day there does not exist a clear model for the design of interactive video instruction (Smith, 1987).

Back in 1985, the design team was faced with the difficulty of having little empirical information upon which to base their design and instructional strategy decisions. Consequently, it was felt that the only alternative was to make these decisions based on our intuition, our limited experience, general instructional design principles and strategies from other technology-based delivery systems.

In order to define specific instructional strategies as well as possible instructional characteristics which could be used within the courseware, an extensive review of literature was

undertaken. The search revealed a rich source of research from within the fields of Programmed Instruction, Computer Assisted Instruction, as well as Instructional Video and Instructional Television. The search provided a number of empirically-based findings on the use and/or application of practice, questions, feedback, remediation, key word checks as well as visual considerations and learner control options. These findings were used to define and support the choice and use of these instructional strategies and characteristics within the courseware. A review of these findings will now be presented.

1. Practice

O'Brian (cited in Floyd, 1982) writes "designers should go to substantial lengths to incorporate legitimate practice in applying, repeating, remembering or interpreting the content. Repetition without interactive work-throughs short changes both the medium and the user". (p. 81) Building in strategies which allow learners the opportunity to enhance retention is the foundation of a practice segment. Salisbury, Richards & Klein, (1985) define a practice segment as "the portion of instruction which takes place after students have initially been presented the information needed to perform an objective but before they have the opportunuty to master it". (p. 10)

2. Questions

Using questions to stimulate interaction as well as to facilitate information processing is fundamentally important to the design of interactive courseware. Wager & Wager, 1985 conclude that questions serve three general functions:

"1) To establish and maintain attention.

2) To facilitate encoding.

3) To provide for rehersal." (p. 3)

On the first point, questions serve to focus a learners attention onto relevant information in the materials being presented. Because of this, designers must take great care in designing questions which are relevant to the objectives. Another device used in association with questions to focus attention involves the use of prompts. In some cases, these are grammatical and involve the restatement of a verbal question illustrated textually on a screen (Markle, cited in Wager & Wager, 1985).

Questions are also very important as an aid to promote the encoding of information. When a student verbalizes an answer by responding to a question, this facilitates the auditory encoding of information (Wager & Wager, 1985). One way of encouraging verbalization, is to have learners answer questions using constructed responses.

Although research in this area is inconclusive, most

designers shy away from using constructed responses because they are of the attitude that natural language processing by the computer is very limiting and it is much easier to judge responses from multiple choice questions. The seriousness of misjudging constructed responses should not be minimized. Frustration by the student due to poor spelling and/or poor typing skills can be detrimental to their attitude concerning the courseware.

One strategy to help minimize the possibility of misjudging constructed responses is to build up a library of words which have been collected from the target audience during the testing phase of the courseware. Another option is to accept a constructed response without judging it to be correct or incorrect. A model answer is then presented to the learner who would then evaluate for themselves the appropriateness of their response. As of yet, no empirical research has been conducted on this type of strategy (Wager & Wager, 1985).

A third function which questions serve is to provide for rehearsal. If questions are appropriately designed and placed immediately following the instructional segment (as opposed to placing them at the beginning or at the end of the courseware) then they will serve as a rehersal mechanism for the content being learned (Kumar, 1971).

3. Feedback

One working definition of feedback is " the message or compound statement which follows the response made by the learner" (Blum Cohen, 1984, p. 18). The primary function of feedback is to provide the learner with information concerning their response. Feedback can simply inform the learner that an answer is incorrect, it can correct the learner or it can allow learners to correct themselves (Wager and Wager, 1985).

Although the effect of feedback on learning is still inconclusive, it has never been shown to be harmful (Wager & Wager, 1985). It is generally accepted that feedback should provide information directed specifically at a learner's error and that informative feedback has its greatest effect immediately following a wrong response. Equally important, when responses are correct, only short affirmative feedback should be given (Wager & Wager, 1985).

Another type of feedback often used is called summary feedback. This basically involves informing a learner of the number of questions they have answered correctly in relation to the total number of questions that they attempted to answer (i.e. you correctly answered 5 out of 7 questions). This type of feedback can either supplement or, in some cases, replace response-specific feedback in drill and

practice segments (Wager & Wager, 1985).

4. Remediation

Remediation is an extremely important feature and is used to support specific informative feedback. It is especially used when a learner is judged to be lacking in pertinent information from the initial instruction. When this is the case, the learner is branched to a remedial sequence whereby content is reviewed using an alternative approach to the initial instruction (Blum Cohen, 1984).

5. Visual Considerations

Presentation of visual content has been shown to be successful (for task-oriented productions) when an objective camera angle is used. This involves shooting the images from the angle of a student seated away from the demonstrator (Grant & Merril, cited in Coldevin, 1981). There is also support for using review segments at the end of instructional units to facilitate information recall (Coldevin, 1975).

6. Learner Control Options.

Offering learner control options is still quite controversial (Laurilard, 1984). Most authors agree, however, that some degree of instructional control should be given to the learner (Jonassen, 1985; Tennyson, 1980). Ross

(1984) recommends that learners be given coaching and advice upon which to base their decisions. Other control options to be offered should allow learners to exit any part of the program, review any segment, and change paramaters of the courseware. One way of allowing the flexibility to change the courseware's paramater is to organize the courseware's content into small discrete modular units which can be easily accessed by the learner. Through the use of content menus, learners can choose their own path through the courseware and proceed at their own pace (Blum Cohen, 1984).

The underlying principle behind offering learner control options is that a learner who has some control over his learning process will be more attentive, more involved and is consequently more apt to learn (Kearsly & Frost, 1985; Blum Cohen, 1984; Jonnasen, 1985).

In principle, the research on feedback, embedded questions, learner control, formal features etc. appear to be generalizable to interactive video. The degree of generalizability and applicability becomes questionnable when these characteristics are considered within the context of interactive video - a medium which can incorporate all these characteristics in association with each other and a medium which, as a whole, has a larger range of programming options than each of its composite technologies.

Clearly, more research is needed in this area. For now, designers of interactive video courseware will have to carefully evaluate their design and strategy decisions. An interesting observation was made by Mielke (1983). He suggests that the more innovative a message design is in its exploitation of production factors (i.e. the use of the medium's attributes), the greater the need for trial and revision. The literature review next examines the implementation of formative evaluation (the process of trial and revision).

B. Formative Evaluation

Formative evaluation can be loosely defined as the process used to obtain data about the effectiveness of a product during its development. According to Dick (1980), the emphasis of formative evaluation is on the collection of data for the purpose of providing feedback that would enable developers to make improvements/revisions before the final release of their product. This process of tryout and revision is advocated to make a product as effective as possible.

The term 'formative evaluation' was first coined by Scriven to distinguish between the kind of evaluation performed on an entity during its development or 'formative stages' and

another, labelled 'summative evaluation', that measures a product's effectiveness after completion (Cambre, 1981). Although the original context to which the term was applied was that of a course in an academic curriculum, Dick (1980) points out that the concept has grown in its application to include a small unit of instruction or an entire multi-media training system. In fact, according to Weston (1985), formative evaluation is a process which is used in business, politics, industry, as well as education.

Although the term 'formative evaluation' is only a few decades old, the use of formative evaluation activities in the development of instructional media products has been going on for a long time. Cambre (1981) indicates that evidence of such activities, albeit by different labels, can be traced back as early as 1921. At this time, formative evaluation procedures were used to obtain early audience reactions about World War 1 training films that had become available for general viewing. According to Cambre's (1981) research, formative evaluation procedures enjoy a relatively long and respectable history in the audiovisual tradition.

The evidence supporting the application of the formative evaluation process is strong. Ragsdale (1983) indicates that early research into the effects of the formative process, particularly the review by Baker and Alkin (1973), has

indicated significant benefit to having at least one revision of materials, as opposed to no revisions at all. Studies by Stolovitch (1982), Baker (1970), Wager (1983) indicate that materials that had undergone formative evaluation were superior to unrevised versions. A review by Andrews and Goodsin (1980) found the requirement for tryout and revision to be the second most common component in instructional design models, appearing in 38 of the 40 models considered.

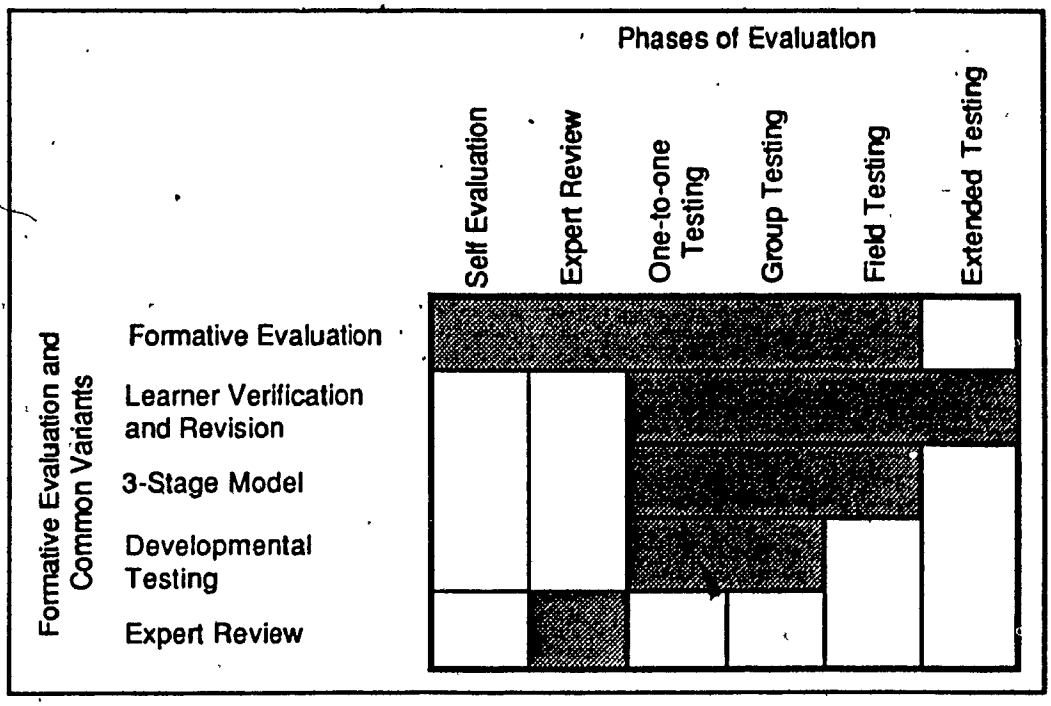
While the literature on formative evaluation is indicative of the value of it for improving instructional materials, there do seem to be doubts concerning the best way to carry out formative evaluation. This is exemplified by Weston (1985) in her research on formative evaluation which did not yield any single set of heuristics, guidelines, or algorithm for conducting formative evaluation.

What her research did reveal was the identification of five common related models that have evolved because they most accurately describe a particular approach to formative evaluation. They include Expert Review, Developmental Testing, the Three-Stage Model, Learner Verification and Revision (LVR), and Formative Evaluation (FE).

Although each approach involves the collection of data that

can be used to improve a product, each advocates a unique set of evaluation phases to accomplish this. These sets include one or a combination of the following: self-evaluation, expert review, one-to-one testing, group testing, field testing, extended testing. Figure 1 illustrates these phases in relation to formative evaluation and its common variants.

Figure 1. Phases of evaluation included in Formative Evaluation and common variants.



(Weston, 1986)

The figure reveals some important differences and inconsistencies concerning how formative evaluation can best be accomplished. The first difference involves the sources

used to obtain feedback information. For example, the Developmental Testing, the Three Stage Model, and the LVR approach require the use of learners from the target audience as the primary source of information. On the other hand, the Expert Review Approach advocates experts as the primary source. The Formative Evaluation approach recommends any review done to improve the material. This would include the use of students or experts, as well as a self-evaluation of one's own materials.

A closer examination of the issue of feedback sources also revealed some inconsistency about when to involve each in the process, about the techniques that should be used for gathering feedback, and the kind of information that should be gathered.

The second major difference in approaches relates to the developmental state of the materials at the time of their evaluation. For example, the developmental testing approach suggests evaluating materials at their draft stage; the expert review approach reviews prototype materials during development, LVR approach reviews materials at development and implementation stages, and the EE approach during the formative stages of product stages of product development.

The third difference between approaches involves the

duration of the evaluations. Although most of the approaches end their evaluations when the final product is produced and released, the LVR approach continues the evaluation for as long as the materials are in use.

Although all these approaches are valid on their own terms, the literature reviewed suggests a number of considerations which should be taken into account before selecting or carrying out a particular approach. These include identifyng the type of information required from the evaluation as well as the duration and frequency with which the evaluation should occur.

Another consideration relates to the importance of feedback sources when selecting and carrying out a formative evaluation approach. While each approach may differ with respect to the primary source of feedback advocated, the involvement of a combination of experts and learners in the formative evaluation process is widely advocated in prescription (e.g. Dick & Carey, 1985; Kandaswamy, 1980; Geis, 1987; Stolovitch, 1982; Thiagarajan, 1978; Weston, 1986) as well as practice (Weston, 1987; Burt & Geis, cited in Weston, 1987). This is mainly because of the different kinds of feedback that each can provide.

According to Weston's (1987) research, depending on the

kinds of materials being developed, a number of different experts could be used to identify problems within their area of professional competence. Learners should be relied upon to provide information about their reactions to the materials and whether the materials actually helped them to achieve the intended objectives. Depending on an evaluator's information needs and his preference of a particular technique, this can be done on a one-to-one basis and/or with a group and/or in a situation which simulates actual use (field testing).

Once the data has been collected, the evaluator is faced with the consideration of revision. Depending on how in depth the evaluator has been in the formative evaluation approach (i.e. with respect to the number of feedback sources, measuring tools used, etc), definite patterns and clear suggestions may become evident. In fact, some revisions may be very obvious (Weston, 1986).

Since not all revisions are always obvious and since there is as of yet no theoretical base upon which revision decision can be made (Wager, 1983; DIck, 1980), evaluators must, in these cases, rely on their own intuition. Although some evaluators may not be comfortable or confident relying on intuition, it should be remembered that even materials that are intuitively revised are more effective than

unrevised materials.

Of particular importance in selecting an approach is a consideration of practical constraints. Palmer and Tovar (1987) suggest that constraints such as time, budgets, facilities, and availability of participants are factors which may not be insurmountable but they can be limiting when considering one's options. Selecting an approach is often based on such practical constraints.

If it is not possible to carry out a defined method from beginning to end, Weston (1986) suggests choosing a combination of evaluation strategies from existing methods. These strategies should take into consideration identified constraints as well as the type of information wishing to be generated.

PART 2- COURSEWARE DESIGN AND DEVELOPMENT

A. BACKGROUND

The Problem

In January of 1984, the author was involved in the development and production of a slide tape presentation which would be used by the Department of Occupational Health at Concordia University. This audiovisual presentation was designed to explain the radiation safety policies of the university and outline the radiation handling procedures for work involving the use of radioisotopes. It was produced with the intent of replacing a text-based manual.

Following the implementation of the audiovisual package into the undergraduate chemistry curriculum, an informal solicitation of feedback was conducted by the author from the technicians and instructors who were using the product. The feedback received was of a positive nature in that the product fulfilled the objectives stipulated by the Department of Occupational Health. However, further discussions with lab technicians revealed that they were still not entirely satisfied with the results of training. A number of situations had been noticed where students had incorrectly carried out important procedures in the laboratory. According to technicians, not all students were transfering learned procedures from the classroom to the laboratory.

In a continuing attempt to improve instruction and training within the faculty of Bio-chemistry, a further investigation was conducted on the specific strategies used to promote the learning and retention of important radiation handling procedures.

Instructional strategies were found to be expositive in nature. Information about radioactive handling procedures and policies would be presented to approximately 30 students at a time using the slide tape presentation. This was then followed by a brief discussion by a lab technician who outlined the important steps. Evaluation consisted of a short multiple-choice questionaire which served to evaluate factual retention of the content rather than assimilation of specific important procedures. Students who failed the quiz were then instructed to read and study Concordia's Radiation Safety Policy manual and no further follow-up testing was carried out.

In the analysis, a number of training needs were identified. First, considering that the students were expected to learn and apply procedures, it was agreed that individual practice in the form of a real or simulated experience would be helpful to the learner. Another training need was related to the emphasis given to the instruction of procedures commonly carried out in the laboratory. It was thought that more emphasis should be placed on these important procedures than

on the factual content of radiation policies. In this respect, it was determined that the most important procedures the student should master involved contamination assesment and decontamination of radioactive materials. To ensure mastery of the required procedures, it was thought that questions and testing procedures should also be revised.

While the audiovisual medium was more effective than the manual for the purpose of presenting information, it was found that it was not sufficient for instructional purposes. One possible solution for increasing its instructional effectiveness was to use the material to present the procedures to be learnt and follow it with practice in the lab. However, since this would require more staff time and since laboratory schedules did not allow the time needed for this practice, the idea was not practical.

It was also thought that the use of the slide tape presentation should be redefined. The slide tape was seen to serve a more useful function as an information tool to explain the University's Radiation Policies. This would include information pertaining to the roles of the university's radiation safety committee, radiation safety officers, as well as guidelines relevant to the inventory, liscencing, purchasing, laboratories and waste disposal.

One important problem remained to be solved. Given the

identified needs and constraints, the selection and development of a more adequate medium was required for the teaching of important radiation handling procedures. It is this particular problem which this thesis addresses.

Rationale for Media Selection

A number of training needs have already been identified for promoting the learning and retention of radiation safety procedures. Of particular importance was the inclusion of opportunities for students to practice the procedures being learned and to receive corrective feedback.

The provision of adequate practice and feedback was complicated by a number of constraints. First, there was a limited amount of time that teaching staff and technicians could devote to instruction. It was stipulated that the instructional approach used should require little set-up time and minumum supervision. As well, the approach would have to comply with a laboratory schedule which was not able to offer a reasonable amount of time for practice.

These constraints severely limited the range of instructional options which could be used for satisfying training needs. The stipulation that minimal supervision be involved made it extremely difficult to use available media and resources for the provision of adequate practice and feedback. The busy laboratory schedule was not flexible enough to let students

access the technical resources and time needed for a real practice session.

Another consideration involved the use of the delicate equipment with which the students must be trained. The equipment used to carry out contamination assesment and decontamination procedures are very delicate and easily broken if not handled correctly. As well, the compounds being detected are radioactive and are therefore extremely dangerous to the learner. These factors needed to be taken into consideration and served to stress the importance of incorporating safe training procedures which would 1) familiarize the learners with the equipment and compounds, 2) offer the opportunity to learn the appropriate procedures in a manner which was safe for the learners and their environment and 3) encourage a smooth transfer from the classroom to the laboratory.

Given the above considerations and constraints, interactive video was explored as a potential solution. Being familiar with the capabilities of interactive video systems, the author was well aware of the technology's potential to offer an audiovisual presentation which would not only provide information but could also allow learners to interact with the system for instruction, live-action demonstrations, practice, and instant corrective feedback on testing. As such, it was seen to be a powerful medium to use as a

self-instructional stand alone system and it required little set up time.

Interactive video has also been successfully used to teach chemistry in a number of American universities (Russel, Staskum, & Mitchell, 1985; Brooks, Lyons, & Tipton, 1985). As well, the medium has been highly praised as a means of teaching procedures (McLean, 1985; Helgerson, cited in Brandt, 1986) especially if the subject matter is stable and not prone to change (Pribble, 1985). It has also been highly recommended as a means of demonstrating the use of delicate equipment in potentially dangerous situations (Angele, 1981; Ketner; Schriver, cited in Brandt, 1986).

From an instructional standpoint, interactive video was seen to be capable of satisfying training needs. One final consideration was the cost of this solution. Since the hardware required to produce and operate the courseware were available, a budget would only be required for producing the courseware. Although interactive video can be quite expensive to produce, the author determined some feasible ways to limit production costs so that they would not exceed the $2500 budget allocated for the project.

First, much of the expense encountered when producing interactive video can be attributed to the multidisciplinary team which is required to develop the different facets of the

technology. However, working within a university setting allowed us to access both human and technical resources at a minimal cost. An agreement was worked out with the audiovisual department which gave us access to their production equipment at no cost to the project. Graduate students who worked on the project received internship credits, this incentive gave us access to highly motivated and qualified individuals.

It was also decided that the courseware would be produced using videotape. This was both a practical and economical decision. The cost of producing interactive videotape can be relatively inexpensive especially with access to production facilities. Secondly, the value of interactive videotape as an inexpensive training tool and prototype for formative evaluation has been suggested in the literature (Cambre, 1984; Gayeski & Williams, 1986).

Given the training problem and the limitations which the training staff had imposed on the instructional options, interactive videotape was seen to be the most suitable medium for meeting the needs of all involved - from an instructional, pedagogical, practical, and economic point of view.

B. COURSEWARE DESIGN

In the literature review of this thesis, a number of authors stressed the integration of sound instructional design principles within interactive video courseware as being the most important component in determining the medium's instructional effectiveness. In this respect, the quality and versatility of a courseware's design cannot be underestimated for determining the effectiveness of interactive video courseware.

The design can be viewed as the foundation upon which video and computer-based characteristics may be exploited and manipulated to produce a structure that promotes learning and retention of the intended content. As O'Brian (1982) has explained,

> "In interactive video, [the] instructional design is the teacher. The design creates the scope, nature and form of the interactive learning experience. It encourages, reacts to, redirects or rewards performance. The content of the program will be enhanced and the user will learn to the extent that the instructional design is an effective teacher" (p. 69).

If the instructional design is considered the teacher in interactive video then clearly the design of interactive video courseware should be couched on the pedagogical

concerns of an effective teacher. This includes considerations such as the target audience, the objectives to be achieved, the instructional strategy to be used, the content and structure of the intended learning, the lesson structure, and the evaluation and control strategies to be used. This section will be devoted to discussing the courseware in these terms.

The Target Audience

The interactive videotape courseware is intended for undergraduate and graduate students in the department of Bio-chemistry at Concordia University. At the undergraduate level, it will be integrated within a laboratory experimentation course offered to third year students. At the graduate level, students who are employed as laboratory assistants will be required to use the courseware and become proficient with the procedures before being allowed to work in the laboratory.

The pre-requisite knowledge which learners are recommended to possess before using the courseware stipulates that they have the equivalent of two years of undergraduate level chemistry. It is also recommended that all learners have successfully completed an introductory biochemistry course at the undergraduate level which will familiarize them with terminology and compounds which are discussed in the courseware. Although a technical manual is provided with the

courseware, it is assumed that students have some familiarity with the keyboard of a computer and how it operates.

Objectives

In the analysis of training needs, the most important procedures for safely handling radioisotopes were identified as Contamination Assesment, Decontamination and Body Decontamination of Radioisotopes. The overall objective of the courseware is to successfully train students to carry out these procedures. The specific behavioral objectives of the courseware are listed in figure 2 in terms of lesson objectives and terminal objectives.

Terminal objectives were defined by considering 1) the equipment that students should be familiar with in order to carry out each procedure, 2) the specific steps which students should be able to explain for each procedure, and 3) the level of mastery required for measuring learning outcome scores. Lesson objectives were defined by considering 1) the computer generated questions which students should be able to answer for each procedure and 2) the level of mastery required for answering these questions within the practice and test segments of the courseware.

Note that evaluations of terminal objectives are summative in nature. They rely on the final learning outcome scores to measure mastery. On the other hand, evaluations of lesson

Figure 2. Lesson and terminal objectives.

Direct Check Method
Terminal Objective:
Given a spill of high-energy radioisotopes, the learner will correctly identify the two tools needed and will correctly carry out the twelve steps of the Direct Check Method with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Lesson Objective:
Given the practice and test segments of the lesson, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Direct Check Method.

Swipe Check Method
Terminal Objective:
Given a spill of low-energy radioisotopes, the learner will correctly identify the eleven tools needed and will correctly carry out the thirteen steps of the Swipe Check Method with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Lesson Objective:
Given the practice and test segments of the lesson, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Swipe Check Method.

Decontamination Procedures
Terminal Objective:
Given a spill of high-energy or low-energy radioisotopes, the learner will correctly identify the four tools needed and will correctly carry out the six steps of the Decontamination Procedure with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Lesson Objectives:
Given the practice and test segments of the lesson, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Decontamination Procedures.

Body Decontamination Procedures
Terminal Objective:
Given a spill of a radioactive material onto clothing and/or skin surfaces, the learner will correctly identify the four tools needed and will correctly carry out the nine steps of the Body Decontamination Procedure with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Lesson Objectives:
Given the practice and test segments of the courseware, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Body Decontamination Procedures.

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objectives are formative in nature. They rely on scores obtained throughout the process of learning each procedure.

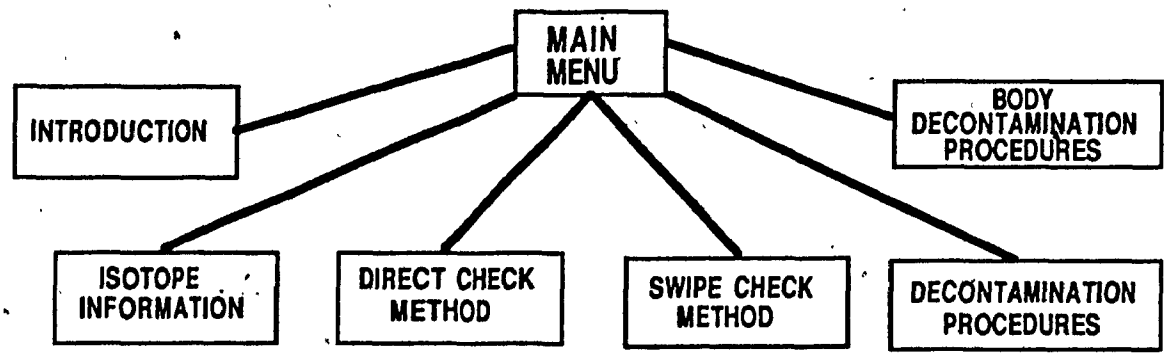
The high level of mastery specified for both types of objectives is an important condition. Improperly conducted procedures are potentially dangerous for the learner, for the environment, and for the delicate equipment being used. Students would apply the procedures in a real laboratory setting only after they had fully mastered them within the safe environment of the courseware.

Content and Structure

The design of this courseware is structured to offer the learner six separate sections . Each section is accessed through the main menu of the courseware and may be viewed in any sequence. A graphic illustration of the courseware structure and a brief description of the content is given in Figure 3.

The first two sections are purely informational. They may be accessed in order to obtain supplemental information pertaining to Radioisotopes in general (i.e., Introduction) or when wishing to obtain information pertaining to a specific Isotope (i.e., Isotope Information). The remaining four sections are instructional lessons. Each of these lessons offer the learner information pertaining to the equipment and steps which must be followed in order to carry

Figure 3. Courseware structure.



INTRODUCTION	The introduction consists of a brief video presentation which describes the characteristics of radioisotopes and how they are caused. This section was designed in order to refresh entry level knowledge as well as to situate the learner concerning the type of information which will be presented.
ISOTOPE INFORMATION	This section consists of textual information pertaining to radioisotopes which are commonly used for experimentation at Concordia University. The information presented is technical in nature and serves as an option for the learner to obtain background information related to the radioisotope with which they are working.
DIRECT CHECK METHOD	This instructional section describes the proper tools and demonstrates the correct procedures necessary to carry out contamination assesment of high energy radioisotopes.
SWIPE CHECK	The instructional segment describes the proper tools and demonstrates the correct procedures necessary to carry out contamination assesment of low energy radioisotopes.
DECONTAMINATION PROCEDURES	This instructional segment describes the proper tools and demonstrates the correct procedures necessary to carry out decontamination of areas where the presence of radioisotopes have been detected.
BODY DECONTAMINATION PROCEDURES	This instructional segment describes the proper tools and demonstrates the correct procedures necessary to carry out decontamination of clothing and skin surfaces in the event of a spill of radioisotopes.

out specific procedures as well as exercises which provide practice, remediation, and feedback.

Instructional Strategy

The intended content to be learnt in this courseware can be classified as procedures. In an attempt to encourage the learning and retention of procedures, an expositive strategy was used as the foundation for the design of this courseware. The strategy favors an inductive approach to learning and includes the main steps recommended by Romiszowski (1984) for teaching procedures:

> 1- Demonstrate the skill that is required, both in its entirety, and in its main parts or key points.
>
> 2- Arrange simplified, or prompted, practice of the skill by the learner.
>
> 3- Arrange supervised "free" practice of the complete skilled activity by the learner, supplying feedback in the form of knowledge of results, appropriate praise or other reinforcers.(p. 61)

Although the use of this strategy is generally accepted and fostered as a valid training technique, Romiszowski, also

cautions the use of this approach for reasons of long term recall. In the case of the biochemistry students, the possible problem of long term recall was not considered to be a major concern. Since these students will be applying the learned procedures in their lab work on a continual basis, the procedures are more likely to become a process which is constantly being reinforced rather than forgotten.

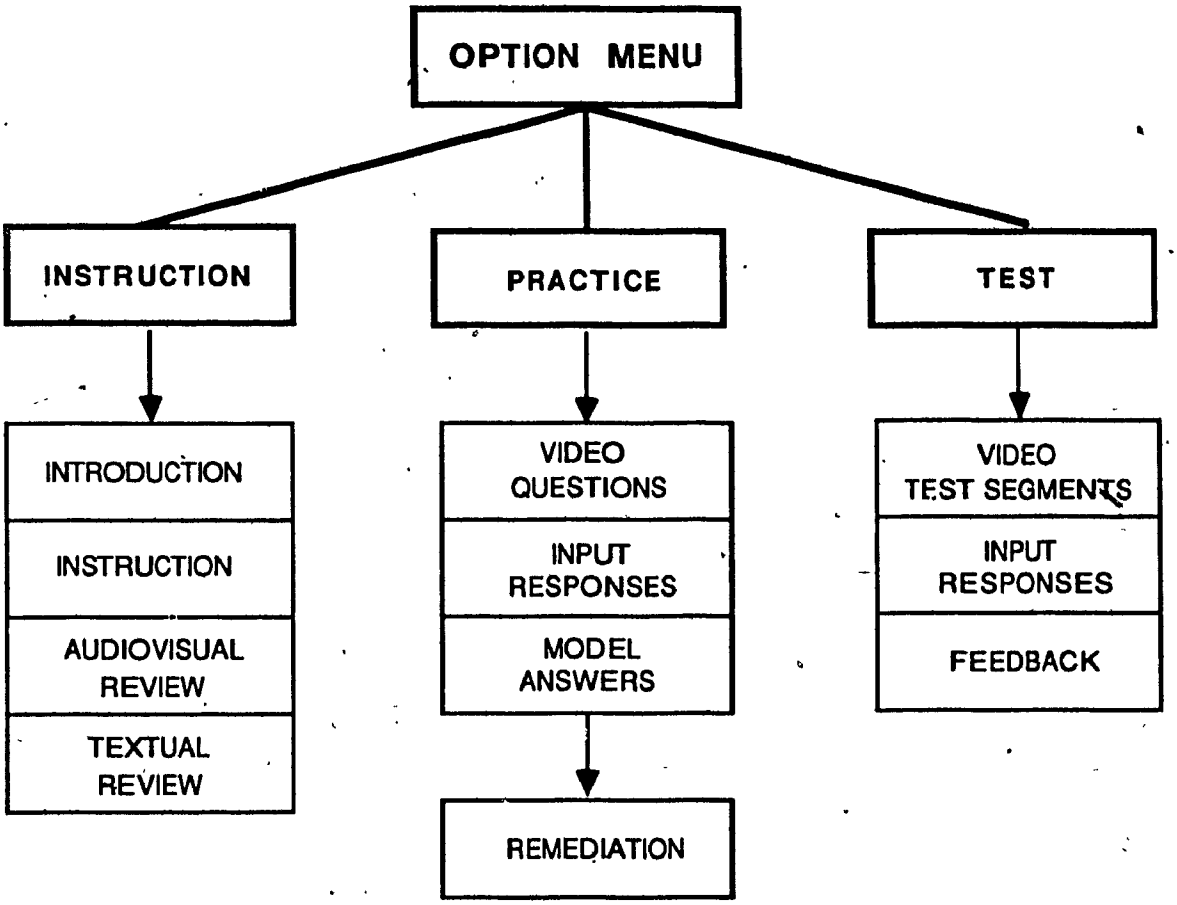
Lesson Structure

Each lesson consists of three segments which are accessed from the **option menu** at the beginning of each lesson. The three segments are entitled **1) Instruction, 2) Practice,** and **3) Test** and can be viewed randomly or in sequence, depending upon the learners choice. Each segment is structured to incorporate specific methods/techniques for teaching students about the equipment and steps which must be followed when carrying out a specific procedure. Each of these segments are explained below. A graphic illustration of the lesson can be found in Figure 4.

1) Instruction Segment

Each instruction segment consists of a four to seven minute video presentation which includes a brief introduction to the procedure and a description specifying the situations which demand its application. This is then followed by an explanation of the tools and a demonstration of the steps which are to be carried out when applying the procedures.

Figure 4. Lesson structure.



The segment concludes with a both a textual and audiovisual review which emphasizes the important steps to be remembered. Following the presentation, the learners are then returned to the option menu where they can choose to see the instruction again or move on to another segment.

2) Practice Segment

The practice segment consists of five to seven video-based questions which pertain to the lesson procedures. Through questioning, the learner is prompted by the demonstrator to

specify in sequence the procedures which were demonstrated in the instruction segment of the lesson. The learner is prompted to answer each question by typing in his/her responses following each question. Responses inputted by the learner are evaluated by a key word check process which allows learners to respond to questions in their own words. A model answer is then presented so that the learner can verify the accuracy of his/her response. At the end of the segment, correct and incorrect responses are automatically tabulated and are presented in the form of a summary feedback.

If all questions were correctly answered, the learner is congratulated and returned to the options menu where they can proceed to the next segment. In the situation where the learner incorrectly answers any of the questions, he or she is advised of this and is then branched to a video based remedial segment which again explains and demonstrates the procedures. Following remediation, it is suggested that the learner repeat the practice segment. However, carrying out this suggestion is purely voluntary.

3) Test Segment

Each test segment consists of between four to six video-based demonstrations of the lesson procedure being carried out. The task of the learner is to view the demonstration and determine whether the steps of the

procedure were correctly or incorrectly conducted. If it is determined that the steps were improperly done, the learner must then specify by typing in their responses exactly which step was incorrect.

Inputted responses are evaluated with a key word check process and the number of correct and incorrect answers are tabulated. Correct responses are reinforced and incorrect responses are remediated with a text screen which explains to the learner which step was incorrect. If all the test demonstrations were correctly answered, the learner is then returned to the option menu. If any of the test demonstrations were incorrectly answered, it is then suggested that the learner redo the lesson.

Learner Control Strategies

The courseware was designed to give learners as much control over their learning as was possible, given the limits of the hardware and software. Considering the nature of the subject matter as well as the skills possessed by students who typically work within the area of biochemistry, it was felt that this target population would be especially well suited to achieve positive outcomes if given control over their learning.

A number of learner control characteristics have been incorporated within the courseware in order to encourage

learners to participate and take responsibility for their learning. Figure 5 provides a brief description of these characteristics.

Figure 5. Learner control characteristics.

Lesson & segment sequence	The sequence of the lessons which are accessed as well as the sequence of the segments which are viewed can be decided by the learner.
Review option	A review option which is easily accessed by the learner and is available following each video-based presentation.
Keyword option	A keyword check process evaluates and tabulates all responses inputed by the learners, thus allowing participants the opportunity to answer questions using their own vocabulary.
Help option	A help menu can be accessed throughout the program and offers the following options: exit, pause & resume, branch to main menu or option menu.
-Exit option	This option allows the learners to exit any part of the program whenever they desire.
-Pause & resume option	This option allows the learners to pause and resume the program at will.
-Main Menu option	This option allows the learners to exit the program and branch to the main menu.
-Option Menu	This option allows the learners to access instruction, practice or test segments.

As previously discussed in the Objective Section, the

learning process is evaluated for the student throughout the practice and test segments of the courseware. Evaluation results are provided to help students to make the appropriate decisions for controling their learning.

Evaluation Strategies

In accordance with the objectives of the courseware, summative evaluation of learning is measured with a procedural checklist that is provided with the courseware. The checklist ensures that teaching staff still have some control over the readiness of students to carry out procedures in a real laboratory setting. It also may signal that a particular student requires an alternate or additional solution to the courseware which has been generally prescribed.

C. COURSEWARE DEVELOPMENT

The development of the interactive videotape courseware was a long process which began in the fall of 1985 and continued for a period of one and a half years. During this time, five phases of development were implemented . These include an Analysis phase, a Design phase, a Pre-production phase, a Production phase and a Post-production phase.

The first two phases were implemented through consultations between the author, an instructional designer and two content experts who served as advisors to the project. The

remaining phases were implemented by the production team which included media specialists and developers from the Graduate Program in Educational Technology.

Evaluation and revisions of the work carried out in each phase was conducted by the team involved in the phases's implementation. Since developing interactive video was a new endeavor for all involved, the process of evaluating and revising work was considered particularly important for future work in this area. A brief description of the work which was carried out in each phase will now be presented.

Analysis Phase

This phase involved the initial analysis of the content to be presented as well as the development of the instructional objectives. This was accomplished through the analysis of print-based biochemistry manuals and through several interviews with the content experts. The target audience was also analysed in order to determine an expected level of knowledge and skill. The production team was also assembled at this time.

Design Phase

This phase involved the development of an instructional plan detailing the content, structure, sequence, strategy, presentation methods and performance measures to be used in the courseware. Selecting the level of interactivity of the

courseware then followed. This led to decisions pertaining to remediation, branching, learner control characteristics and learner response techniques. Having settled these issues, we were then able to decide on the appropriate hardware and software systems which were to be assembled or purchased. The computer program was also initially structured during this phase.

Pre-Production Phase

During this phase, a flowchart was developed which defined the sequence and branching of the courseware for the programmer (See Appendix A). A storyboard was also designed by the author which enabled a page by page description of video segments, text screens, question segments and branching schemes to be used by the programmer and production team (See Appendix B). Graphics were produced by an artist and a script was outlined for the talent which had also been selected.

Production Phase

This phase involved the shooting of the video segments. The video shoot took four days to complete and was conducted on location in a chemistry laboratory. In order to achieve a good quality video image as well as to have access to a number of video enhancement techniques (e.g., fades, overlays and titles) during the final edit, it was decided that the segments would be recorded using 3/4 inch video.

Voice-over narration segments were also recorded in the universities' audio laboratory.

As well, during this phase, the programmer chose the Super Pilot Authoring system to develop the computer software that was needed and used it to write the computer program for the courseware. This software enabled the creation of text screens, branching sequences, key word checks, video segment addressing and a management component.

Post-Production Phase

Video segments which were origionally recorded on 3/4 inch video were transfered to 1/2 inch video to allow for an off-line edit that would be conducted using the available equipment in the Education department. Audio editing and dubbing was carried out in order to eliminate unneccessary background noises. Address codes were also recorded onto the video master. The computer programme was debugged and frame addresses were calculated and written into the software.

PART 3 - FORMATIVE EVALUATION OF COURSEWARE

A. OBJECTIVE

Interactive videotape courseware integrates a number of components and technologies (i.e. CAI, video, instructional design). When designing, developing, and producing the courseware, these components and techologies must be considered not only on their own terms but as part of an integrated system. As a result, the objective for conducting formative evaluation was not only to ensure the product's instructional effectiveness, it was also to provide the design and production team with feedback on their first interactive video project which would be beneficial for their future work in this area.

Accordingly, six categories have been defined for evaluation. They include:

1) Content of the courseware.

Information gathered within this category would help to determine whether facts, and procedures were correctly explained and/or demonstrated within the courseware.

2) Instructional Format.

Information gathered within this category would help to determine whether the format of the instruction in the courseware (i.e. vocabulary used, difficulty of questions, quantity of information presented etc...) was appropriate for the target audience.

3) Instructional design of the courseware.

Information gathered within this category would help to validate and improve courseware design and instructional strategies used in the courseware.

4) Learning outcomes achieved by the users.

Information gathered within this category would help to identify incorrectly learned procedural steps achieved by students following the use of the courseware.

5) Learners attitudes towards the courseware.

Information gathered within this category would help to determine the learners attitudinal reactions to the courseware.

6) Technical Quality.

Information gathered within this category would help to validate the courseware manuals structure, format, and comprehensibility. It would also help to verify the effectiveness of the information displays as well as the ease of use with which the intended users could operate the program.

B. METHODS

In order to retrieve formative evaluation data, a number of methods were employed. Since developing interactive video was a new endeavor for all involved, it made sense that the designer and the development team discuss, critique and revise rough drafts of instructional materials, especially

during the design and pre-production phases of the product's development. This process has been defined as the "self evaluation" method (Kandaswamy, 1980).

While this method was considered a useful first step for evaluating the courseware, the obvious subjectivity of the method prompted the addition of a method which uses an external evaluation source (i.e., Expert Review).

Expert Review can be defined as the process whereby experts are asked to review the instructional materials in order to provide comments, criticisms, and suggestions about those factors which fall into their area of expertise, such as accuracy, completeness, and technical quality (Geis, 1987; Weston ,1986). These experts are uniquely qualified to evaluate features which may be invisible to students as well as to detect problems, gaps, or inconsistencies which may have been overlooked during self-evaluation. For this evaluation, both subject matter experts and design experts were consulted during the evaluation.

The Expert Review Method was complemented by another method which considers student data. Considering that the courseware was designed to be self-instructional, the method perferred for collecting student data was "Individual Testing".

"Individual Testing" can be defined as a process where an individual student, who is typical of the target audience, works through draft or prototype materials with a developer (Weston, 1986) . Kandaswamy (1980) describes it as a "debugging" process where the developer carefully moniters the processes and the outcomes of learning from the materials and then uses this information to revise the materials. The student's reactions, responses, remarks and achievement scores are recorded to obtain in depth information about the students interactions with the courseware (such as instructional problems, patterns of errors and possible causes).

Tools used to obtain feedback information from students should include not only outcome measures (such as post-tests) but also input measures (e.g. pre-tests) and process measures (e.g. process responses) (Kandaswamy, 1980). It is suggested that at least three student testing sessions be held (Weston, 1986).

Figure 6 illustrates the kind of feedback that was sought with each of the methods described. Notice that the feedback sought for each method corresponds to the six categories which were defined for evaluation. The three methods (i.e.,Self-evaluation, Expert Review, and Individual Testing) which were used for evaluation have been generally described along with the rationale for their selection.

Figure 6. Evaluation methods in relation to the categories defined for evaluation.

METHODS	EVALUATION CATEGORIES					
	Content	Instruction Format	Instruction Design	Learner Outcomes	Learner Attitudes	Technical Quality
SELF EVALUATION	√	√	√			√
SME REVIEW	√	√				√
ID EXPERT REVIEW		√	√			√
STUDENT TESTING		√	√	√	√	√

The application of each of these methods will now be described in terms of the specific participants, instrumentation, criteria as well as the specific evaluation and data analysis procedures that were used for evaluating this courseware. This section ends with a description of how these methods were applied to evaluate the Courseware Manuals.

Self-Evaluation

Participants:

These included members of the design and pre-production team.

Instrumentation:

No formal instrumentation was used. Following the review of the material, discussions and/or brainstorming sessions were used to determine possible improvements.

Criteria:

The specific criteria are related directly to the design and pre-production phase of the courseware and the work involved

during those phases.

Evaluation Procedure:

"Self-evaluation" procedures were applied during the design and pre-production phase of the courseware. Self-evaluation was quite informal. Procedures involved reviewing the material in it's draft form to ensure that objectives were being met in the most effective and efficient way. Accordingly, revisions were immediately acted upon.

Data Analysis Procedure:

Not Applicable

Subject Matter Expert Review

Participants:

During the analysis phase of development, two subject matter experts from Concordia University's Biology and Chemistry departments participated in the evaluation of the content. These individuals were also knowledgeable about the target audience. Thus, they served to evaluate the presentation of the content for these students.

Instrumentation:

A five point likert scale questionaire was created and used to evaluate the correctness as well as the appropriateness of the content (see Appendix C). Informal interviews were also used to record comments and suggestions made by subject matter experts (see Appendix D).

Criteria:

Based on their knowledge and expertise, the specific criteria evaluated by subject matter experts fall into two categories. The first category relates directly to the subject matter of the courseware and includes,

a) Correctness of the information/explanations presented (verbal and textual)

b) Correctness of the procedures demonstrated.

c) Correctness of the graphics presented.

Specific criteria evaluated by subject matter experts which related to the presentation of content for the target audience included,

a) Appropriateness of the vocabulary used.

b) Quantity of information presented.

c) Clarity of content presented.

d) Difficulty level of questions presented.

e) Appropriateness of questions presented.

(A detailed description of these criteria can be found in Appendix E)

Evaluation Procedures:

Each subject matter expert viewed the courseware individually during two one-and-a-half hour time blocks. Following the viewing of each lesson or segment of the courseware, the questionaire was answered. Comments, discussions and recomendations for improvement were noted throughout the viewing of the courseware.

Data Analysis Procedures:

Responses generated from the questionnaires were placed in a table and mean scores were calculated for each criteria. The mean scores comments and observation data were then analysed to determine possible corrections to the courseware content and the appropriateness of the instructional format.

Learner Review

Participants:

As previously mentioned, the target audience for this courseware are graduate and under-graduate chemistry students who have at least two years background of undergraduate chemistry and who have completed the introduction to biochemistry course. These criteria enable learners to be sufficiently familiar with the terminology to easily follow the courseware.

When attempting to select a representative sample to evaluate the courseware, a number of logistical problems were encountered. One problem relates to the introductory Biochemistry course that the target audience is required to complete. A present objective of this course stipulates that contamination assessment and decontamination procedures be explained and discussed. This objective will remain unchanged until the interactive video courseware is completed and can be integrated within the curriculum. This situation created significant sampling problems since

students who currently meet the target audience criteria have also recieved instruction on the procedures taught in the courseware during their introductory course.

A second complication was due to the timing of the evaluation. Since production and post-production schedules had been delayed, it was necessary to conduct the student evaluation phase during the summer months. Since the Chemistry Department does not offer any summer courses, students who fit the target audience criteria were difficult to find.

Given the above considerations, it was decided that the criteria used to select a sample would have to be redefined. To ensure that the sample would have no prior exposure to the procedures being taught in the courseware, the students in the sample should not have taken the Introduction to Biochemistry course. However, students were still required to have a minimum of two years of undergraduate chemistry so that they would have sufficient background knowledge to learn from the courseware.

Through the cooperation of the biochemistry technicians, four graduate and four undergraduate chemistry students (n=8) were selected based on their eligibility, their availability, as well as their willingness to participate in the evaluation. Twelve students had origionally agreed to

participate. However, four of these students dropped out of the sample for various reasons. All of the participants were employed at Concordia University during the summer of 1987 and had permission to take the time necessary to participate in the evaluation.

Instrumentation:

A pre-test and a post-test were constructed in the form of procedural checklists. Each checklist consisted of a breakdown of the equipment and steps needed to carry out the specific procedures which must be learnt (see Appendix F).

A five point likert scale attitudinal questionaire was constructed in order to determine individual learners reaction to the courseware as well as to identify any particular area of difficulty (see Appendix G).

Student responses to the embedded practice and test questions were recorded throughout their interaction with the courseware in order to obtain process responses. Observation forms were used to record comments, questions and suggestions made by the learners as they viewed the courseware (see Appendix D). These forms would help to detect unanticipated problems with the courseware and with the evaluation itself.

Criteria:

Criteria which were evaluated in the pre-test and post-test

(procedural checklists) include the knowledge of the procedures to be learnt in the courseware as well as the equipment used to carry out the procedures.

Specific criteria which were evaluated by learners of the target audience through the use of attitude questionaires included:

1) Clarity of graphics.
2) Clarity of information presented.
3) Quantity of information presented.
4) Length of instruction.
5) Interest of segments presented.
6) Manipulation of courseware.
7) Clarity of instruction screens.
8) Clarity of demonstrations.
9) Clarity of review.
10) Clarity of questions.
11) Difficulty of questions.
12) Helpfulness of feedback.

Further criteria which pertain to the courseware in general include,

13) Learning with interactive video.
14) Difficulty of lessons.
15) Interest of technician.
16) Technical quality.
17) Key word check.

18) Content structure.

19) Operating the computer.

20) Usefulness of the option and menu screens.

(A detailed description of these criteria can be found in Appendix H)

Criteria for process responses include student responses to the embedded practice and test questions of the courseware. These were designed in a manner which would focus the learner's attention onto important content. Responses to the questions were recorded in order to identify procedural steps which were not retained or possibly misunderstood during instruction. Practice and test question responses were also recorded in order to build up the key word check library.

No specific criteria were used for observation forms. These were mainly used to record any comments, suggestions, or questions that students may have had while viewing the courseware.

Evaluation Procedures:

Evaluation procedures began with the initial screening of applicants by the technician for relevant background. However, for the most part evaluation procedures were carried out by the author in 2 sessions. Accordingly, these will be discussed.

Session 1:

Students who had volunteered to participate in the evaluation were summoned individually to the interactive video research office where the pre-test was conducted. Learners were asked to first identify the name of a specific procedure, given it's purpose. (i.e. What is the name of the procedure to be carried out when attempting to detect the presence of High-Level radioisotopes?) Having previously set up on a workbench all the tools necessary to carry out the four procedures taught by the courseware, learners were then asked to choose the equipment necessary to carry out the appropriate procedure.

Finally they were asked to explain and demonstrate the steps of the procedure. Using the procedural check list, an observer checked off the correct and incorrect tools and steps of the procedure as identified by the learner. Participants were then scheduled for two one-and-one-half hour time blocks where they would be available to participate in an individual evaluation of the courseware. Participants were then given a copy of the students courseware manual which explains the objectives of the courseware, how the segments are structured as well as how to operate the system. Learners were then asked to read the manual before their scheduled evaluation and note any recommendation for changes to the manual.

Session 2:

Individual evaluation of the courseware consisted of individual learners working through all six sections of the courseware. Following each segment of a lesson , the learners were then asked to answer the attitude questionaire and verbalize any comments or criticisms pertaining to their experience. Their comments, criticisms, as well as responses to the embedded questions were all recorded by an observer. Following each instructional segment, the procedural checklist (i.e.posttest) was conducted in exactly the same manner as the pretest.

Data Analysis Procedures:

A table with Pre and post test scores was constructed to determine if learners experienced difficulty with any procedural steps and if there were any patterns of error. Embedded practice and test results were placed in a table and analysed to determine process response patterns which may identify potential courseware limitations as well as improper question structures.

Attitudinal data generated from the questionnaires was summarized and mean scores were evaluated for each criteria. These mean scores and the comment and observation data were analysed to determine overall attitudinal reactions towards the courseware.

Design Expert Review

Participants:

Two instructional design experts participated in the evaluation of the courseware design. Dr. Cynthia Weston from the Department of Education at McGill University served as an expert in instructional design. Dr. David Walker of Loughborough University served as an expert in the design of interactive video courseware.

Instrumentation:

Informal interviews were used to solicit comments and suggestions concerning the improvement of the courseware (see Appendix D).

Criteria:

You will recall that expert review was used to detect problems that may have been missed during the self-evaluation as well as features that may be invisible to students. To ensure that unanticipated problems or features would not be excluded, no lists of specific criteria were given. Instead, experts were given broad guidelines to follow (see Procedure)

Evaluation Procedure:

Each design expert individually viewed the courseware in a one-and-one-half hour time block. Since the instructional sections of the courseware are all based upon the same design, it seemed acceptable to require the viewing of only one section in order to obtain a good understanding of how the instructional sections were structured. The remaining

informational sections would both require viewing.

Thus, the design experts viewed a total of three sections of the courseware. These included "Introduction to Isotopes", "Isotope Information", and the "Direct Check Method". To assist experts in identifying problem areas within the courseware, collected data from student performance scores, attitude scales and comment sheets were made available. Their expertise was also solicited to comment on the formal and functional features of the courseware.

Following the viewing of the courseware, the design experts were then asked to recommend changes to the design taking into consideration their own experience as well as the outcomes and comments which had been made by students and subject matter experts.

Data Analysis Procedure:

Comments and recommendations from design experts were recorded for each courseware section. They were analysed for their relevance to features which may not be visible to students as well as for their relevance to problems, gaps, or inconsistencies which may have been overlooked during previous evaluations.

COURSEWARE MANUAL EVALUATION

Evaluation of the courseware manuals was conducted with all the participants. Subject matter experts and design experts

evaluated the instructors version of the manual (see Appendix I), while the learners evaluated the student version of the manual (see Appendix J). Expert evaluation involved examining the materials for content, structure and clarity while student manuals were evaluated for clarity. All the participants were given a copy of the manual to read before their scheduled evaluation session and were asked for criticisms as well as recommended changes.

PART 4 - EVALUATION RESULTS

A. SUBJECT MATTER EXPERT REVIEW

The raw data which was obtained through the subject matter expert review can be found in Appendix K and Appendix L. Appendix K presents SME questionnaire responses obtained during the evaluation. Appendix L presents the comments and recommendations of these experts. Note that the results in both appendices are presented for each section of the courseware.

As previously outlined, the subject matter expert review method was used to obtain feedback on the content, instructional format, and technical quality of the courseware. Accordingly, all the data collected from subject matter experts is summarized below for each courseware section.

Introduction To Radioisotopes

Content:

1) The graphic illustration on slide six is incorrect. The arrows which represent the alpha, beta, and gamma rays should be illustrated in different lengths.

2) Slide seven which is a graphic illustration of ionozing radiation should be significantly simplified and four directional electron arrows should be added to the

illustration.

Instructional Format:

It was found that too much information was presented in the segment. Both graphic and narrative information should be clarified and simplified in order to reduce the amount of information presented in this segment.

Technical Quality:

No criticisms.

Isotope Information

Content:

1) The radiation source formula should be deleted from the segment.

2) The mathematical formula which is used to "calculate effective half life" should be included in the segment.

Format:

1) There was too much information presented in the segment.

2) All the text in this segment should be double spaced to facilitate reading.

Technical Quality

Color distortion was noticed on the text screens but this may be attributed to technical limitations. The authoring language used to program the text did not reproduce itself well on the color monitor.

Direct Check Method

Content:

1) The instruction segment of this section does not:

    1) Clarify that gloves must always be worn in laboratories.

    2) Clarify that the probe has controls and not components.

    3) Place enough emphasis on setting the meter at Times one.

    4) Clarify that decontamination should be applied until counts are below permissible levels and not at permissible levels.

    5) Clarify that audio counts and not scale counts are used to measure radiation levels.

2) In the practice segment of this lesson, learners are told that the probe should be held 3mm from the surface and that it should not touch the surface. This should be reduced to one step since they both mean the same thing.

3) The remediation segment of this lesson does not

    1) State that the probe should be turned on and set at Times 1 and that the probe should be passed slowly.

    2) Emphasize equally and clearly all the procedural steps.

4) No content inaccuracies were cited in the test segment of this lesson.

Instructional Format:

No significant problems were cited in the instruction, remediation, and test segments of this lesson. However, in the practice segment, it was suggested that each question be designed to address one procedural step at a time .

Technical Quality:

In the instruction segment, the video image of the meter is obstructed by a reflection of light. Also, a stronger source of radiation should be used for the demonstration. No problems were cited in the practice, remediation, or test segments.

Swipe Check Method

Content:

1) The instruction segment of this lesson should
    1) Specify that gloves must be removed following the dismanteling of equipment.
    2) Show the technician swiping a smaller area. He is shown swiping too large an area.
    3) Show the technician swipe the filter paper from left to right when he is swiping.
    4) Include a demonstration of filling the vials with scintillation fluid.
    5) Clarify and emphasize the process of marking vials.
2) In the practice segment of the lesson, the technician did

3) No content inacuracies were found in the remediation or the test segments.

Instructional Format:

1) The instructional segment is too long.

2) In the practice segment, the step by step breakdown should be more structured and the practice questions should address one procedural step at a time.

3) No format problems were cited in the remediation and test segments.

Technical Quality:

No criticisms

Decontamination Procedure

Content:

1) In the instruction segment, the following inacuracies were found:

   1) The paper towel used to decontaminate should not be flipped over by the technician during wiping.

   2) The demonstration should also include applying soap directly to the workbench.

   3) Paper towels must be gently placed and not thrown into the dry waste container.

2) In the practice segment, marking the area 30cm larger than the spill was not specified in the segment.

3) No content inaccuracies were found in the remediation segment.

4) In the test section, the following inacuracies were

noted:

1) Marking the area 30cm larger than the spill was not specified. This content inaccuracy could lead to improperly recognizing the procedures.

2) In the last feedback text page of the test segment, add "From outside of contaminated area towards the inside".

Instructional Format:

No problems were cited in the instruction, remediation and test segment. However, in the practice segment, it was suggested that each practice question address one procedural step at a time.

Technical Quality:

No criticisms on any segment of the lesson

Body Decontamination Procedure

Content:

Inaccuracies were only found in the instruction segment. This segment should:

1) Demonstrate the five step procedure used to remove contaminated gloves.

2) Emphasize that the hand which is not contaminated must be used to manipulate soap, water, and equipment.

3) Clarify that hands should not be swipe checked, they should be rewashed two or three times.

4) Stress that paper towels should be gently placed and not thrown into the dry waste container.

5) Emphasize that any case of body contamination should be immediately reported to a radiation safety officer.

Instructional Format:

No criticisms

Technical Quality:

No criticisms

B. INDIVIDUAL TESTING

As previously outlined, this evaluation method was used to obtain several types of feedback. A summary of results pertaining to learner outcomes will first be presented and discussed. Results pertaining to learner attitudes will then be presented for each section of the courseware. This includes attitudes towards the instructional design and format of the courseware, its technical quality, as well as the general attitude/interest shown in each section.

Learner Outcomes

Results:

1) During the process of learning with the courseware, students experienced the most difficulty responding to questions pertaining to the Decontamination Method. Specific courseware problems which were identified while students were learning with the courseware include:

1) Improper question structuring for question 3a in the Direct Check Practice Segment, for question 1a and 1b of the Swipe Check Practice Segment, and for question

2a and 4 of the Decontamination Practice Segment

2) Too much incidental information was presented in the Swipe Check instruction segment.

2) After students had gone through the courseware, marked increases were noticed in their overall knowledge of the procedures. However, a pattern of difficulty was evident when students were required to identify the twelfth step of the Direct Check procedure. A specific couseware problem identified in the analysis was the omission of a practice and test question pertaining to this step.

Discussion:

The first results were obtained by looking at how students were performing on the practice and test questions which are embedded within the courseware. As previously outlined, these questions relate directly to the lesson objectives. One of the purposes for monitering these responses was to identify possible patterns of difficulty during the learning process.

Appendix N presents how students performed on the embedded practice questions in each lesson and Appendix O presents how they performed on the embedded test questions in each lesson. Notice that no test questions are included for Body Decontamination Procedures. This is because body decontamination involves the removal of contaminated clothing as well as the washing of contaminated skin

surfaces. These procedures are fairly straight forward and do not require the application of specialized steps. Thus, the embedded practice questions in the Body Decontamination lesson were considered sufficient and embedded test questions were not included.

The scores reveal that students encountered the most difficulty when answering the practice and test questions which pertain to the Decontamination Procedure. Notable problems included practice questions 2.a, 3, and 4. The reason for incorrectly answering question 2.a seems to be due to having asked the learner to identify two steps using one question. There is no particularly evident reason for incorrectly answering question 3. Question 4 was incorrectly answered due to incorrect question structuring and because of improper presentation of the content during instruction.

Note, however, that all the steps of the Decontamination Procedure were correctly mastered on the posttest. When students were asked to rate the difficulty of the questions related to the Decontamination procedure using the five point scale, their responses did not indicate any difficulty (i.e. a 4.63 mean response was calculated for the practice questions and a 4.50 response for the test questions). As well, students did not make any comments or recommendations regarding the difficulty of these questions (see Appendix Q).

Appendix N also shows that students experienced some difficulty with question 3a in the Direct Check Practice Segment and question 1a and 1b of the Swipe Check Practice Segment. All the steps relating to these questions however, were correctly identified on the post test.

Figure 7 presents outcome scores of the learners after they had gone through the courseware. These results were obtained by comparing how students performed on the pre-test and post-test questions for each of the lessons taught within the courseware. As previously explained, these questions are directly related to the terminal objectives of the courseware. Responses to these questions were used to identify any pattern of difficulty which may indicate possible courseware limitations or problems in teaching of the procedures.

Figure 7. Student pre and post test scores

STUDENT	D CHECK		S CHECK		DECONTAM		BODY D	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	0%	93%	0%	100%	0%	100%	36%	100%
2	7%	100%	0%	100%	0%	100%	0%	100%
3	0%	100%	0%	100%	0%	100%	21%	100%
4	7%	93%	0%	100%	9%	100%	7%	100%
5	0%	93%	0%	100%	0%	100%	0%	100%
6	13%	93%	16%	100%	36%	100%	43%	100%
7	7%	87%	16%	100%	18%	73%	14%	100%
8	7%	[illegible]	8%	100%	0%	100%	14%	100%

Notice that on the post-test, all students showed 100% mastery of the Swipe Check and Body Decontamination procedures. Only one student did not achieve mastery of Decontamination Procedures. Students appeared to have the most problem achieving mastery of the Direct Check Method. In particular, the breakdown of scores for the pre and post test of the Direct Check Lesson revealed that 5 out of the 8 students improperly carried out the twelfth step of the Direct Check procedure (see Appendix R). Aside from this step, all students showed an excellent knowledge of the procedures.

The noticable area of difficulty (i.e., step twelve of the Direct Check Method) stipulates that a "decontaminated area should be rechecked using the Swipe Check Method".
An apparant reason for the poor performance involves the omission of practice or test questions which pertained to the step. This type of oversight hampers the learners ability to remember the step since no exercises are offered to encourag its retention.

Learner Attitudes

The data which was obtained on learners attitudes can be found in Appendix P (Attitude Questionaire Results) and Appendix O (Student Comments and Recommendations). Mean Scores from the Student Attitude Questionnaire have also been calculated and are provided in Table 1.

Table 1

Mean Scores from the Student Attitude Questionnaire

Question	Means
Introduction Section	
1) Clarity of graphics	4.25
2) Clarity of information	4.50
3) Quantity of information	2.88*
4) Length of instruction	3.25*
5) Interest of segment	3.75
Radioisotope Information Section	
1) Clarity of instruction screens	4.38
2) Quantity of information	3.00*
3) Manipulation of courseware (ease of use)	4.88
5) Interest of segment	1.88
Direct Check Section	
Instruction	
1) Clarity of information	4.88
2) Clarity of demonstration	4.63
3) Amount of information	2.63*
4) Length of instruction	3.50*
5) Clarity of review	4.88
6) Interest of segment	4.38

Table 1 (cont'd)

Question	Means
Direct Check Section	
Practice	
1) Clarity of instruction screens	5.00
2) Courseware manipulation (ease of use)	5.00
3) Clarity of questions	4.88
4) Easiness of questions	4.38
5) Helpfulness of feedback	4.63
6) Interest of segment	4.50
Remediation	
1) Clarity of information	5.00
2) Amount of information	3.38*
3) Length of information	3.00*
4) Helpfulness of feedback	4.50
Test	
1) Clarity of instruction screens	4.88
2) Courseware manipulation (ease of use)	5.00
3) Easiness of test questions	4.88
4) Helpfulness of feedback	4.13
5) Interest of segment	4.25

Table 1 (continued)

Question	Means
Swipe Check Section	
Instruction	
1) Clarity of information	3.63
2) Clarity of demonstration	3.63
3) Amount of information	3.00*
4) Length of instruction	3.50*
5) Clarity of review	4.88
6) Interest of segment	4.63
Practice	
1) Clarity of instruction screens	4.63
2) Courseware manipulation (ease of use)	5.00
3) Clarity of questions	3.38
4) Easiness of questions	3.88
5) Helpfulness of feedback	4.25
6) Interest of segment	4.50
Remediation	
1) Clarity of information	3.88
2) Amount of information	4.63*
3) Length of information	2.75*
4) Helpfulness of feedback	4.25
Test	
1) Clarity of instruction screens	4.63
2) Courseware manipulation (ease of use)	5.00

Table 1 (continued)

Question	Means
Swipe Check Section	
Test (cont'd)	
3) Easiness of test questions	4.13
4) Helpfulness of feedback	4.13
5) Interest of segment	4.38
Decontamination Procedures Section	
Instruction	
1) Clarity of information	4.88
2) Clarity of demonstration	4.38
3) Amount of information	3.38*
4) Length of instruction	2.88*
5) Clarity of review	4.88
6) Interest of segment	4.63
Practice	
1) Clarity of instruction screens	4.88
2) Courseware manipulation (ease of use)	5.00
3) Clarity of questions	4.88
4) Easiness of questions	4.63
5) Helpfulness of feedback	4.38
6) Interest of segment	4.50
Remediation	
1) Clarity of information	5.00

Table 1 (continued)

Question	Means
Decontamination Section	
Remediation (cont'd)	
2) Amount of information	2.88*
3) Length of information	3.25*
4) Helpfulness of feedback	4.13
Test	
1) Clarity of instruction screens	4.75
2) Courseware manipulation (ease of use)	5.00
3) Easiness of test questions	4.50
4) Helpfulness of feedback	4.75
5) Interest of segment	4.63
Body Decontamination Section	
Instruction	
1) Clarity of information	4.38
2) Clarity of demonstration	4.63
3) Amount of information	3.00*
4) Length of instruction	3.13*
5) Clarity of review	4.88
6) Interest of segment	3.75
Practice	
1) Clarity of instruction screens	4.88
2) Courseware manipulation (ease of use)	4.50

Table 1 (continued)

Question	Means
Body Decontamination Section	
Practice (cont'd)	
3) Clarity of questions	4.50
4) Easiness of questions	4.13
5) Helpfulness of feedback	4.50
6) Interest of segment	4.50
Remediation	
1) Clarity of information	4.25
2) Amount of information	2.88*
3) Length of information	2.50*
4) Helpfulness of feedback	4.38
General Attitude Section	
1) Interest learning with IVT	5.00
2) Easiness of lessons	3.88
3) Interest of technician	3.25
4) Technical quality	4.00
5) Interest in using key word check	4.50
6) Content structure (easy to follow)	4.88
7) Ease in operating the computer	5.00
8) Clarity of menu and option screens	5.00

Note: Mean scores for each question represent students

responses to a five point likert scale. Scores followed by a star(*) indicate that the ideal mean score is 3 and not 5.

The mean scores from the attitude questionnaire indicate that the overall attitude and interest concerning the criteria of each courseware section was generally positive. In particular, the responses to the general questions at the end of the questionnaire indicate that learners found it interesting to learn with the use of interactive video and had no problems operating the computer. They also found the use of the keyword word check fairly interesting and the content structure was easy to follow. As well, the menu and option screens were considered clear. The technical quality of the courseware was found to be good. However, there was only borderline interest in the technician. This may be due to the fact that many of the participants were personally acquainted with the technician. The lessons were not found to be too easy or too difficult.

The particular data pertaining to each section of the courseware has been summarized by the author. More specifically, the author used results from both the Attitude questionnaire and the comments/ recommendations in order to summarize students' attitudes towards the instructional design and format of the courseware, the technical quality, and the general interest/attitude of students in the courseware section. Accordingly, these results are now

presented.

Introduction to Radioisotopes

Instructional Design and Format:

Learner comments indicated there was a lot of information crammed into a short amount of time.

Technical Quality:

Learner comments indicated some of the graphics were not easily understandable.

General Attitude/Interest

There was only borderline interest in this section.

Isotope Information

Instructional Design and Format:

There was some content confusion concerning the technical nature of the information presented in this segment (e.g. the terms MEV's, E means, effective half lives and biological half lives) . Much of this confusion may be attributed to the learners lack of exposure to Biochemical terminology.

Technical quality

Computer text should be double spaced in order to fascilitate reading. This may be more of a technical problem since the authoring language used to program the text did not reproduce itself well on a high resolution color screen.

General Attitude/Interest

Attitudinal feedback concerning the criteria in this section

was generally positive. Attitudinal feedback concerning the relevance of this section was also positive. However, learners found the segment presentation to be boring.

Direct Check Method

Instructional Design and Format

Overall, students attitudes towards the instructional design and format of this section were positive. However, a number of issues were revealed from student comments. They include:

1) With respect to the instruction segment of this lesson, some students mentioned that the isotopes which the procedure is used to detect should be stressed. This is an important point which must be considered for revision.

2) Some students mentioned that the test segment was a little long.

Technical Quality

No criticisms.

General Attitude/Interest

Attitudinal feedback concerning the criteria in this section were generally positive. Interest in each segment of this section was positive except learners found the instruction segment to be a little long.

Swipe Check Method

Instructional Design and Format

1) With respect to the instruction segment of this section a number of issues were raised by learners. They include:

1) The issue concerning the addressing of specific isotopes which apply to the procedure was also brought up here. (See Issue 1 Direct Check Method Instruction)

2) Issues concerning the demonstration of filling scintillation vials, as well as the the removal of gloves following the dismantelling of equipment were mentioned but will not be developed here since they are content issues and have already been addressed by subject matter experts.

3) The issue concerning the commands used to operate the scintillation counter were examined and it was felt that it would not be appropriate to teach these procedures. This is due to the fact that scintillation counters and their appropriate operating procedures vary widely between makes and models.

4) In general, the presentation of the content and demonstration was a little confusing and was also considered too long. The confusion was mostly due to the large number of steps involved in the swipe check procedure. The length of the instruction could be remedied by splitting the instruction into two segments. One segment would deal with the laboratory steps and the second would deal with the scintillation counter.

2) With respect to the practice segment, the questions presented were found to be somewhat confusing and difficult.

These difficulties may be attributed to the confusion created in the instruction segment, as well as not having addressed one step with one question. A number of the questions involved asking the learners for the next two steps of the procedure. This approach seems to have created some confusion. Another problem involves the amount of incidental information which was retained from instruction. This incidental learning caused much of the confusion in attempting to identify the first step of the procedure.

3) With respect to the remediation segment, it was felt that there was too much information and that this information was not very clear. One possible means of correcting this would be to present the remedial information in a briefer point form version.

Technical Quality

No criticisms

General Attitude/Interest

Attitudinal feedback concerning the criteria in this section were all positive. The instruction segment, the practice segment, and the test segment were found to be fairly interesting. The remediation segment was considered to be helpful.

Decontamination Procedures

Instructional Design and Format:

1) With respect to the instruction segment of this lesson, a number of content issues were revealed from learner

comments. These issues concern marking 30 cm larger than a spill, the demonstration of marking procedures, as well as the demonstration of cleaning an area from the outside towards the inside of a spill in the review section. These issues will not be discussed here since they are content issues and have already been addressed by subject matter experts.

2) Learners comments revealed that in the practice segment, there was some confusion in answering question four. This was primarily due to inconsistent structure of the practice question.

3) Learner comments also indicated a problem with the test segment of this lesson. The voice-over used in this segment failed to mention that a contaminated area should be marked 30 cm larger than the spill. This issue will not be developed here since they are content issues and have already been addressed by subject matter experts.

Technical Quality

No criticism

General Attitude/Interest

Attitudinal feedback concerning the criteria in this section was generally positive.

Body Decontamination Procedure

Instructional Design and Format:

1) Learners comments revealed a number of content problems in the instruction segment. Issues concerning how to carry

out decontamination with contaminated hands, as well as the correct removal of contaminated clothing and gloves were raised. These issues will not be developed here since they are content issues and have already been addressed by subject matter experts.

2) In the practice segment of this lesson, the appropriateness of the practice questions was raised by some learners. This was primarily due to inconsistent structure of some of the questions.

3) The remediation segment was thought to be somewhat long. One possible means of correcting this would be to present the remedial information in a briefer point form version.

Technical Quality:

No criticisms

General Attitude/ Interest

Attitudinal feedback concerning the criteria in the instruction segment was generally positive except learners did not find the segment interesting. Attitudinal feedback concerning the criteria in the practice section were all positive. The remediation segment was considered helpful,

C. COURSEWARE MANUAL EVALUATION RESULTS

A number of recommendations for changes were suggested by both learners and experts. The revised version of the Instructors Manual can be found in Appendix I and the revised version of the Student Manual can be found in Appendix J.

The changes which were suggested by learners for the Learner Manual include:

1) On page 3 in the introduction section, the word caused should be changed to originate.

2) On page 3, the words high and low energy should be changed to high and low level.

3) On page 6, the word "enter" should be changed to the word "type".

4) On page 7, the viewing matrix was confusing to some learners. One suggestion was to have students input into the courseware the isotope of interest and have the courseware recommend the segments which should be viewed.

5) On page 7, it was also recomended that letters representing not required (NR), required (R), and optional (O) be used to identify the important sections.

6) On page 7, it was suggested that the example describing how to use the matrix be located directly below it.

The changes which were suggested for the Instructor's Manual include:

1) On page 6, it was found that the cybernetic model illustrating the structure of the courseware was somewhat confusing and should be replaced by a simpler flow-chart.

2) On page 9, it was recomended that letters representing not required (NR), required (R), and optional (O) be used to identify the important sections.

3) On page 9, it was suggested that the example describing how to use the matrix be located directly below it.

D. DESIGN EXPERT REVIEW

The process of using design experts to evaluate the courseware was very interesting since the type of information collected from the two participants were quite different. The instructional design expert examined the courseware in a traditional fashion. Taking into consideration student and subject matter expert data, she examined the courseware in terms of objectives, sequence, strategy and evaluation schemes.

The interactive video designer on the other hand evaluated the courseware from the perspective of "How would I have designed this material". Although the type of information varied due to the two differing perspectives, they did serve to complement each other.

The data which was obtained through the design expert review can be found in Appendix M. Since no formal questionnaires were given to these experts, data includes the comments and recommendations of the design experts.

Since this evaluation method was used to obtain feedback on the instructional format and design of the courseware as

well as its technical quality, all the data collected from these experts has been summarized accordingly for each section of the courseware.

Introduction to Radioisotopes:

Instructional Format and Design

1) The narration used in the segment was not appropriately sequenced to the visuals; one did not necessarily support the other.

2) Some of the graphic visuals were very complicated and cluttered; they were somewhat difficult to understand.

Technical Quality

No comment

Isotope Information:

Instructional Format and Design

Some difficulty was experienced in attempting to explain to the designers that this section was not meant to be instructional, rather it was purely informational. Whatever the case, they recommended that the information in this segment should not be presented in point form. It should be presented in a practical way using full sentences and practical english.

Technical Quality

No comment

Instructional Sections

Note that the following results pertain to each of the couseware sections which are instructional . This includes the lessons on the Direct Check, Swipe Check, Decontamination, and Body Decontamination Procedures .

Instructional Format and Design

1) With respect to the instruction segment of each lesson:

   1) The narration and introduction visuals were not adequately sequenced.

   2) It was suggested by one expert that the principles of the procedures be discussed in the introduction segment.

   3) The instructional segments were too long. This could be remedied by breaking the instruction into two or three separate segments.

   4) One expert suggested that the content being presented during instruction should be reinforced with cartoons or graphics.

2) With respect to the practice segments of each lesson, a controversial design issue involved whether or not to directly remediate responses to practice questions. One design expert recommended that each incorrect response should be immediatley remediated. He felt that without this strategy learners ran the risk of not remembering which steps were incorrectly answered. A further suggestion involved the further development of the help option to be used to assist in the answering of practice questions.

3) As for the remediation segments, it was suggested that

the remediation segment be presented in point form.

4) For the test segments, the important issue raised involved the risk of learners retaining the improperly conducted steps which are demonstrated.

Technical Quality

There was some criticism of the technician who was used to present the content in the instruction segments. It was suggested that a real actor be used and that the script be read from a telepromptor.

PART 5 - COURSEWARE REVISIONS AND DISCUSSION

The revisions suggested in this chapter includes a list of recommended changes which should be made to the courseware in order to improve its instructional effectiveness. All of the recommended changes were generated from the formative evaluation which was conducted on the prototype.

The revisions will be discussed under two seperate headings: 1) content revisions and 2) presentation revisions. Content revisions include changes which effect the content of the courseware. Presentation revisions include changes which effect the presentation of the content and instruction (e.g. the instructional design, format, and technical quality of the courseware) .

A. CONTENT REVISIONS

Introduction to Radioisotopes.

Slides six and seven of the introduction segment must be changed in order to correctly illustrate the different radiation potential of radioisotopes as well as to simplify the visual representation of the ionizing process.

Isotope Information

Content Experts suggested that the radiation source formula which is presented in the segment should be deleted. In its place, the formula used to calculate the effective half life of a radioisotope should be included and explained.

Direct Check Method

The Instruction Segment

1) This segment should be videotaped inside of a fumehood and not in a typical laboratory setting.

2) Stress that rubber gloves must always be worn in laboratories.

3) Clarify that the guiger muller probe has two sets of controls and not components.

4) Clearly explain the process of setting the guiger muller probe to "times one" in order to detect the presence of radioisotopes.

5) Indicate that a contaminated area should be decontaminated until radiation counts are below permissible levels and not until radiation counts are at permissible levels.

6) Clarify that when the guiger muller probe is being used to detect the presence of radiation that audio counts and not scale counts are to be used as the measure.

The Practice Segment

The three step method used to explain how to correctly pass the probe over a contaminated area should be reduced to two steps. Step 2 which states to hold the probe 3mm from a contaminated surface and step 3 which states not to let the probe make contact with a contaminated surface both accomplish the same ends. They can therefore be reduced to one step.

The Remediation Segment

1) The process of setting the guiger muller probe at times one should be clearly emphasized.

2) The process of passing the probe slowly over a contaminated area should be mentioned during remediation.

The Test Segment

No content revisions in this segment

Swipe Check Method

The Instruction Segment

1) The dismantling of the experimental equipment should not be included in this segment.However, mention that gloves should be changed after dismantling.

2) During the demonstration of the swiping technique, the swiping process should be limited to an area of approximately 200 to 400cm^2.The technician should stress the zig-zag motion when swiping and he should not swipe too long.

3) Filling the scintillation vial with scintillation fluid should be demonstrated in the segment.

4) The process and reasons for individually marking vials should be clarified.

The Practice Segment

The process of marking the vials must be mentioned during the practice segment..

The Remediation Segment

No content revision required in this segment.

The Test Segment

No content revisions required in this segment

Decontamination Procedures

The Instruction Segment

1) In the present demonstration the technician flips the paper towel over while he is decontaminating the work bench. During decontamination, paper towels should never be flipped over, they should be replaced with another dry towel.

2) Decontaminating a contaminated area by applying the cleaning solution directly to the workbench (rather than spreading on a towel) should also be demonstrated.

3) The process of marking a contaminated area 30cm larger than the spill should be further explained and demonstrated in the segment.

4) It should be stressed that paper towels used during decontamination should be placed "gently" into waste containers.

The Practice Segment

No content revisions for this segment

The Review Segment

The process of cleaning a contaminated area from the outside parameter in towards the inside should be clearly demonstrated.

The Test Segment

The process of marking a contaminated area 30cm larger than the spill should be included in the segments.

Body Decontamination Procedures

The Instruction Segment

1) The five step procedure used to remove contaminated gloves should be explained and demonstrated in the segment.

2) It should be emphasized that once an individuals hand has become contaminated, all manipulation of tools and equipment must be carried out using the uncontaminated hand.

3) It should be stressed that decontaminated body surfaces are not to be swipe checked, rather they are to be thoroughly washed two or three times to ensure decontamination.

4) It should be stressed that any case of body contamination must be reported to a radiation safety officer.

5) It should be stressed that paper towels used during decontamination should be placed gently into a waste container rather than thrown.

The Practice Segment

No content revisions for this segment

The Remediation Segment

No content revisions for this segment

The Test Segment

No content revisions for this segment

B. PRESENTATION REVISIONS

Courseware Start-Up

Revisions

A sub-routine should be programmed within the software. This would 1) allow learners to choose their isotope of interest from a menu and 2) generate textually the sections of the courseware which should be viewed.

Discussion

This strategy would eliminate the need for the viewing matrix located in the student manual which seems to have created some confusion for a few learners.

Introduction to Radioisotopes.

Revisions

1) Simplify both the visual and narrative information presented in the segment. For example, graphics could be simplified by changing abbreviated terms to full words (i.e. neutron, proton, nucleus) which would facilitate their comprehension.

2) Narrative information should also be designed in such a way as to support and reinforce each graphic. Special attention should be given to the sequencing of narrative information for each individual visual.

Discussion

There was concensus between all three evaluation groups that this introduction segment was generally unclear. Accordingly, the above revisions have been recommended.

Isotope Information

Revisions

1) An updatable database should be included within the courseware.

2) Some practical revisions were suggested by the design experts. They include:

1) double spacing all the text to facilitate reading

2) presenting the information in practical english and using full sentences instead of the point form as is presently the case.

Discussion

While content experts enjoyed the overall rationale of the segment, the first revision (i.e. having an updatable data base within the courseware) was suggested to allow the parameters of the courseware to be easily expanded.

Content experts also expressed slight reservations concerning the amount of information presented in this section and design experts expressed concern about its presentation. Accordingly, the second revision has been recommended. Note that learners expressed no problem with the amount of information but a few learners expressed some

confusion concerning the clarity of the content. However, much of this may be attributed to their lack of exposure to biochemical terminology.

A number of attitudes expressed by the learners suggest that further improvements for this section could be helped by a further examination of theoretical issues. For example, a significant learner attitude was that the segment was found to be somewhat boring. Aside from practical recommendations for formatting the information (such as those made by design experts), it is difficult to suggest ways of improving the segment so that it is stimulating and less boring without further research. This would involve researching a hypothesis concerning the formulation of guidelines for effectively integrating text within interactive video courseware.

A telling comment mentioned by one of the learners stated her dissapointment that the segment did not have any voiceover narration which therefore forced her to read. It may be useful, therefore, to also examine the types of expectations possessed by individuals using interactive video courseware and the effects that long segments of purely text based information may have on these attitudes.

The Instructional Sections/ Lessons

The revisions and discussions which follow apply to all four

instructional sections. This includes the Direct Check, Swipe Check, Decontamination, and Body Decontamination sections.

1) The Introduction of each Section

Revisions

Design this segment as more of an advanced organizer rather than simply as an informational introduction. This could be easily accomplished by outlining in more detail the content which will be discussed and by presenting this through tightly sequenced narration and video segments. If desired, the content could be further emphasized by overlaying textual information.

Discussion

This revision was prompted by another suggestion put forward by the design experts. Their suggestion involved the possibility of discussing the principles of the particular procedure during the introduction of each instructional segment. Although this is a valid recommendation, the evaluation had revealed that the learners successfully achieved the coursewares objectives without this type of attention. Since this is the case, there may not be any justifiable reason to discuss a procedures principles if learners are already correctly retaining the procedural steps. This issue may be further clarified by examining long term recall of the content by the learners which may determine the need to include the instruction of principles

within the courseware.

A better alternative would be to simply tighten up the introduction segment. This could be accomplished by carrying out the recommended revision.

2) The Instruction Segment

Revisions

1) Use voice-over narration instead of using the actor to narrate.

2) Name the isotopes which are detected by a specific procedure during the instruction and demonstration. Implement this revision with caution (see discussion for details)

Discussion

Revisions to the instruction segments were suggested by both students and design experts. The largest complaint involved the length of the segments as well as the amount of incidental information which was presented. Both of these concerns would be effectively resolved through the implementation of the first revision.

A further revision was suggested by the students and involved naming the isotopes which are detected by a specific procedure during the instruction and demonstration. Although this is a legitimate request, the recommendation should be followed up with caution. If, after viewing the revised courseware, it is decided to distribute the finished product outside of the university, then identifying isotopes

within the courseware is not recommended since the kinds and numbers vary extensively. However, if the finished courseware will definitely be used exclusively by Concordia University then mentioning the isotopes which are used within the university is possible and the implementation of revision two is recommended.

3) The Review of Instruction

Revision

Eliminate the five second pause between the instruction segment and the review segment.

Discussion

It was recommended by the learners that there should not be any pause between the instruction segment and the review segment. A conscious decision had been made to leave a five second pause between the two segments. This had been done in order to determine whether learners would prefer a small amount of time to ponder the content which had been presented in the instruction. In the end learners reacted to this pause with impatience and preferred that the review be immediately presented.

4) Practice Segments

Revisions:

1) Each practice question should focus on one procedural step at a time

2) Include cues immediately following an incorrect response

or a remedial option which identifies incorrect responses. 3) If the necessary resources become available, the help option could be designed to offer assistance in answering practice questions.

Discussion

The first revision was suggested by both learners and subject matter experts and is the most important revision for this segment. It was prompted by the unnecesary confusion that was created by the process of asking learners to identify two or three procedural steps through one question.

The second revision was prompted by the concern that improperly answered responses would not be remembered by the time the practice segment was completed. As it stands, practice responses are remediated with model answers and a summary remediation which explains how many incorrect responses were given.

Although the segment was designed to encourage learners to verbalize the procedural steps, there is validity in the recommendation that improperly answered practice questions be identified further than through model answers and remedial summary. The suggestion was made that cues be given immediately following an incorrect response.

However, since it is felt that the model answers already

accomplish this end, another option is also suggested. This option involves the implementation of a textual overview which could be presented along with the remedial summary. The overview would textually present each step of the procedure. The steps which were incorrectly answered could then be outlined in a different color. This strategy would not only identify incorrect responses but would also serve as a further source of content review.

One design expert also suggested that the help option included in the courseware be designed to offer assistance in answering practice questions and that it not simply be used as a means of stopping or exiting the program. From an instructional perspective this revision is quite valid. However, in practical terms the redesign and reprogramming of this option may not be possible with the limited budget which has been allocated to the project. If the monies and energies do somehow become available, the implementation of this option would only help further the effectiveness of the courseware.

5) Remediation Segments

Revisions

The procedural steps should be presented in brief point form utilizing voiceover narration. Special attention should be given to emphasizing each procedural step equally.

Discussion

All three evaluation groups suggested that the remediation segments were too long. It is therefore suggested that the procedural steps be presented in brief point form utilizing voiceover narration. This could be done along the same lines as the review segments.

The recommendation that special attention be paid to emphasizing each procedural step equally was suggested by the subject matter experts. This problem was evident in the prototype and is largely due to inconsistencies encountered when the content was presented by the technician and when the content was presented through narration. This problem should be easily avoided if voiceover narration is used throughout the courseware.

6) Test Segments

Revisions

1) The segment should allow the learners to stop the test segment and access the response page as soon as the incorrect step is recognized. This could be easily accomplished by providing a key to be pressed once the incorrect step is recognized

Discussion

Learners strongly recommended that the testing segments be shortened. This problem could be remedied in either of two ways. The first option involves re-editing the segment using quicker cuts and shorter video shots to demonstrate the

steps. The problem with this option is that if the video segments are reduced in length, there is a risk that the learners will retain incomplete or a shorter version of the procedures.

A better solution would be to implement the first revision given above. This option would allow learners to decide whether they wish to view the entire test segment or whether to work through it at a slightly quicker pace.

7) All Segments

Revisions

Voice-over narration, with special attention devoted to closely sequencing the content with the visual images should be used throughout the courseware.

Discussion

This revision will offer more control over the length of the segments as well as to the continuity of the content. Voiceover narration should also significantly reduce the amount of incidental information presented in the courseware which created some difficulties for a number of learners. Since the overall budget of the courseware did not allow for the use of an experienced actor, script writter or teleprompter during production, the use of voice-over narration would also help to correct the criticism which related to the use of a technician as a talent.

Although the preparation and application of formative evaluation on interactive video can be quite time consuming. There is no doubt that these strategies yield an enormous amount of valuable information. Within the context of interactive video productions, there are so many facets of the courseware to be considered (especially for first time producers) that formative evaluation should be conducted if at all possible.

C. CLOSING REMARKS

Even though the production and evaluation of the radioisotope courseware took over two and a half years to complete. The prototype has served as a foundation upon which numerous individuals and projects have benefited.

Throughout the projects development, a number of graduate students have received valuable feedback and experience concerning the production of interactive video courseware. The application of formative evaluation has also introduced many individuals to the implementation of these strategies within the context of a working courseware.

Since the completion of this evaluation, suggested revisions have been incorporated within the second version of the courseware which was pressed to a videodisc. Initial results

of the videodisc evaluation have been so successful that the Chemistry department plans to implement the courseware within their curriculum as of september 1988.

The revised courseware is also presently being used to conduct research on the effects of varying review strategies on learning. The results of this research is expected to be published later this year. Both versions of the courseware have also been presented at numerous conferences and to date two articles pertaining to the courseware have been published in educational journals.

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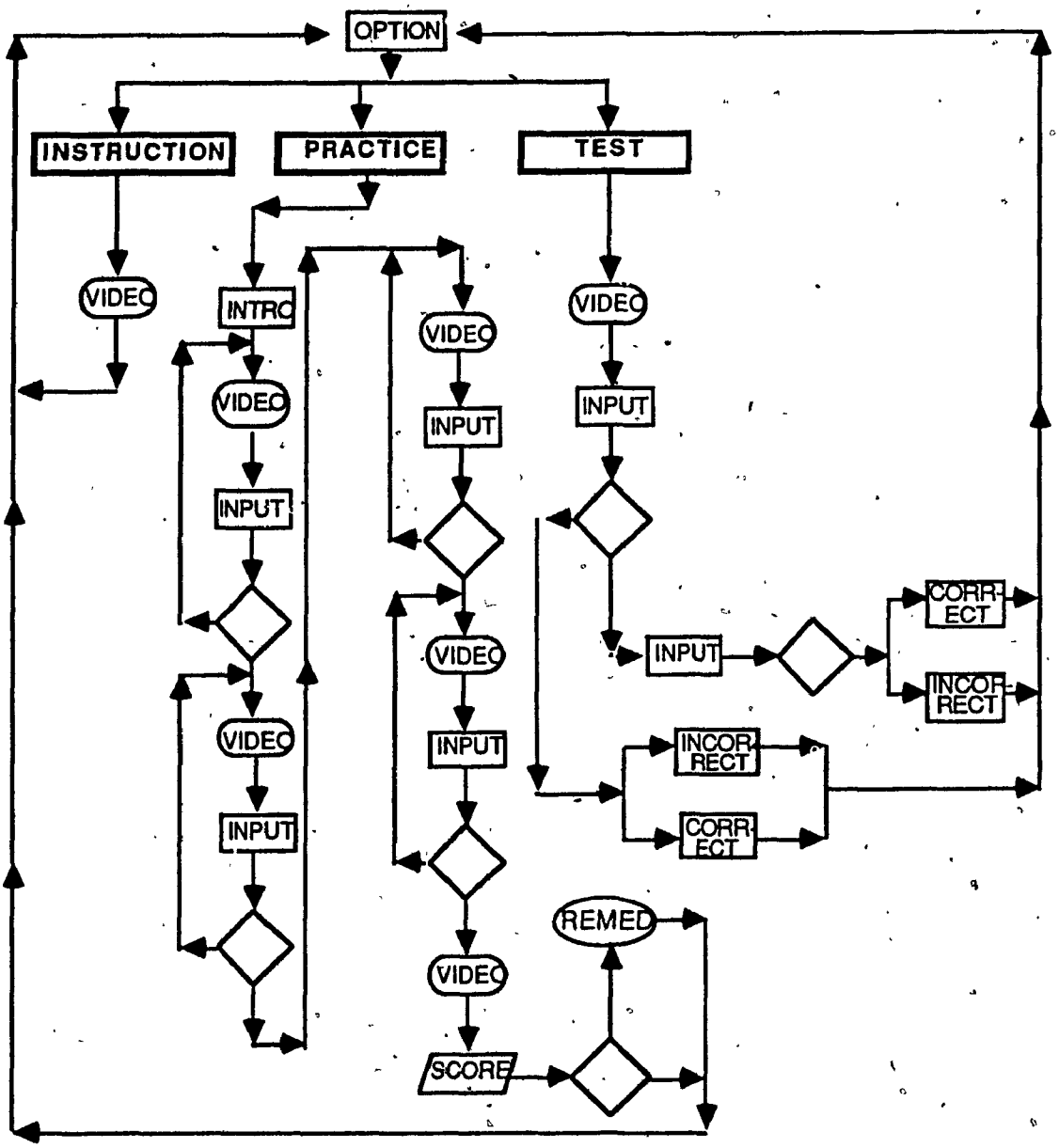
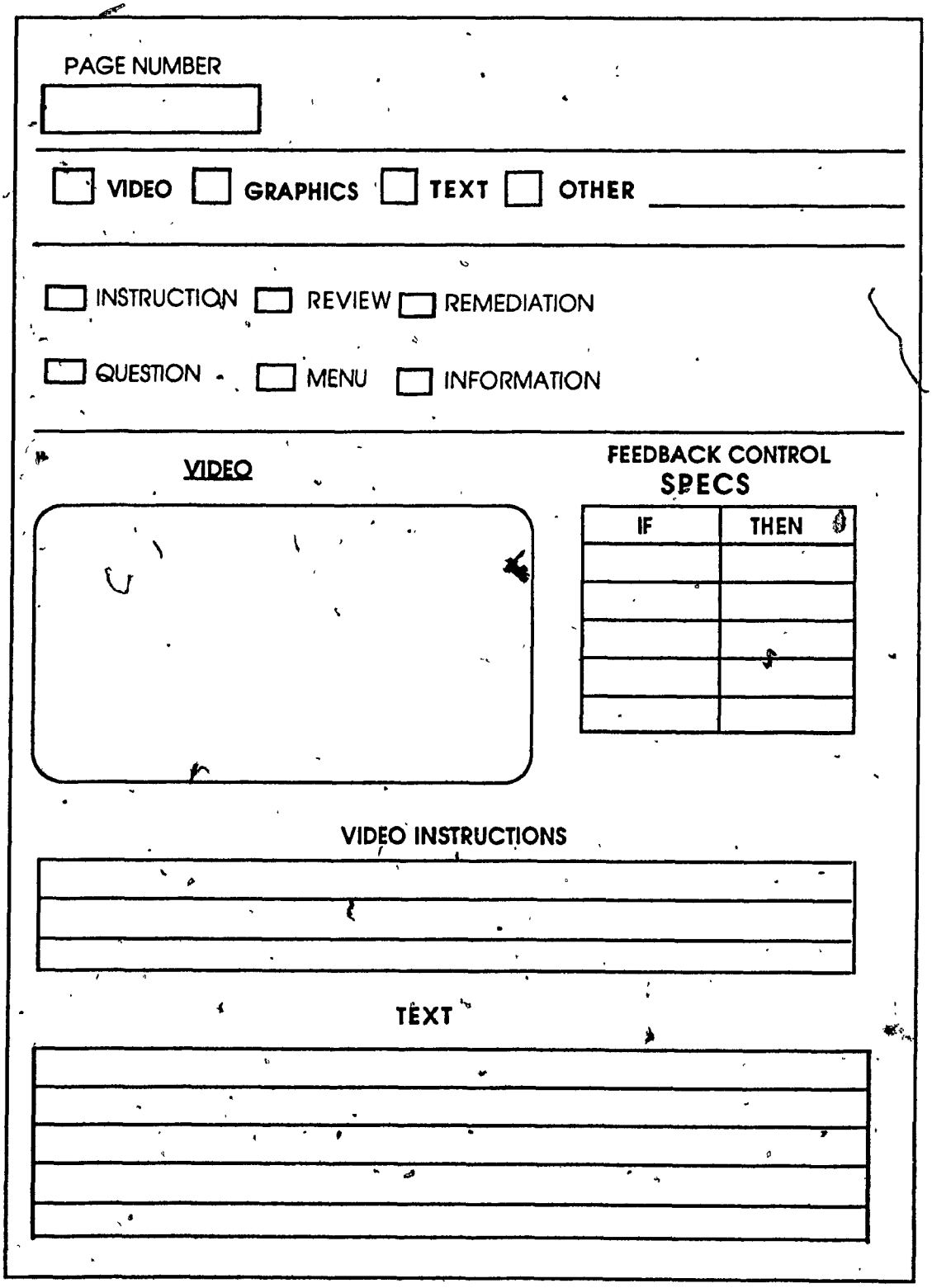
Appendix A
Courseware Flowchart


OPTION
INSTRUCTION
PRACTICE
TEST
VIDEO
INTRO
VIDEO
INPUT
VIDEO
INPUT
VIDEO
INPUT
VIDEO
INPUT
VIDEO
INPUT
INPUT
CORR-ECT
INCOR-RECT
INCOR-RECT
CORR-ECT
REMED
SCORE

Appendix B
Storyboard Model


PAGE NUMBER
VIDEO
GRAPHICS
TEXT
OTHER
INSTRUCTION
REVIEW
REMEDIATION
QUESTION
MENU
INFORMATION
VIDEO
FEEDBACK CONTROL SPECS
IF
THEN
VIDEO INSTRUCTIONS
TEXT

Appendix C
Subject Matter Expert Questionnaire

EVALUATOR'S NAME: .....

INSTRUCTIONS: Circle the abbreviation (rating) to indicate the extent to which criteria are met. Write any suggestions you may have which would improve the courseware	RATING SA - Strongly Agree A - Agree U - Undecided D - Disagree SD - Strongly Disagree
INTRODUCTION TO COURSEWARE	
1. THE CONTENT OF THE NARRATION IS FACTUALLY CORRECT.	SA A U D SD
2. THE VISUALS USED ARE FACTUALLY CORRECT.	SA A U D SD
3. THE VOCABULARY USED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
4. THE AMOUNT OF INFORMATION PRESENTED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
5. THE CONTENT IN THIS SECTION IS CLEARLY PRESENTED.	SA A U D SD
SUGGESTIONS FOR IMPROVEMENT:	
ISOTOPE INFORMATION	
1. THE CONTENT PRESENTED IS FACTUALLY CORRECT.	SA A U D SD
2. THE VOCABULARY USED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
3. THE AMOUNT OF INFORMATION PRESENTED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
4. THE CONTENT IN THIS SECTION IS CLEARLY PRESENTED.	SA A U D SD
SUGGESTIONS FOR IMPROVEMENT:	

EVALUATOR'S NAME: .....
SECTION EVALUATED .....

INSTRUCTIONS: Circle the abbreviation (rating) to indicate the extent to which criteria are met. Write any suggestions you may have which would improve the courseware	RATING SA - Strongly Agree A - Agree U - Undecided D - Disagree SD - Strongly Disagree
INSTRUCTION	
1. THE CONTENT PRESENTED IS FACTUALLY CORRECT.	SA A U D SD
2. THE PROCEDURES PRESENTED ARE FREE FROM ERROR.	SA A U D SD
3. THE VOCABULARY USED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
4. THE AMOUNT OF INFORMATION PRESENTED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
5. THE CONTENT IN THIS SECTION IS CLEARLY PRESENTED.	SA A U D SD
SUGGESTIONS FOR IMPROVEMENT:	
PRACTICE	
1. THE CONTENT PRESENTED IS FACTUALLY CORRECT.	SA A U D SD
2. THE PROCEDURES PRESENTED ARE FREE FROM ERROR.	SA A U D SD
3. THE VOCABULARY USED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
4. THE LEVEL OF DIFFICULTY OF THE QUESTIONS IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
5. THE QUESTIONS PRESENTED ARE ANSWERABLE ON THE BASIS OF THE INSTRUCTION GIVEN.	SA A U D SD
6. THE QUESTIONS PRESENTED FOCUSES THE LEARNERS ATTENTION TO IMPORTANT CONTENT.	SA A U D SD
SUGGESTIONS FOR IMPROVEMENT:	

EVALUATOR'S NAME: .....
SECTION EVALUATED .....

INSTRUCTIONS: Circle the abbreviation (rating) to indicate the extent to which criteria are met. Write any suggestions you may have which would improve the courseware	RATING SA - Strongly Agree A - Agree U - Undecided D - Disagree SD - Strongly Disagree
REMEDIATION	
1. THE CONTENT PRESENTED IS FACTUALLY CORRECT.	SA A U D SD
2. THE PROCEDURES PRESENTED ARE FREE FROM ERROR.	SA A U D SD
3. THE VOCABULARY USED IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
4. THE AMOUNT OF INFORMATION PRESENTED IS REASONABLE FOR THE TARGET AUDIENCE.	SA A U D SD
5. THE CONTENT IN THIS SECTION IS CLEARLY PRESENTED.	SA A U D SD
SUGGESTIONS FOR IMPROVEMENT:	
TEST	
1. IMPROPERLY CONDUCTED PROCEDURES ARE CLEARLY RECOGNIZABLE.	SA A U D SD
2. THE CONTENT PRESENTED AS FEEDBACK IS FACTUALLY CORRECT.	SA A U D SD
3. THE LEVEL OF DIFFICULTY OF THE TESTING EXERCISE IS APPROPRIATE FOR THE TARGET AUDIENCE.	SA A U D SD
4. THE QUESTIONS PRESENTED ARE ANSWERABLE ON THE BASIS OF THE INSTRUCTION GIVEN.	SA A U D SD
5. IMPROPERLY CONDUCTED PROCEDURES FOCUSES THE LEARNERS ATTENTION ON MISTAKES	
COMMONLY MADE DURING THE APPLICATION OF THE	SA A U D SD
SUGGESTIONS FOR IMPROVEMENT:	

Appendix D
Interview Forms

OBSERVATIONS

Introduction to Radioisotopes

Isotope Information

Direct Check (instruction)

Direct Check (practice)

Direct Check (test)

General

Appendix E
Subject Matter Expert Criteria

FACTUAL CORRECTNESS OF THE CONTENT

Criteria applies to the factual correctness of the information presented in the segment.

FACTUAL CORRECTNESS OF THE PROCEDURES

Criteria applies to the factual correctness of the procedures which are demonstrated in the segment.

FACTUAL CORRECTNESS OF THE VISUALS

Criteria applies to the factual correctness of the graphic representations which are presented in the segment.

APPROPRIATENESS OF THE VOCABULARY

Criteria applies to the appropriateness of the vocabulary used in relation to the audience for whom the courseware was designed.

QUANTITY OF INFORMATION

Criteria applies to the amount of information presented in relation to the ability of the audience for whom the courseware was designed.

CLARITY OF THE CONTENT

Criteria applies to the clarity or the ease experienced in understanding the information presented in the segment.

DIFFICULTY LEVEL OF THE QUESTIONS

Criteria applies to the level of difficulty of the questions presented in the segment.

ANSWERABILITY OF THE QUESTIONS

Criteria applies to whether questions which are presented in the courseware are answerable on the basis of the instruction given.

RECOGNIZABILITY OF INCORRECT PROCEDURES

Criteria applies to whether improperly conducted steps in the testing segment are clearly recognizable.

FOCUS OF ATTENTION

Criteria applies to whether improperly conducted steps in the testing segments focus a learners attention to mistakes which are commonly made during the application of the procedure.

CORRECTNESS OF FEEDBACK

Criteria applies to the factual correctness of the feedback screens presented in the testing segments

Appendix F
Procedural Checklist

DIRECT CHECK METHOD
PROCEDURAL CHECKLIST

1) In order to detect the presence of High Level Radioisotopes, what is the name of the Contamination Assesment Procedure which should be applied ?

Answer: _____

2) Can you pick out the equipment which would be necessary to carry out this procedure ?

2.A) Guiger Probe ___

2.B) Chalk ___

3) Can you demonstrate the steps of the procedure ?

		Correct	Incorrect
3.1)	The Guiger Muller probe is turned on.	--------	--------
3.2)	The sensitivity level is set at times one.	--------	--------
3.3)	The probe is passed over an area where there is no contamination to obtain a background radiation count.	--------	--------
	To obtain a reliable reading the probe should be:		
3.4)	Passed slowly over the area being monitored.	--------	--------

		Correct	Incorrect
3.5)	The probe should be kept approx 3cm or 1/8 from the area being monitored.	--------	--------
3.6)	The probe should not make contact with the surface.	--------	--------
3.7)	The probe is passed over an area where there is suspected contamination.	--------	--------
3.8)	If area counts are higher then background levels:	--------	--------
3.9)	The contaminated area is marked with a chalk.	--------	--------
3.10)	Decontamination procedures are applied.	--------	--------
3.11)	The area is then rechecked with the Direct Check method &	--------	--------
3.12)	The Swipe Check Method.	--------	--------

SWIPE CHECK METHOD
PROCEDURAL CHECKLIST

1) In order to detect the presence of High Level Radioisotopes, what is the name of the Contamination Assesment Procedure which should be applied ?

Answer: _____

2) Can you pick out the equipment which would be necessary to carry out this procedure ?

2.A) Filter Paper ___

2.B) Ethanol ___

2.C) Thongs ___

2.D) Scintillation Vial ___

2.E) Scintillation Fluid ___

2.F) Vial ___

2.G) Marker ___

2.H) Rack ___

2.I) Scintillation Counter ___

2.J) RSP Manual ___

2.K) Record Book ___

3) Can you demonstrate the steps of the procedure ?

	Correct	Incorrect
3.1) Filter paper is gripped with thongs.	--------	--------
3.2) The filter paper is wet with a solution of ethanol.	--------	--------

		Correct	Incorrect
3.3)	An area of approximately 200 - 400 cm^2 is swiped.	-------	-------
3.4)	The filter paper is placed in a scintillation vial.	-------	-------
3.5)	Scintillation fluid is placed in the vial.	-------	-------
3.6)	The vial is marked.	-------	-------
3.7)	The vial is placed in a rack.	-------	-------
3.8)	The rack is placed in a scintillation counter.	-------	-------
3.9)	Area counts are measured.	-------	-------
3.10)	Obtained results are recorded in a record book.	-------	-------
3.11)	Obtained results are compared to permissible levels.	-------	-------
3.12)	If obtained results are higher than permissible levels, then decontamination procedures are applied.	-------	-------
3.13)	Following decontamination, the area is then rechecked with the Swipe Check Method.	-------	-------

DECONTAMINATION PROCEDURES
PROCEDURAL CHECKLIST

1) If contamination is detected following the application of contamination assesment, which procedures should then be applied ?

Answer: _____

2) Can you pick out the equipment which would be necessary to carry out this procedure ?

2.A) Paper Towels ___ 2.C) Cleaning Solution ___

2.B) Chalk ___ 2.D) Dry Waste Cont ___

3) Can you demonstrate the steps of the procedure ?

		Correct	Incorrect
3.1)	When contamination is detected, an area six inches larger then the contaminated area is marked with a chalk.	--------	--------
3.2)	A paper towel is wet with a cleaning solution.	--------	--------
3.3)	The contaminated area is then wiped from the outside parameters in towards the inside.	--------	--------
3.4)	The paper towel is disposed as dry waste.	--------	--------

		Correct	Incorrect
3.5)	The area is rechecked with the Swipe Check method.	--------	--------
3.6)	If contamination is again found decontamination procedures are reapplied.	--------	--------

BODY DECONTAMINATION PROCEDURES
PROCEDURAL CHECKLIST

1) If during an experiment you should accidentally spill radioisotopes on yourself which procedure should you then apply ?

Answer: _____

2) Can you pick out the equipment which would be necessary to carry out this procedure. ?

2.A) Paper Towels ___ 2.C) Mild Soap ___

2.B)Water ___ 2.D) Dry Waste Cont ___

3) What should you do if isotopes are spilled on your laboratory coat or street clothes ?

		Correct	Incorrect
3.1)	If isotopes are spilled on laboratory coats or street clothes, they must be immediately removed.	--------	--------
3.2)	Contaminated clothing are disposed as dry waste.	--------	--------

(What should you do if isotopes are spilled on skin surfaces?)
If isotopes are spilled onto skin surfaces they should be decontaminated by:

3.3)	Wetting with water.	--------	--------
3.4)	Generously washing with a mild non-abrasive soap.	--------	--------

		Correct	Incorrect
3.5)	Rinsing well with water.	--------	--------
3.6)	Drying with paper towels.	--------	--------
3.7)	Discard paper towels as dry waste.	--------	--------
3.8)	Recheck skin surfaces with the Swipe Check Method.	--------	--------
3.9)	If contamination is still detected, reapply body decontamination procedures.	--------	--------

Appendix G
Student Attitude Questionnaire

STUDENT FEEDBACK QUESTIONAIRE

Name: _____

Age: _____

Sex: _____

Educational Status:

Undergraduate Student ____ Which Year ____

Graduate Student ____ Which Year ____

The Questionaire is to be filled out by circling the number which best indicates your response to the question. If you have any comments pertaining to the courseware, please feel free to report them to the observer.

STUDENT QUESTIONAIRE

INTRODUCTION TO RADIOISOTOPES

1) The information presented in this segment was

Clear 1 2 3 4 5 Confusing

2) The graphics presented in this segment were

Confusing 1 2 3 4 5 Clear

3) The amount of information presented was

Too Little 1 2 3 4 5 Too Much

4) The length of the segment was

Too Long 1 2 3 4 5 Too Short

5) The content presented was

Interesting 1 2 3 4 5 Boring

ISOTOPE INFORMATION

1) The information screen explaining how to work through this section was

Difficult to Understand 1 2 3 4 5 Easy to Understand

2) The amount of information presented was

Too Little 1 2 3 4 5 Too Much

3) The keys used to access the information (menu's, forward, backward) were

Easy to Use 1 2 3 4 5 Difficult to Use

4) The content presented was

Very Useful 1 2 3 4 5 Not Useful

INSTRUCTION

1) The information presented in this segment was

Confusing 1 2 3 4 5 Clear

2) The demonstration presented in this segment was

Clear 1 2 3 4 5 Confusing

3) The amount of information presented in this segment was

Too Much 1 2 3 4 5 Too Little

4) The length of this segment was

Too Short 1 2 3 4 5 Too Long

5) The review segment was

Confusing 1 2 3 4 5 Clear

6) The content presented was

Interesting 1 2 3 4 5 Boring

PRACTICE

1) The information screen explaining how to work through this section was

Easy to Understand 1 2 3 4 5 Difficult to Understand

2) The keys used to operate the system (Spacebar & Return) were

Difficult To Use 1 2 3 4 5 Easy To Use

3) The questions presented were

Confusing 1 2 3 4 5 Clear

4) The questions presented were

Easy 1 2 3 4 5 Difficult

5) The feedback presented was

Not Helpful 1 2 3 4 5 Very Helpful

6) Participating in this section was

Boring 1 2 3 4 5 Interesting

REMEDIATION

1) The information presented in this segment was

Confusing 1 2 3 4 5 Clear

2) The amount of information presented was

Too Little 1 2 3 4 5 Too Much

3) The lenght of the segment was

Too Long 1 2 3 4 5 Too Short

4) As a review of the procedures, this segment was

Very Helpful 1 2 3 4 5 Not Helpful

TEST

1) The information screen explaining how to work through this section was

Easy to Understand 1 2 3 4 5 Difficult to Understand

2) The keys used to operate the system (Spacebar & Return) were

Difficult To Use 1 2 3 4 5 Easy To Use

3) Deciding upon which step was incorrectly carried out was

Difficult 1 2 3 4 5 Easy

4) The feedback presented when an answer was incorrect was

Not Helpful 1 2 3 4 5 Very Helpful

5) Participating in this exercise was

Boring 1 2 3 4 5 Interesting

GENERAL

1) Learning about radioisotopes with the use of an Interactive Videotape System was

Interesting 1 2 3 4 5 Boring

2) Overall, the lessons presented in this courseware were

Easy 1 2 3 4 5 Difficult

3) The technician who explained and demonstrated the procedure was

Boring 1 2 3 4 5 Interesting

4) The technical quality of the video images were

Very Good 1 2 3 4 5 Very Poor

5) Answering questions using your own vocabulary was

Interesting 1 2 3 4 5 Boring

6) The way the information was structured (six lessons divided into Instruction, Practice and Test) was

Easy to Follow 1 2 3 4 5 Difficult to Follow

7) Operating the computer was

Difficult 1 2 3 4 5 Easy

8) The menu and option screens presented in this program were

Confusing 1 2 3 4 5 Clear

Appendix H
Student Criteria

CLARITY OF GRAPHICS

Criteria applies to the clarity or the ability of the student to understand the graphic representations presented in the segment.

CLARITY OF INFORMATION

Criteria applies to the clarity or the ability of the student to understand the information presented in the segment.

QUANTITY OF INFORMATION

Criteria applies to the amount of information presented in the segment.

LENGTH OF INSTRUCTION

Criteria applies to the length of the segment presented.

INTEREST OF SEGMENT

Criteria applies to the interest level of a particular segment.

MANIPULATION OF COURSEWARE

Criteria applies to the amount of difficulty experienced by the student in using the specified keys to work through the courseware.

CLARITY OF INSTRUCTION SCREENS

Criteria applies to the amount of difficulty experienced by the student in understanding the instruction screens.

CLARITY OF DEMONSTRATION

Criteria applies to the clarity or ability of the student to understand the procedures demonstrated in a segment.

CLARITY OF REVIEW

Criteria applies to the clarity or ability of the student to understand the procedures demonstrated in a segment.

CLARITY OF QUESTIONS

Criteria applies to the clarity or ability of the student to understand the questions presented in the segment.

DIFFICULTY OF QUESTIONS

Criteria applies to the level of difficulty of the questions presented in the segment.

HELPFULNESS OF FEEDBACK

Criteria applies to the helpfulness of the feedback screens offered in the courseware.

LEARNING WITH INTERACTIVE VIDEO

Criteria applies to the interest generated through the use of an Interactive Video system.

DIFFICULTY OF LESSONS

Criteria applies to the overall level of difficulty experienced in the courseware.

INTEREST OF TECHNICIAN

Criteria applies to the interest generated by the technician.

TECHNICAL QUALITY

Criteria applies to the technical quality of the courseware.

KEY WORD CHECK

Criteria applies to the interest generated from answering questions using one's own vocabulary.

CONTENT STRUCTURE

Criteria applies to the structure used to present the content in the courseware.

OPERATING THE COMPUTER

Criteria applies to the level of difficulty experienced when using the computer.

USEFULNESS OF MENU AND OPTION SCREENS

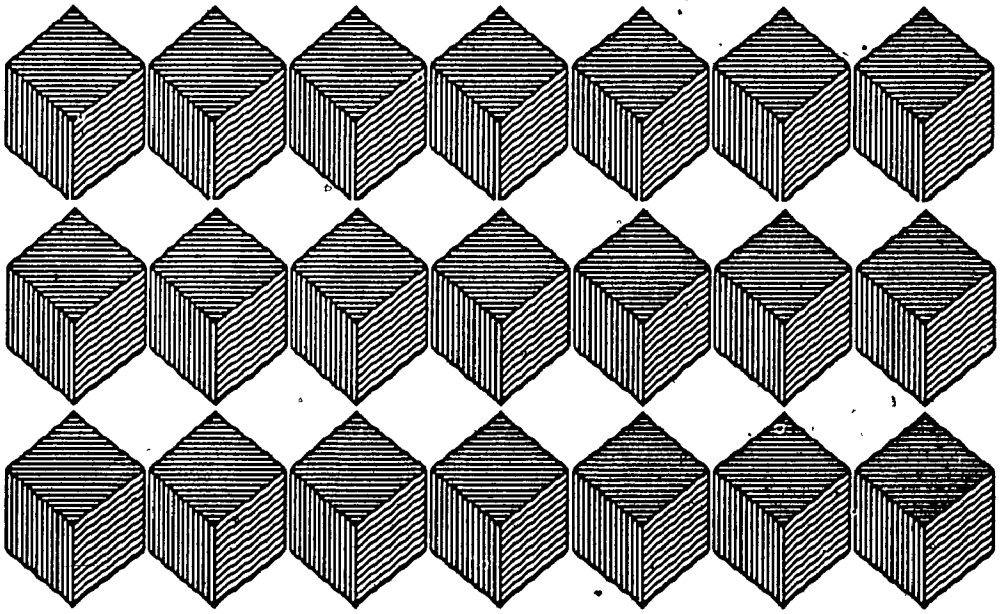
Criteria applies to the ability of the student to understand the menu and option screens.

Appendix I
Instructor's Manual

INSTRUCTORS MANUAL

INTERACTIVE VIDEO

THE SAFE HANDLING OF RADIOISOTOPES



MICHAEL PALMER
Department of Educational Technology
Concordia University

TABLE OF CONTENTS

INTRODUCTION

Part of the laboratory work which Chemistry students of Concordia University experience involves working and experimenting with radioactive isotopes. An important concern to the teaching staff involved in the training and the overseeing of these experiments, involves the risk of radioactive contamination as well as the potential damage to the fragile equipment used when detecting radioactivity.

In an attempt to minimize these potential dangers, as well as to improve the transfer of learned procedures from the classroom to the laboratory, a unique training program has been developed through the cooperative efforts of Concordia's Chemistry, Education and Audio-Visual Departments.

A Microcomputer/Videotape system accompanied with a computer assisted instruction (CAI) package has been produced in order to teach appropriate Contamination Assesment and Decontamination Procedures which must be applied in order to ensure THE SAFE HANDLING OF RADIOISOTOPES.

The "Interactive Videotape" courseware has been designed to be used as a source of initial instruction which should then be followed with a summative procedural test. The courseware can also be used as a support tool to facilitate the review and practice of the necessary equipment and procedures.

This courseware manual has been made available in order to explain the objectives, structure and operating functions of the courseware. It is recomended that instructors first read both the teacher and student manuals before using the courseware with students. If technical assistance should be required to assemble the system, it is recomended that the technical manual be consulted.

HARDWARE REQUIREMENTS

The hardware needed to be interfaced in order to operate the system includes:

1 Apple IIc Computer
2 Single Sided Disc Drives
1 High Resolution Monitor
1 Panasonic AG 6300 Videocassette Player
1 BCD 450 Interface Card
1 RF Modulator

Lesson Objective: Direct Check Method
Given a spill of high-energy radioisotopes, the learner will correctly identify the two tools needed and will correctly explain the twelve steps of the Direct Check Method with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Terminal Objective
Given participation in the Test segment of the courseware, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Direct Check Method.

Lesson Objective: Swipe Check Method
Given a spill of low-energy radioisotopes, the learner will correctly identify the eleven tools needed and will correctly explain the thirteen steps of the Swipe Check Method with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Terminal Objective
Given participation in Test segments of the courseware, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Swipe Check Method.

Lesson Objectives: Decontamination Procedures
Given a spill of high-energy or low-energy radioisotopes, the learner will correctly identify the four tools needed and will correctly explain the six steps of the Decontamination Procedure with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Terminal Objective
Given participation in the Test segments of the courseware, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Decontamination Procedures.

Lesson Objectives: Body Decontamination Procedures
Given a spill of a radioactive material onto clothing and/or skin surfaces, the learner will correctly identify the four tools needed and will correctly explain the nine steps of the Body Decontamination Procedure with 100% accuracy. Accuracy will be measured with a summative procedural checklist.
Terminal Objective
Given participation in the Test segments of the courseware, the learner will correctly answer with 100% accuracy computer generated questions pertaining to the Body Decontamination Procedures.

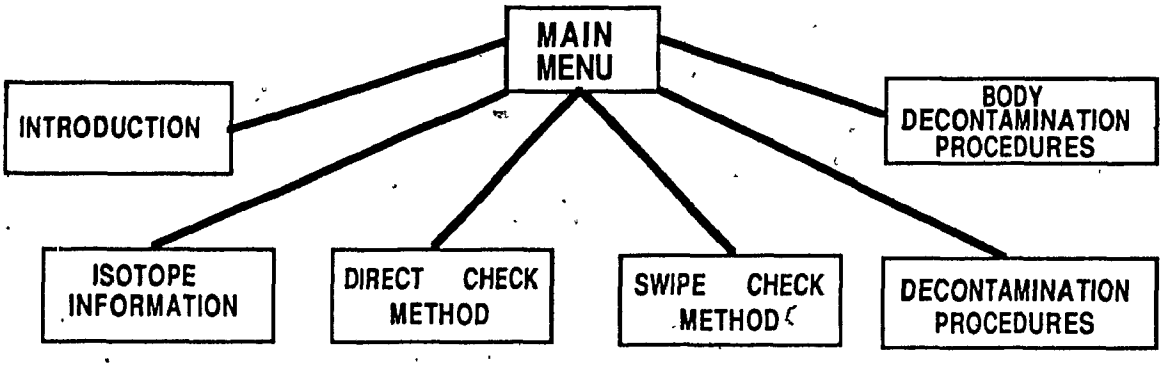
INSTRUCTIONAL PLAN

TARGET POPULATION	University undergraduate and graduate students majoring in Bio-Chemistry
KNOWLEDGE/ SKILLS ACQUIRED	Knowledge of procedures, equipment, elements of radioisotopes Psychomotor skills, reproductive skills, skills of performing the required steps
INSTRUCTIONAL STRATEGY USED	Expositive approach- explanation followed by practice, feedback, and remediation (if necessary)
INSTRUCTIONAL METHODS USED	Tutorial, practice, audio/video, demonstrations, remediation.
EVALUATION & CONTROL STRATEGIES	Corrective and summative feedback, remediation, instructional management component, help options and menus for individual student needs
IDEAL GROUPING	Individual or small group
INSTRUCTIONAL MEDIA	Video tape system with a microcomputer

COURSEWARE CONTENT & STRUCTURE

Within this courseware, six sections are offered to the learner. Figure 1 lists the lesson content and a brief decription of each section.

FIGURE 1



INTRODUCTION	The introduction section consists of a brief video presentation which describes the characteristics of radioisotopes and how they are caused. This section was designed in order to refresh entry level knowledge as well as to situate the learner concerning the type of information which will be presented.
ISOTOPE INFORMATION	This section consists of textual information pertaining to radioisotopes which are commonly used for experimentation at Concordia University. The information presented is technical in nature and serves as an option for the learner to obtain background information related to the radioisotope with which they are working.
DIRECT CHECK METHOD	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out contamination assesment of high energy radioisotopes.
SWIPE CHECK METHOD	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out contamination assesment of low energy radioisotopes.
DECONTAMINATION PROCEDURES	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out decontamination of areas where the presence of radioisotopes have been detected.
BODY DECONTAMINATION PROCEDURES	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out decontamination of clothing and skin surfaces in the event a spill of radioisotopes.

It should be noted that the first two sections are purely informational and are accessed in order to obtain supplemental information pertaining to Radioisotopes in general (e.g. Introduction) or when wishing to obtain information pertaining to a specific Isotope (e.g. Isotope Information). The remaining four sections are instructional lessons and offer information and exercises pertaining to the equipment and steps used in order to carry out the specific procedures. Each of the sections are accessible from the main menu and they may be viewed in any sequence.

LESSON STRUCTURE

Each instructional lesson consists of three segments which are accessed from the **option menu** presented at the beginning of each lesson. The three segments are titled **1) Instruction 2) Practice 3) Test** and can be viewed randomly, or in sequence depending upon the learners choice. A graphic illustration of the segments is given in Figure 2 and a brief explanation of each segment follows.

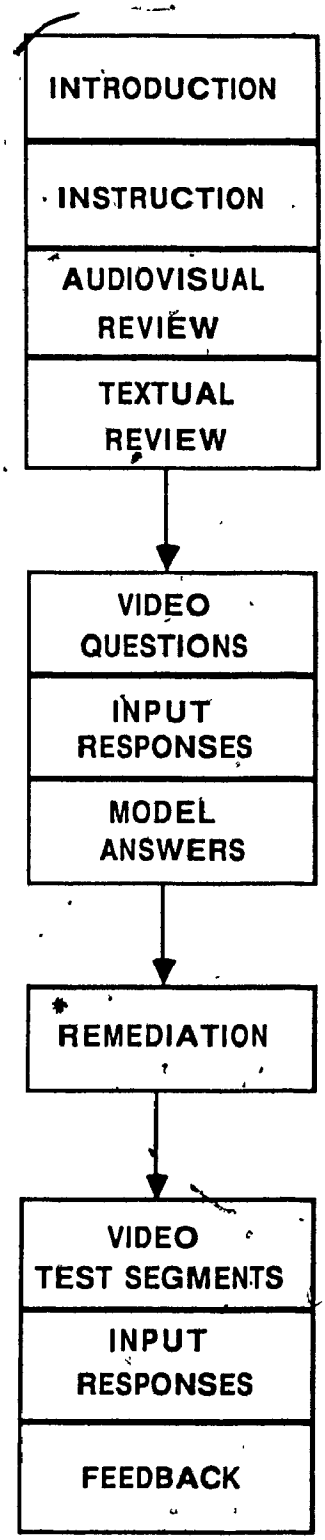
INSTRUCTION

The instructional segments consist of a four to seven minute video presentation which includes a brief introduction to the procedure and a description specifying the situations which demand its application.This is then followed by an explanation of the tools and a demonstration of the steps which are to be carried out when applying the procedures. The segment then concludes with a brief review which emphasises the important steps to be remembered. Following the presentation, the learners are then returned to the option menu where they can choose to review the instruction or move on to another segment.

PRACTICE

The practice segment consists of four video-based questions which pertain to the lesson procedures. Through questioning,the learner is prompted by the demonstrator to specify in sequence the procedures which were demonstrated in the instruction segment of the lesson. The learner is prompted to answer each question by typing in his/her responses on a computer text screen. Following each response a video based model answer is presented with which learners can compare their answers. Responses inputted by the learner are evaluated by a key word check process which allows learners to respond to questions in their own words. At the end of the segment, correct and incorrect responses are automatically tabulated. If all questions were correctly answered, the learner is congratulated and returned to the options menu where they can proceed to the next segment. In the situation where the learner incorrectly answers one of the questions, they are advised of this and are then branched to a video based remedial segment which again explains and demonstrates the procedures. Following remediation, it is suggested that the learner repeat the practice segment. However, carrying out this suggestion is purely voluntary.

Figure 2


INTRODUCTION
INSTRUCTION
AUDIOVISUAL REVIEW
TEXTUAL REVIEW
VIDEO QUESTIONS
INPUT RESPONSES
MODEL ANSWERS
REMEDIATION
VIDEO TEST SEGMENTS
INPUT RESPONSES
FEEDBACK
INSTRUCTION
PRACTICE
TEST

TEST

The test segments consist of between four and six video based demonstrations of the lesson procedure being carried out. The task of the learner is to view the demonstration and determine whether the steps of the procedure were correctly or incorrectly conducted. If it is determined that the steps were improperly done, the learner must then specify by typing in their responses the exact step which was incorrect. Inputted responses are evaluated with a key word check process and the number of correct and incorrect answers are tabulated. Correct responses are reinforced and incorrect responses are remediated with a text screen which explains to the learner which step was incorrect. If all the test demonstrations were correctly answered, the learner is then returned to the option menu. If any of the test demonstrations were incorrectly answered, it is then suggested that the learner redo the lesson.

LEARNER CONTROL CHARACTERISTICS

The courseware is designed to give learners as much responsibility for their own learning as was possible given the limits of the hardware and software. In order to encourage participation and facilitate acceptance of learning responsibility, a number of learner control characteristics have been implemented within the courseware. It should be noted that all learner control options are clearly displayed throughout the courseware. These options are accessed by pressing defined keys on the keyboard. A short description of these characteristics are outlined below.

Lesson & segment sequence	The sequence of the lessons which are accessed as well as the sequence of the segments which are viewed can be decided by the learner.
Review option	A review option which is easily accessed by the learner and is available following each video-based presentation.
Keyword option	A keyword check process evaluates and tabulates all responses inputted by the learners thus allowing participants the opportunity to answer questions using their own vocabulary.
Help option	A help menu can be accessed throughout the program and offers the following options: exit, pause & resume, branch to main menu or option menu.
Exit option	This option allows the learners to exit any part of the program whenever they desire.
Pause & resume option	This option allows the learners to pause and resume the program at will.
Main Menu option	This option allows the learners to exit the program or branch to the option menu.
Option Menu	This option allows the learners to access instruction, practice or test segments.

VIEWING SEQUENCE

All the lessons available in this courseware are directly related to one or a number of radioisotopes discussed in the isotope information segment of the courseware.

In order to allow the user as much flexibility as possible, the selection and viewing sequence of the lessons may be decided by the learner according to his/her objective(s) for using the courseware. As an aid, the matrix in Figure 3 is provided to assist in determining the lessons which match his/her objective(s).

Figure 3

ISOTOPES	ISOTOPE INFORMATION	INTRODUCTION	DIRECT CHECK METHOD	SWIPE CHECK METHOD	DECONTA-MINATION PROCEDURES	BODY DECONTA-MINATION
IODINE	O	O	R	R	R	R
HYDROGEN	O	O	NR	R	R	R
CARBON	O	O	NR	R	R	R
SULFUR	O	O	NR	R	R	R
PHOSPHORUS	O	O	R	R	R	R

(O = Optional, NR = Not Required, R = Required)

Example:

IF OBJECTIVE IS: To learn about the contamination assessment and decontamination procedures to apply when working with the isotope **Iodine.**

THE MATRIX INDICATES THE RECOMMENDED LESSON SELECTION IS:

Direct Check Method, Swipe Check Method, Decontamination Procedures, Body Decontamination Procedures.

(The introduction and isotope information segments are optional but are recomended for first time users.)

Note that the first column of the matrix lists the isotopes discussed in the courseware. The remaining columns indicate the informational and lesson

segments available in the courseware for learning about the safe handling of these isotopes.

To determine the recommended sequence and selection of the lessons for a particular isotope, the isotope of interest must first be identified in the matrix. The matrix should then be read from left to right, beginning with the isotope of interest. The letter ('**R**') is used to indicate which lessons are required for viewing. The letter ('**O**') indicates that the segment is optional. However, it is recomended that optional segments be viewed by first time users. The letters ('**NR**') indicate that the lesson is not required to be viewed for that particular isotope.

SUGGESTIONS

It is suggested that all students who intend to use the courseware first be given the opportunity to read the student courseware manual. It is also recommended that a copy of the student manual be left with the interactive videotape system so that it may be consulted by the students during their use of the courseware.

FOLLOW-UP

After a student has completed viewing the lessons on the interactive videotape system, it is recomended that they carry out the learned procedures in the presence of an instructor. The procedural checklists included in this manual should be used to evaluate student's comprehension and retention of the learned procedures.

All the equipment needed to carry out the procedures should be made available to the students. These would include

Guiger Probe	Chalk	Filter Paper	Cleaning Solution
Ethanol	Rack	RSP Manual	Scintillation Counter
Thongs	Record Book	Vial	Scintillation Fluid
Paper Towels	Mild Soap	Marker	Dry Waste Container
Water			

Following the completion of a lesson on the courseware, students should be asked to identify the procedure which is appropriate due to the isotope or situation which is being addressed. Students should then be asked to choose the tools which are necessary to carry out the procedure. Students should then asked to explain and demonstrate the steps of the procedure.

With the use of the procedural checklist, the instructor should carefully identify whether the tools and steps were correctly identified by placing a check in the appropriate columb. If a satisfactory achievement score is not attained the student should be asked to redo the lesson.

DIRECT CHECK METHOD
PROCEDURAL CHECKLIST

1) In order to detect the presence of High Level Radioisotopes, what is the name of the Contamination Assesment Procedure which should be applied ?

Answer: _____

2) Can you pick out the equipment which would be necessary to carry out this procedure ?

2.A) Guiger Probe ___

2.B) Chalk ___

3) Can you demonstrate the steps of the procedure ?

		Correct	Incorrect
3.1)	The Guiger Muller probe is turned on.	--------	--------
3.2)	The sensitivity level is set at times one.	--------	--------
3.3)	The probe is passed over an area where there is no contamination to obtain a background radiation count.	--------	--------
	To obtain a reliable reading the probe should be:		
3.4)	Passed slowly over the area being monitored.	--------	--------

		Correct	Incorrect
3.5)	The probe should be kept approx 3cm or 1/8 from the area being monitored.	-------	-------
3.6)	The probe should not make contact with the surface.	-------	-------
3.7)	The probe is passed over an area where there is suspected contamination.	-------	-------
3.8)	If area counts are higher then background levels:	-------	-------
3.9)	The contaminated area is marked with a chalk.	-------	-------
3.10)	Decontamination procedures are applied.	-------	-------
3.11)	The area is then rechecked with the Direct Check method &	-------	-------
3.12)	The Swipe Check Method.	-------	-------

SWIPE CHECK METHOD
PROCEDURAL CHECKLIST

1) In order to detect the presence of High Level Radioisotopes, what is the name of the Contamination Assesment Procedure which should be applied ?

Answer: _____

2) Can you pick out the equipment which would be necessary to carry out this procedure ?

2.A) Filter Paper ___

2.B) Ethanol ___

2.C) Thongs ___

2.D) Scintillation Vial ___

2.E) Scintillation Fluid ___

2.F) Vial ___

2.G) Marker ___

2.H) Rack ___

2.I) Scintillation Counter ___

2.J) RSP Manual ___

2.K) Record Book ___

3) Can you demonstrate the steps of the procedure ?

		Correct	Incorrect
3.1)	Filter paper is gripped with thongs.	--------	--------
3.2)	The filter paper is wet with a solution of ethanol.	--------	--------

		Correct	Incorrect
3.3)	An area of approximately 200 - 400 cm^2 is swiped.	--------	--------
3.4)	The filter paper is placed in a scintillation vial.	--------	--------
3.5)	Scintillation fluid is placed in the vial.	--------	--------
3.6)	The vial is marked.	--------	--------
3.7)	The vial is placed in a rack.	--------	--------
3.8)	The rack is placed in a scintillation counter.	--------	--------
3.9)	Area counts are measured.	--------	--------
3.10)	Obtained results are recorded in a record book.	--------	--------
3.11)	Obtained results are compared to permissible levels.	--------	--------
3.12)	If obtained results are higher than permissible levels, then decontamination procedures are applied.	--------	--------
3.13)	Following decontamination, the area is then rechecked with the Swipe Check Method.	--------	--------

DECONTAMINATION PROCEDURES
PROCEDURAL CHECKLIST

1) If contamination is detected following the application of contamination assesment, which procedures should then be applied ?

Answer: _____

2).Can you pick out the equipment which would be necessary to carry out this procedure ?

2.A) Paper Towels ___ 2.C) Cleaning Solution ___

2.B) Chalk ___ 2.D) Dry Waste Cont ___

3) Can you demonstrate the steps of the procedure ?

		Correct	Incorrect
3.1)	When contamination is detected,an area six inches larger then the contaminated area is marked with a chalk.	--------	--------
3.2)	A paper towel is wet with a cleaning solution.	--------	--------
3.3)	The contaminated area is then wiped from the outside parameters in towards the inside.	--------	--------
3.4)	The paper towel is disposed as dry waste.	--------	--------

		Correct	Incorrect
3.5)	The area is rechecked with the Swipe Check method.	--------	--------
3.6)	If contamination is again found decontamination procedures are reapplied.	--------	--------

BODY DECONTAMINATION PROCEDURES
PROCEDURAL CHECKLIST

1) If during an experiment you should accidentally spill radioisotopes on yourself which procedure should you then apply ?

Answer: _____

2) Can you pick out the equipment which would be necessary to carry out this procedure. ?

2.A) Paper Towels ___ 2.C) Mild Soap ___

2.B)Water ___ 2.D) Dry Waste Cont ___

3) What should you do if isotopes are spilled on your laboratory coat or street clothes ?

		Correct	Incorrect
3.1)	If isotopes are spilled on laboratory coats or street clothes, they must be immediately removed.	--------	--------
3.2)	Contaminated clothing are disposed as dry waste.	--------	--------

(What should you do if isotopes are spilled on skin surfaces?)
If isotopes are spilled onto skin surfaces they should be decontaminated by:

3.3)	Wetting with water.	--------	--------
3.4)	Generously washing with a mild non-abrasive soap.	--------	--------

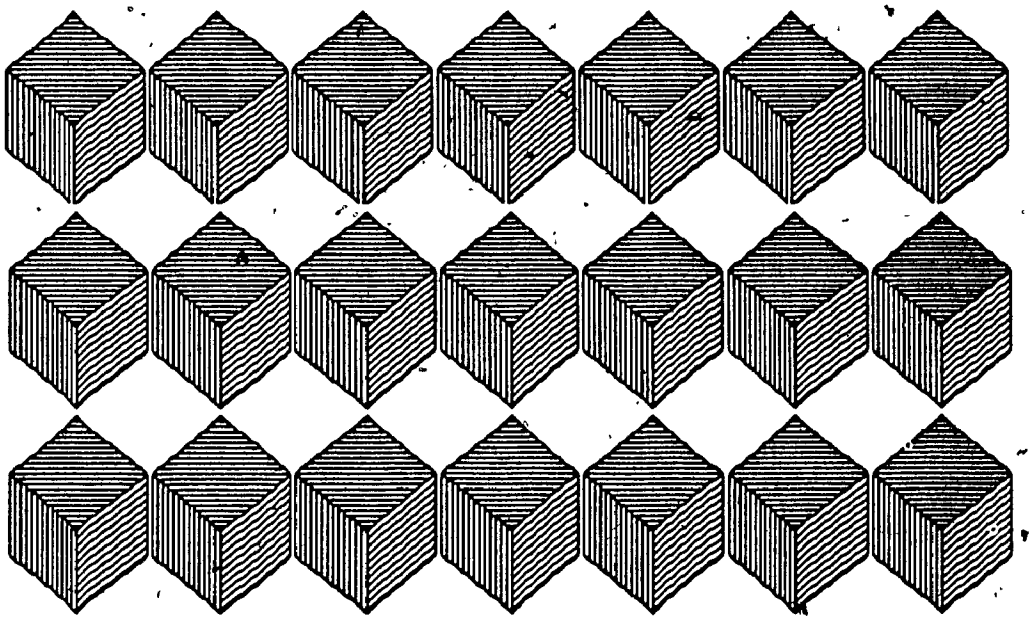
		Correct	Incorrect
3.5)	Rinsing well with water.	--------	--------
3.6)	Drying with paper towels.	--------	--------
3.7)	Discard paper towels as dry waste.	--------	--------
3.8)	Recheck skin surfaces with the Swipe Check Method.	--------	--------
3.9)	If contamination is still detected, reapply body decontamination procedures.	--------	--------

Appendix J
Student Manual

STUDENT MANUAL

INTERACTIVE VIDEO

THE SAFE HANDLING OF RADIOISOTOPES



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INTRODUCTION

An important concern of anyone who works or experiments with radioactive isotopes is the risk of radioactive contamination. As well, there is also the risk of damage to the fragile equipment used when detecting radioactivity.

In an attempt to minimize these potential dangers, a unique training program has been developed to teach the appropriate contamination assessment and decontamination procedures for the safe handling of radioisotopes.

Through the use of a microcomputer/videotape system and the courseware " The Safe Handling of Radioisotopes ", you will have access to technical information about radioisotopes, instruction on procedures for handling them, practice using the procedures, and remediation and tests to ensure your understanding of them.

The unique features of an interactive video system have been used to help you to learn independently in an interesting manner and at your own pace with some control over the selection and sequence of your learning.

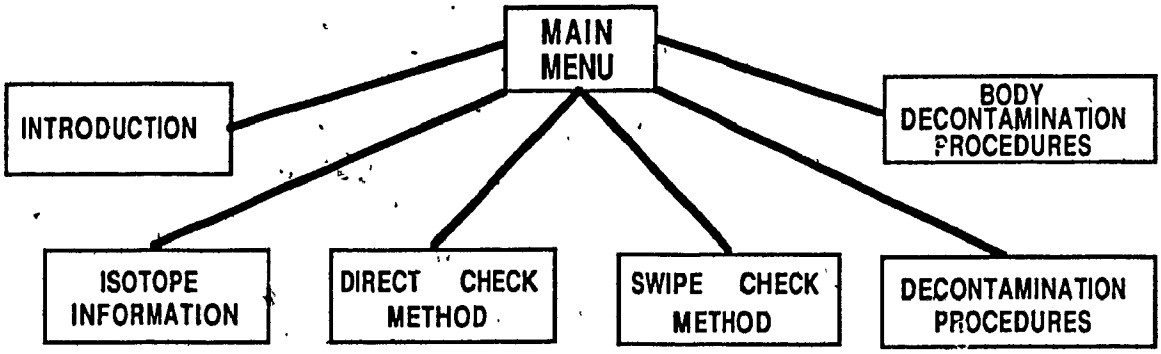
This Student Manual has been made available to help you to use the courseware in a way that will accomodate your own learning style and objectives. It will also explain how to operate and view the courseware as well as describe the special user-control options that have been built in the courseware.

It is assumed in this manual, that you have been familiarized with the components of your interactive video system. If you are uncertain about any of the interactive video system components, you should consult the technical manuals.

WHAT YOU CAN EXPECT TO LEARN

What you can expect to learn from this courseware will depend on the section of the courseware you have selected. All sections are represented in the Main Menu of the courseware and are illustrated in Figure 1.
This part of the Manual will outline the content and objective of each section of the courseware.

Figure 1



The first two sections (the 'Introduction' and 'Isotope Information' section) are purely informational. For example, the 'Introduction' can be accessed in order to obtain supplemental information pertaining to Radioisotopes in general. The 'Isotope Information' section can be accessed when wishing to obtain information pertaining to a specific Isotope.

The remaining four sections are instructional lessons and offer information and exercises pertaining to the equipment and steps used in order to carry out the specific procedures. Each of the sections are accessible from the main menu and they may be viewed in any sequence.

A description of the content and objective of each section follows in Figure 2.

Figure 2.

Section	Content	Objective
INTRODUCTION	The introduction section consists of a brief video presentation which describes the characteristics of the radioisotopes and how they originate.	This section was designed to refresh your knowledge of isotopes as well as to acquaint you with the information to be presented.
ISOTOPE INFORMATION	This section consists of textual information pertaining to radio-isotopes which are commonly used for experimentation at Concordia University.	The information presented is technical in nature and serves as an option for you to obtain background information related to the radioisotope with which you are working.
DIRECT CHECK METHOD	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out contamination assesment of high level radioisotopes.	By the end of this lesson, you should be able to carry out the procedures and answer computer-generated questions pertaining to them.
SWIPE CHECK METHOD	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out contamination assesment of low level radioisotopes.	By the end of this lesson, you should be able to carry out the procedures and answer computer-generated questions pertaining to them.
DECONTAM PROCEDURES	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out decontamination of areas where radioisotopes have been detected.	By the end of this lesson, you should be able to carry out the procedures and answer computer-generated questions pertaining to them.
BODY DECONTAM PROCEDURES	This instructional section describes the proper tools and illustrates the correct procedures necessary to carry out decontamination of clothing and skin surfaces in the event of a spill of radioisotopes.	By the end of this lesson, you should be able to carry out the procedures and answer computer-generated questions pertaining to them.

HOW YOU WILL BE LEARNING

Each time you select a lesson, you will be given three options for learning the lesson: **instruction, practice,** and **test**.
These options can be viewed randomly or in sequence. For example, you can view the instruction and practice segments as many times as you feel is needed. If you feel that you do not require practice, you can choose the test segment immediately after the instruction. Giving you these options allows you to achieve your objectives at your own pace and with more control over your learning.
In this section of the Manual, a brief explanation of each of these options is presented.

INSTRUCTION

The instructional segments consist of a four to seven minute video presentation which includes a brief introduction to the procedure and a description specifying the situations which demand its application. This is followed by an explanation of the tools and a demonstration of the steps which are to be carried out when applying the procedures.
The segment concludes with a brief review which emphasizes the important steps to be remembered.
Following the presentation, you can choose to review the instruction or move on to another segment.

PRACTICE

The practice segment consists of four or five video-based questions which pertain to the lesson procedures. Through questioning by the demonstrator, you are prompted to specify in sequence the procedures which were demonstrated in the instruction segment of the lesson.
Following each of the demonstrator's questions, you are prompted to answer each question by typing in your responses on a computer text screen.
Your responses are evaluated by a key word check process that allows you to respond to questions in your own words.

At the end of the segment, correct and incorrect responses are automatically tabulated. If all questions were correctly answered, you are congratulated and returned to the options menu where you can proceed to the next segment. In the situation where you improperly answer one of the questions, you are advised of this and are then branched to a video based remedial segment which again explains and demonstrates the procedures.
Following remediation, it is suggested that you repeat the practice segment. However, carrying out this suggestion is purely voluntary.

TEST

The test segments consist of four to six video based demonstrations of the lesson procedure being carried out. Your task is to view the demonstration and determine whether the steps of the procedure were correctly or incorrectly conducted.
If the steps were improperly done, you must then specify which step was incorrect by typing in your response. All your responses are evaluated with a key word check process and the number of correct and incorrect answers are tabulated. Correct responses are noted and incorrect responses are remediated with a text screen which explains which step was incorrect. If any of the test demonstrations were incorrectly answered, it is then suggested that you repeat the lesson.

RUNNING THE COURSEWARE

This section of the manual outlines instructions to run the courseware. It is assumed that you have been familiarized with the components of your interactive video system. If you are uncertain about any of the interactive video system components, you should consult the technical manuals of your system.

1. ***Start up the system by following these steps:***
   - Turn on the videotape player and insert the videotape "The Safe Handling of Radioisotopes".
   - Turn on the color monitor.
   - Insert floppy disk 1 into disk drive 1.
   - Insert floppy disk 2 into disk drive 2
   - Turn on the computer (switch is located at the back left hand side of the computer)

   Waiting approximately 20 seconds, a "Super Pilot Menu" screen will appear on the moniter.

2. ***Type the letter "L" and then press the <Return> key.***
   You should now see a screen titled, "Super Pilot - Lesson Text Editor".

3. ***Type the letter "R" and then press the <Return> key.***
   The screen will not change.

4. ***Type the letters "ST" and then press the <Return> key.***
   The production credits will be displayed on the screen. This will be followed by the main menu from which you may make your viewing selection.

HOW TO VIEW THE COURSEWARE

According to your objectives for viewing this courseware, you may or may not need to view all the courseware sections. The matrix in Figure 3 is provided to assist you in determining *at a glance* all the lessons which match your objectives.

FIGURE 3

ISOTOPES	ISOTOPE INFORMATION	INTRODUCTION	DIRECT CHECK METHOD	SWIPE CHECK METHOD	DECONTA-MINATION PROCEDURES	BODY DECONTA-MINATION
IODINE	O	O	R	R	R	R
HYDROGEN	O	O	NR	R	R	R
CARBON	O	O	NR	R	R	R
SULFUR	O	O	NR	R	R	R
PHOSPHORUS	O	O	R	R	R	R

NOTE: The first column of the matrix lists the isotopes discussed in the courseware. The remaining columns indicate the informational and lesson segments for learning about the safe handling of these isotopes.

To determine the recommended selection of the lessons for a particular isotope, the isotope of interest must first be identified in the matrix. Reading the matrix from left to right, note the symbols in each cell.

R indicates that the lesson is required for viewing

O indicates that the section is optional. However, it is recomended that optional sections be viewed by first time users.

NR indicates that the lesson is not required to be viewed for that particular isotope.

Once you have determined the lessons which are of interest to you, you can select them from the Main Menu of the courseware in *any* sequence.
An example of how the matrix can be used follows.

Example:

IF YOUR OBJECTIVE IS: To learn about the contamination assessment and decontamination procedures to apply when working with the isotope **Iodine.**

THE MATRIX INDICATES THE REQUIRED LESSON SELECTION IS:
Direct Check Method, Swipe Check Method, Decontamination Procedures, and Body Decontamination Procedures.

(The INTRODUCTION and ISOTOPE INFORMATION sections are optional but are recommended viewing for first time users.)

USER-CONTROL OPTIONS

This courseware has been designed with options that will allow you some control over the way you can use this courseware to achieve your learning objectives. This section of the manual lists and describes each of these options.
Note that all the user-control options are clearly displayed throughout the courseware and are accessed by pressing defined keys listed on the computer text screens.

Main Menu option	The Main Menu is displayed at the beginning of the courseware and can be accessed within the courseware through the Option Menu and the Help Option. It allows you to exit the program or to select the information or instructional sections (lessons) of your choice .
Option Menu	The Option Menu is accessed when you select a lesson from the Main Menu. It allows you to select instruction, practice or test segments. These segments may be selected in sequence or in a random order and as many times as you desire.
Review option	A review option is available following each video-based presentation. It allows you to view a video segment as many times as you require.
Help option	A help menu can be accessed throughout the program and offers the following options: exit, pause & resume, branch to main menu or option menu.
Exit option	This option can be accessed through the main menu, the option menu, and the help option. It allows you to exit any part of the program whenever you desire.
Pause & resume option	This option can be accessed through the help menu. It allows the you to pause and resume the program at will.
Keyword option	This is a built-in feature of the courseware that automatically evaluates and tabulates all your responses thus allowing you to answer questions using your own vocabulary.

Appendix K
SME Questionnaire Data

SUBJECT MATTER EXPERTS - DISTRIBUTION OF RESPONSES

THIS SECTION INDICATES THE DISTRIBUTION OF RESPONSES MADE BY TWO SUBJECT MATTER EXPERTS FOR EACH SECTION OF THE COURSEWARE.

RATINGS

SA - Strongly Agree
A - Agree
U - Undecided
D - Disagree
SD - Strongly Disagree

INTRODUCTION

	SA	A	U	D	SD
1) CORRECTNESS OF CONTENT PRESENTED	2				
2) CORRECTNESS OF VISUALS PRESENTED	1	1			
3) APPROPRIATENESS OF VOCABULARY USED	2				
4) QUANTITY OF INFORMATION USED	1	1			
5) CLARITY OF CONTENT PRESENTED	2				

RADIOISOTOPE INFORMATION

	SA	A	U	D	SD
1) CORRECTNESS OF CONTENT PRESENTED	2				
2) APPROPRIATENESS OF VOCABULARY USED	2				
3) QUANTITY OF INFORMATION PRESENTED		2			
4) CLARITY OF CONTENT PRESENTED	2				

INSTRUCTION	DIRECT CHECK					SWIPE CHECK					D PROCEDURES					BODY DEC				
	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD
1) CORRECTNESS OF CONTENT PRESENTED	1	1				1	1				1	1				1	1			
2) CORRECTNESS OF PROCEDURES PRESENTED	1	1							2		1	1				1	1			
3) APPROPRIATENESS OF VOCABULARY USED	1	1				2					2					2				
4) QUANTITY OF INFORMATION PRESENTED	2					2					2					2				
5) CLARITY OF CONTENT PRESENTED	2					2					2					2				

PRACTICE	DIRECT CHECK					SWIPE CHECK					D PROCEDURES					BODY DEC				
	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD
1) CORRECTNESS OF CONTENT PRESENTED	1	1				1			1		1	1				2				
2) CORRECTNESS OF PROCEDURES PRESENTED	2					1			1		1	1				2				
3) APPROPRIATENESS OF VOCABULARY USED	2					2					2					2				
4) DIFFICULTY LEVEL OF QUESTIONS PRESENTED	2					2					2					2				
5) ANSWERABILITY OF QUESTIONS PRESENTED	1	1				2					1	1				2				
6) FOCUS OF ATTENTION	2					2					2					2				

REMEDIATION	DIRECT CHECK					SWIPE CHECK					D PROCEDURES					BODY DEC				
	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD
1) CORRECTNESS OF CONTENT PRESENTED		2				2					2					2				
2) CORRECTNESS OF PROCEDURES PRESENTED				2		2					2					2				
3) APPROPRIATENESS OF VOCABULARY USED	2					2					2					2				
4) QUANTITY OF INFORMATION PRESENTED	2					2					2					2				
5) CLARITY OF CONTENT PRESENTED	2					2					2					2				

TEST	DIRECT CHECK					SWIPE CHECK					D PROCEDURES					BODY DEC				
	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD	SA	A	U	D	SD
1) RECOGNIZABILITY OF IMPROPER PROCEDURES	2					2					1		1			2				
2) CORRECTNESS OF FEEDBACK	2					2					1	1				2				
3) DIFFICULTY LEVEL OF QUESTIONS	2					2					2					2				
4) ANSWERABILITY OF QUESTIONS	2					2					1	1				2				
5) REPRESENTATIVE OF COMMON MISTAKES	2					2					2					2				

Appendix L
SME Comments and Recommendations

SECTION	COMMENTS / RECOMMENDATIONS
Introduction to Courseware	a) Slide number 6 : The arrows in the graphic representations should be different lengths (as illustrated below): alpha -----> Beta --------> Gamma ----------> b) Slide number 7 : Ionizing radiation - Confusing for students - Add 4 directional electron arrows - Simplify the information on this graphic c) There is possibly too much information presented in too short a time period.
Isotope Information	a) Delete source formula b) Add formula for determining effective 1/2 life c) Be conscious to double space of all paragraphs (clearer to read).
Direct Check Method Instruction:	a) Clarify that gloves should always be worn. b) Reflection of light on meter obstructs the image. c) Use a stronger radiation source during demonstration. d) The probe has controls not components. Say

SECTION	COMMENTS / RECOMMENDATIONS
	"Two sets of controls or two control knobs ".
	e) More emphasis that the first step is to set meter at (times 1).
	f) Deconamination should be applied until counts are below permissible levels.
	g) Use audio counts and not scale counts to measure radiation levels.
Practice:	a) All the procedural steps should be emphasized equally.
	b) Holding probe 3 mm and not touching surface is the same. This should be changed from three steps to two steps.
	c) Each practice question should address one step of the procedure.
Remediation:	a) The technician does not mention to pass probe slowly.
	b) The technician does not mention to turn probe on and set at times 1.
	c) Place emphasis on the key steps equally throughout the demonstration.
Swipe Check Method	
Instruction:	a) Gloves should be changed after dismantling equipment.
	b) Technician is swiping too long , also zig-zag more.

SECTION	COMMENTS / RECOMMENDATIONS
	c) Clarify the process of marking & keeping track of vials. d) The instruction segment is too long. e) Include a demonstration of filing ascintilation vials with scintilation fluid.
Practice:	a) The technician did not mention marking the vials. b) Include a more structured step breakdown. c) Each practice question should address one step of the procedure at a time.
Decontamination	
Instruction:	a) When decontaminating the area, the technician should not flip the towel over. b) The technician could demonstrate decontaminating by applying soap directly to the work bench. c) Paper towel should be gently placed in dry waste container.
Practice:	a) Add " decontamination solution " to key word check. b) Emphasize marking an area which is 30cm larger than the contamination. c) Each practice question should address one step of the procedure.

SECTION	COMMENTS / RECOMMENDATIONS
Test:	a) The technician does not specify marking the area 30 cm larger than the spill. b) Final question, text page : "From outside of contaminated area towards the inside" to feedback text.
Body Decontamination	
Instruction:	a) Wrong procedure to remove gloves (5 step procedure) b) Stress that they should use hand which is not contaminated to manipulate the soap, tap and equipment. c) Instead of swipe checking the hands/wash hands thoroughly at least two times. d) Place paper towel gently into dry waste container. e) Report any cases of body contamination to a Radiation Safety Officer.

Appendix M
Instructional Design Expert Comments and Recommendations

SECTION	COMMENTS / RECOMMENDATIONS
Introduction to Courseware	1) Visual information on the screen is not sequenced with the narration. 2) Some of the graphic visuals on the screen are very complicated. 3) Lots of information on screen. 4) Explain and clarify graphics. 5) Attempt to reinforce graphics with narration.
Isotope Information	1) This is not a good way to teach this material. 2) It should be assumed that they know this material and this segment is used to remind them. 3) Bit of a jumble of information. 4) This information should be presented in a practical way, using full sentences and practical english. 5) This information does not have to be presented in point form.
Direct Check Method <u>Instruction:</u>	1) The narration and introduction visuals are not sequenced. 2) Try to present the principles of the procedure during the introduction. 3) The segment is very long - too much information - break the segment up. 4) The content being presented should be reinforced with cartoons /graphics.

Direct Check Method (cont'd)

Instruction:

5) Should use a real actor.
6) Try to use a telepromptor.

Practice:

1) Is it possible to remediate each response directly.
2) I am not sure what I answered incorrectly.
3) Could you remediate all the wrong responses at the end.
4) Possibly have an overview of the questions which were incorrectly answered and what the correct responses should have been.
5) Could the help option be programmed to help with the questions.
6) Maybe you could have a text word appear on the screen to cue the learner that the response was incorrect.

Remediation:

1) Possibly present remedial information in point form.

Test:

1) There is a danger that the learner will retain incorrect information.
2) Well structured.

Appendix N
Embedded Practice Questions Data

	DIRECT CHECK							SWIPE CHECK						DECONTAM					BODY D		
	1	2	3a.	3b	3c	4a.	4b	1a.	1b	2a.	2b	3	4	1	2a.	2b	3	4,	1	2	3
Student 1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
Student 2	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0
Student 3	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
Student 4	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1
Student 5	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1
Student 6	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1
Student 7	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
Student 8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTALS:	7	7	5	8	8	7	7	6	3	8	8	8	8	8	5	8	5	4	8	8	7

Appendix O
Embedded Test Questions Data

	DIRECT CHECK						SWIPE CHECK					DECONTAM				
	Q1	Q2	Q3	Q4	Q5	Score	Q1	Q2	Q3	Q4	Score	Q1	Q2	Q3	Q4	Score
Student 1	1	1	1	1	1	100%	1	1	0	1	75%	1	1	1	1	100%
Student 2	1	1	1	1	1	100%	1	1	1	1	100%	1	0	1	1	75%
Student 3	1	1	1	1	1	100%	1	1	1	1	100%	1	0	1	1	75%
Student 4	1	1	1	1	1	100%	1	1	0	1	75%	0	1	1	1	75%
Student 5	1	1	1	1	1	100%	1	1	1	1	100%	1	1	1	1	100%
Student 6	1	1	1	1	1	100%	1	1	1	1	100%	1	1	0	1	75%
Student 7	1	1	1	1	1	100%	1	1	1	1	100%	1	1	1	1	100%
Student 8	1	1	1	1	1	100%	1	1	1	1	100%	1	1	1	1	100%
	--	--	--	--	--		--	--	--	--		--	--	--	--	
Totals:	8	8	8	8	8		8	8	6	8		7	6	7	8	

Appendix P
Student Attitude Questionnaire Data

DISTRIBUTION OF STUDENT RESPONSES

INTRODUCTION N=8

		1	2	3	4	5	
1) CLARITY OF GRAPHICS	Confusing			1	4	3	Clear
2) CLARITY OF INFORMATION	Confusing			1	2	5	Clear
3) QUANTITY OF INFORMATION	Too Little		2	5	1		Too Much
4) LENGTH OF INSTRUCTION	Too Long			6	2		Too Short
5) INTEREST OF SEGMENT	Boring			4	2	2	Interesting

RADIOISOTOPE INFORMATION N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand		1		2	5	Easy to Understand
2) QUANTITY OF INFORMATION	Too Little		2	5		1	Too Much
3) MANIPULATION OF COURSEWARE	Difficult to use				1	7	Easy to Use
4) INTEREST OF SEGMENT	Boring	2	5	1			Interesting

DIRECT CHECK (INSTRUCTION) N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing				1	7	Clear
2) CLARITY OF DEMONSTRATION	Confusing		1			7	Clear
3) AMOUNT OF INFORMATION PRESENTED	Too Much	1	1	6			Too Little
4) LENGTH OF INSTRUCTION	Too Short			5	2	1	Too long
5) CLARITY OF REVIEW	Confusing				1	7	Clear
6) INTEREST OF SEGMENT	Boring			2	1	5	Interesting

DIRECT CHECK (PRACTICE) N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand					8	Easy To Understand
2) MANIPULATION OF COURSEWARE	Difficult to use					8	Easy To Use
3) CLARITY OF QUESTIONS	Confusing				1	7	Clear
4) DIFFICULTY OF QUESTIONS	Difficult			2	1	5	Easy
5) HELPFULNESS OF FEEDBACK	Not Helpful				3	5	Very Helpful
6) INTEREST OF SEGMENT	Boring			1	2	5	Interesting

DIRECT CHECK (REMEDIATION) N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing					8	Interesting
2) AMOUNT OF INFORMATION	Too Little			6	1	1	Too Much
3) LENGTH OF INFORMATION	Too Long		1	6	1		Too Short
4) HELPFULNESS OF FEEDBACK	Not Helpful				4	4	Very Helpful

DIRECT CHECK (TEST) N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand				1	7	Easy To Understand
2) MANIPULATION OF COURSEWARE	Difficult To Use					8	Easy to Use
3) DIFFICULTY OF TEST QUESTIONS	Difficult				1	7	Easy
4) HELPFULNESS OF FEEDBACK	Not Helpful			1	5	2	Very Helpful
5) INTEREST OF SEGMENT	Boring		1	1	1	5	Interesting

SWIPE CHECK (INSTRUCTION) N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing		1	2	4	1	Clear
2) CLARITY OF DEMONSTRATION	Confusing	1	1		4	2	Clear
3) AMOUNT OF INFORMATION PRESENTED	Too Much		2	4	2		Too Little
4) LENGTH OF INSTRUCTION	Too Short			5	2	1	Too long
5) CLARITY OF REVIEW	Confusing				1	7	Clear
6) INTEREST OF SEGMENT	Boring			1	1	6	Interesting

SWIPE CHECK (PRACTICE) N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand		1			7	Easy To Understand
2) MANIPULATION OF COURSEWARE	Difficult to use					8	Easy To Use
3) CLARITY OF QUESTIONS	Confusing		3	1	2	2	Clear
4) DIFFICULTY OF QUESTIONS	Difficult			3	3	2	Easy
5) HELPFULNESS OF FEEDBACK	Not Helpful			2	2	4	Very Helpful
6) INTEREST OF SEGMENT	Boring			1	2	5	Interesting

SWIPE CHECK (REMEDIATION) N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing		1	1	4	2	Clear
2) AMOUNT OF INFORMATION	Too Little			1	1	6	Too Much
3) LENGTH OF INFORMATION	Too Long	1		7			Too Short
4) HELPFULNESS OF FEEDBACK	Not Helpful			1	4	3	Very Helpful

SWIPE CHECK (TEST) N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand				3	5	Easy To Understand
2) MANIPULATION OF COURSEWARE	Difficult To Use					8	Easy to Use
3) DIFFICULTY OF TEST QUESTIONS	Difficult		1	1	2	4	Easy
4) HELPFULNESS OF FEEDBACK	Not Helpful		1		4	3	Very Helpful
5) INTEREST OF SEGMENT	Boring			1	3	4	Interesting

D PROCEDURES (INSTRUCTION N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing				1	7	Clear
2) CLARITY OF DEMONSTRATION	Confusing		1		2	5	Clear
3) AMOUNT OF INFORMATION PRESENTED	Too Much			5	3		Too Little
4) LENGTH OF INSTRUCTION	Too Short		1	7			Too long
5) CLARITY OF REVIEW	Confusing				1	7	Clear
6) INTEREST OF SEGMENT	Boring			1	1	6	Interesting

D PROCEDURES (PRACTICE) N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand				1	7	Easy To Understand
2) MANIPULATION OF COURSEWARE	Difficult to use					8	Easy To Use
3) CLARITY OF QUESTIONS	Confusing				1	7	Clear
4) DIFFICULTY OF QUESTIONS	Difficult				3	5	Easy
5) HELPFULNESS OF FEEDBACK	Not Helpful			1	3	4	Very Helpful
6) INTEREST OF SEGMENT	Boring			1	2	5	Interesting

D PROCEDURES (REMEDIATION) N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing					8	Interesting
2) AMOUNT OF INFORMATION	Too Little		1	7			Too Much
3) LENGTH OF INFORMATION	Too Long			7		1	Too Short
4) HELPFULNESS OF FEEDBACK	Not Helpful			1	5	2	Very Helpful

D PROCEDURES (TEST) N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand				2	6	Easy To Understand
2) MANIPULATION OF COURSEWARE	Difficult To Use					8	Easy to Use
3) DIFFICULTY OF TEST QUESTIONS	Difficult			2		6	Easy
4) HELPFULNESS OF FEEDBACK	Not Helpful				2	6	Very Helpful
5) INTEREST OF SEGMENT	Boring			1	1	6	Interesting

BODY DECONT (INSTRUCTION) N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing		1		2	5	Clear
2) CLARITY OF DEMONSTRATION	Confusing			1	1	6	Clear
3) AMOUNT OF INFORMATION PRESENTED	Too Much		2	4	2		Too Little
4) LENGTH OF INSTRUCTION	Too Short		1	5	2		Too long
5) CLARITY OF REVIEW	Confusing				1	7	Clear
6) INTEREST OF SEGMENT	Boring		2	1	2	3	Interesting

BODY DECONT (PRACTICE) N=8

		1	2	3	4	5	
1) CLARITY OF INSTRUCTION SCREENS	Difficult To Understand				1	7	Easy To Understand
2) MANIPULATION OF COURSEWARE	Difficult to use	1				7	Easy To Use
3) CLARITY OF QUESTIONS	Confusing			1	2	5	Clear
4) DIFFICULTY OF QUESTIONS	Difficult			2	3	3	Easy
5) HELPFULNESS OF FEEDBACK	Not Helpful				4	4	Very Helpful
6) INTEREST OF SEGMENT	Boring			1	2	5	Interesting

BODY DECONT (REMEDIATION) N=8

		1	2	3	4	5	
1) CLARITY OF INFORMATION	Confusing				6	2	Interesting
2) AMOUNT OF INFORMATION	Too Little		1	7			Too Much
3) LENGTH OF INFORMATION	Too Long		4	4			Too Short
4) HELPFULNESS OF FEEDBACK	Not Helpful				5	3	Very Helpful

GENERAL	N=8							
		1	2	3	4	5	
1) LEARNING WITH IVT	Boring					8	Interesting
2) DIFFICULTY OF LESSONS	Difficult			3	3	2	Easy
3) INTEREST OF TECHNICIAN	Boring	1		3	4		Interesting
4) TECHNICAL QUALITY	Very Poor			3	2	3	Very Good
5) KEY WORD CHECK	Boring			1	2	5	Interesting
6) CONTENT STRUCTURE	Difficult To Follow				1	7	Easy To Follow
7) OPERATING THE COMPUTER	Difficult					8	Easy
8) MENU AND OPTION SCREENS	Confusing					8	Clear

Appendix Q
Student Comments and Recommendations

Section: Introduction to Courseware

1) VG/OK
2) Text unclear because of different colors on the moniter.
3) Over some students head if they don't know chemistry.
4) Confusing , too much information crammed into a little time.
5) Had to look hard at pictures.
6) Add more practical information.

Section: Isotope Information

1) Did not like that there was no voice.
2) Pretty good info to have.
3) Very interesting.
4) Some of the info was too technical.
5) ? E MEAN = EY =.
6) Text paragraphs should be double spaced.
7) Change from MEV to MeV.
8) Clarify difference between effective & biological half life.
9) Easy to use computer.
10) A little confused with page turning instructions.
11) Maybe talk about the difference between ordinary sulfur and radioisotope sulfur.

Section: Direct Check Method

Instruction

1) OK/ Fair / VG / Good /
2) Clarify whether to measure with audio counts or scale counts.
3) Guage is not very visible.
4) Mention isotope which applies to procedure.

[redacted]iew

1) OK/VG
2) ,Segment presented too long after instruction.

3) Clear/ maybe add specific isotopes for each procedure.
4) Clear and concise

Practice

1) Good
2) Good feedback
3) V/G exercise

Remediation

1) OK
2) Does not mention turn probe at X 1.

Test

1) Test segments a little long.
2) Lots of key words to update.
3) OK

Section: Swipe Check Method

Instruction

1) OK
2) Maybe demonstrate filling the vials with scintillation fluid.
3) A little confusing/ Many, many steps/ A bit long/ a bit too much info.
4) Not as clear as direct check.
5) Maybe add to which isotope this procedure applies.
6) Paul should remove gloves after dismantling experiment.

Review

1) What are commands to work scintillation counter.
2) Section did not stress steps as much as Direct Check.
3) How well should filter paper be saturated or damp.

Practice

1) Confusing.
2) Not sure which step is the first step *
3) Is dismantling equipment the first step?
4) Question sequence is not clear.

Remediation

1) Maybe do remediation in point form.

Test

1) OK

2) Did not like camera angle of first question.
3) Very good.

Section: Decontamination Procedures

Instruction

1) Very easy.
2) Very clear.

Review

1) He did not mention 30 cm larger than spill.
2) Did not explain marking very well.
3) Should demonstrate clearly how to clean from the outsie to inside.

Practice

1) Question 4: Some confusion between throwing out paper towel and rechecking the area. People have said both to dispose of towel & recheck area.
2) Good

Test

1) Nicer if technician speaks but narrator was very clear.
2) Narrator does not specify marking 30 cm larger.

Section: Body Decontamination

Instruction

1) OK
2) How do you turn on water with contaminated hands?
3) If you are contaminated, how do you take vials to scint counter?
4) Gloves are removed wrong.
5) More detail on removing contaminated clothing.

Practice

1) Questions were inconsistent with instruction.
2) Gloves are removed in instruction but no questions about this in practice.

Appendix R
Pre and Post Test Mix Data

DIRECT CHECK MIX DATA (N=8)

	Pretest		Posttest	
	Correct	Incorrect	Correct	Incorrect
1)	___	_8_	_8_	___
2)				
a)	_5_	_3_	_8_	___
b)	___	_8_	_8_	___
3)				
1)	_1_	_7_	_8_	___
2)	___	_8_	_8_	___
3)	___	_8_	_8_	___
4)	___	_8_	_8_	___
5)	___	_8_	_7_	_1_
6)	___	_8_	_8_	___
7)	___	_8_	_8_	___
8)	___	_8_	_8_	___
9)	___	_8_	_8_	___
10)	___	_8_	_8_	___
11)	___	_8_	_8_	___
12)	___	_8_	_3_	_5_

SWIPE CHECK DATA (N=8)

	Pretest		Posttest	
	Correct	Incorrect	Correct	Incorrect
1)	___	_8_	_8_	___
2)				
a)	_1_	_7_	_8_	___
b)	___	_8_	_8_	___
c)	_2_	_6_	_8_	___
d)	_2_	_6_	_8_	___
e)	_1_	_7_	_8_	___
f)	___	_8_	_8_	___
g)	___	_8_	_8_	___
h)	___	_8_	_8_	___
i)	_1_	_7_	_8_	___
j)	___	_8_	_8_	___
k)	___	_8_	_8_	___
3)				
1)	___	_8_	_8_	___
2)	___	_8_	_8_	___
3)	___	_8_	_8_	___
4)	___	_8_	_8_	___
5)	___	_8_	_8_	___
6)	___	_8_	_8_	___
7)	_1_	_7_	_8_	___
8)	_1_	_7_	_8_	___
9)	___	_8_	_8_	___

SWIPE CHECK DATA (cont'd)

	Pretest		Posttest	
	Correct	Incorrect	Correct	Incorrect
10)	___	_8_	_8_	___
11)	___	_8_	_8_	___
12)	___	_8_	_8_	___
13)	___	_8_	_8_	___

DECONTAMINATION MIX DATA (N=8)

	Pretest		Posttest	
	Correct	Incorrect	Correct	Incorrect
1)	2	5	8	
2)				
a)		8	8	
b)		8	8	
c)	3	5	8	
d)	1	7	7	1
3)				
1)		8	7	1
2)		8	8	
3)	1	7	8	
4)		8	8	
5)		8	8	
6)		8	7	1

BODY DECONTAMINATION MIX DATA (N=8)

	Pretest		Posttest	
	Correct	Incorrect	Correct	Incorrect
1)	___	_8_	_8_	___
2)				
a)	_2_	_6_	_8_	___
b)	_3_	_5_	_8_	___
c)	_4_	_4_	_8_	___
d)	_1_	_7_	_8_	___
3)				
1)	_3_	_5_	_8_	___
2)	_2_	_6_	_8_	___
3)	_2_	_6_	_8_	___
4)	_2_	_6_	_8_	___
5)	___	_8_	_8_	___
6)	___	_8_	_8_	___
7)	___	_8_	_8_	___
8)	___	_8_	9) _8_	___
10)	___	_8_	10) _8_	___