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LA THÈSE A ÉTÉ MICROFILMÉE TELLE QUE NOUS L'AVONS REÇUE

Formative Evaluation of an Instructional Design Aid for Microcomputer Courseware Creation

Claudia L. Amasuno

A Thesis Equivalent

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ABSTRACT

Formative Evaluation of an Instructional Design Aid for Microcomputer Courseware Creation

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Microcomputers can now be found in almost every school, yet teachers are still heard to complain that they cannot seem to find the piece of software that exactly fits their needs. Many teachers are neither too familiar with computer capabilities nor with formal instructional design methods. In order to fill this gap, an Instructional Design Aid was created, based on the systematic approach to instruction and including pertinent microcomputer considerations. Worksheets accompany the guide. A formative evaluation was carried out on this design aid, using the method proposed by Dick and Carey. First, one-to-one evaluations were carried out with experts, then with subjects from the target population, and finally with a small group of subjects from the target population. The results of this evaluation, as well as the proposed revisions to the design aid are included.

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1. INTRODUCTION

Microcomputers in the classroom are the buzzwords for education in the 80's. They seem to hold the same promise to revolutionize education as television did in the 60's. Educational television fizzled out; proponents of computers in education hope that the same will not happen to this new technology.

Courseware presented on microcomputers is seen to have many advantages. Citing others, Stuart Crawford (1981) presents five:

1. As opposed to traditional modes of education, the student using C.A.I.* can never be totally passive.

2. C.A.I. has the potential to highly individualize the learning experience.

3. Experiments and situations too expensive and dangerous to reproduce in real life can be simulated and so explored by the students.

4. Teachers can become "facilitators" of instruction giving them more free time to aid each student individually.

5. The student is evaluated in a completely objective manner, eliminating any potential bias.

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* JEM refers to C.A.I. (Computer-Assisted Instruction), however, I prefer Godfrey's definition of C.A.L. (Computer-Assisted Learning) which puts the emphasis on the learner rather than on the instruction (Godfry & Sterling, 1982). This learner centered focus is part of the systems approach to instructional design.

In a review of empirical studies of student attitudes toward computer courseware, Lawton and Gerschner (1982) found that students perceived this type of instruction to "have infinite patience, never get tired, frustrated or angry, never forget to correct or praise, and to individualize learning" (p. 50). They also noted that technical considerations, such as the preparation of materials to produce low student error and so limit student frustration, are other positive elements of computer courseware. Students also feel that computers show no racial prejudice and are great motivators helping them learn more. According to Clement (1981) students like computers for the possibilities they offer to progress at their own pace, for the immediate feedback, and because if they make mistakes the machine does not embarass them.

Hathaway (1984), as evidenced by Hall's 1982 study, points out that computer instruction produced as much, and sometimes more, learning in less time than did traditional methods of instruction. Parry, Thorkildsen, Biery, and Macfarlane (1985) have compiled research results which show that computer-based instruction can result in learning gains for most learners, and that it "is particularly effective with low achievers" (p. 33).

If computer courseware offers all these advantages for both the teacher and the learner, then one must ask why more use is not being made of microcomputers in the classroom? Microcomputers have been accessible from a cost perspective for the last four years or so, yet enthusiasm for their use by teachers in the classroom has been somewhat less than overwhelming. Aside from the fact that teachers do not feel capacitated generally to teach programming, which is one of the

potential uses of the microcomputers, another reason seems to be the lack of exciting and instructionally well designed courseware. Roblyer (1982) feels that the microcomputer will come of age as an educational tool when quality courseware becomes available.

Alfred Bork (1984) states categorically: "Extremely little good computer-based learning material is available in any country. Much of the material, including commercially published material, is of very poor quality. The standards currently in use in computer-based learning material are extremely low . . ." (p. 1). Fisher (1982) concurs, saying that courseware is mostly simplistic and fails to exploit the full teaching power of the computer. C.A.L. instruction, Fisher concludes, is restricted neither by cost nor by fear on the part of the teachers, but rather by poor quality courseware. "Much educational software does not incorporate those features of the computer that make it a unique learning tool, such as colorful graphics, sound, fast-paced action, and branching capabilities" (Bitter & Gore, 1985, p. 18).

Roblyer (1983) suggests that the reason that microcomputers in education have not been as effective as expected is because the "courseware materials have been insufficient to the task, and that methods used to develop courseware are the source of many of the problems and limitations" (p. 23).

There are many reasons why courseware has not lived up to expectations. First and foremost is the fact that there are very few people who have all the requirements to become courseware designers. To design courseware one would have to be a content specialist (probably the teacher could be considered as such), an instructional

designer and a programmer. Although most people are not these three things, it is generally felt by teachers with new computers that they should take it upon themselves, albeit without any training, to create programs to fit their own needs and the needs of others. Faced with a new technology, and probably not being instructional design experts, it is no wonder that the courseware they produce is not of top quality. "Content specialists, however, often have not received professional preparation as educators and therefore may be unaware of basic instructional design principles and procedures" (McPherson-Turner, 1979, p. 47). Clement (1981) states that those who developed computer-based instructional materials in the 60's and 70's were not very experienced in the principles of instructional design. Teachers need guidance in the creation of computer-based instructional materials, for faced with the new delivery vehicle and a new approach to instructional design they seem to have a lack of confidence and do not know whether the instructional design or computer system should provide the basis for the development of the materials (Eisele, 1978). Sometimes it even seems that educators are left to carry out computer-related responsibilities armed with little more than intuition (Hall, Comer, & Merrill, 1982).

Based on this evidence, there appears to be a real need to familiarize teachers, who are or soon will be in contact with microcomputers, with both instructional design principles and the capabilities of the microcomputer so that they can be helped to create pedagogically effective courseware.

The design of educational courseware has been both helped and hindered by the microcomputer's unique capabilities. On the one hand some

of the creators of courseware, who are probably more programmers than teachers or instructional designers, have been overwhelmed by the technical possibilities of the micro and have put great emphasis on their virtuosity as programmers, while on the other hand, in other cases, these capabilities have not been put at the service of instruction.

Ragsdale (1982) feels that this tendency to view courseware as a program must be combatted. It should be viewed as instruction from which students learn. Wall and Taylor (1982) believe that there is a need to shift to more dynamic interactive systems with the focus on the learning of the person rather than on the program.

Learning theory must be wed to the microcomputer's unique capabilities if this medium is to reach its full potential in helping students to develop higher level cognitive skills. Caldwell (1980) sees the microcomputers as having this potential. Programs can be designed that "will use the capacity of the microcomputer system in a way that will develop in learners a range of cognitive skills and help learners to evolve useful learning strategies" (p. 7). Kehrberg (1979) advocates courseware that uses the unique capabilities of the computer to achieve educational goals and objectives. Viki Blum Cohen (1982) concluded after examining several programs that these did not use instructional strategies which facilitate conceptual learning and subsequently did not stress higher order skills. However, she does feel that the micro is up to this task, for if its unique capabilities are used these can "affect learning in a unique way" (Blum Cohen, 1983, p. 9).

Utilized by those with a full understanding of the technology, then microcomputers "can be an extremely powerful and exciting instructional device that promotes higher learning in the student. . . There is a great need to incorporate instructional strategies into the design of all types of computer-based materials and to try and increase the quality of interactivity within the program" (Blum Cohen, 1984, p. 17). The ultimate success of the microcomputer in the classroom depends on the quality of the courseware.

Another problem faced by novice courseware designers is the temptation to computerize all experiences. This tendency has led to boring and ineffective courseware which does not take advantage of the computer's capabilities and was created simply because the untrained teacher found a computer in the classroom, and this computer had to be used.

Rawitsch (1983) states that "if activities are worth implementing on the computer, they should be taking advantage of computer capabilities which are not available through other methods" (p. 332) of instruction, and Christine Johnston (1983) feels that "good courseware . . . makes appropriate use of the medium" (p. 11).

Good materials are "self contained, a complete learning experience on the computer" (Bork, 1984, p. 2). This is one of the unique capabilities of the computer; it can create an interactive, visual, tactile and auditory experience all at once. Kehrberg (1979) suggests incorporating as many sensual experiences as possible and designing the courseware for active users. A failure to do so will mean that we'll lose the students, for theses have been weaned on Sesame Street and so demand a high level of entertainment. Bork (1984) agrees that learning

must be an active process "if ideas, methods, [and] concepts are to be internalized" (p. 2).

Microcomputers not only offer the possibility of enhancing learning but also afford the opportunity of making it more fun. Learning and enjoyment are not anathema contrary to the belief of many students. Roblyer (1983) declares that students should enjoy themselves and Lally and Macleod (1982) state that enjoyment is a powerful motivator contributing "strongly to the speed with which skills are acquired and to the level of proficiency achieved" (p. 450). Malone (1983) analysed video computer games that have turned some youngsters into video-game addicts and wonders why courseware cannot be made as fascinating and fun using the same techniques.

Enjoyment does not also necessarily preclude creating instructionally sound courseware. In his analysis Malone (1983) found that computer games had goals and that these were personally meaningful, rather than just goals using skills (like solving math problems). These goals had a variable difficulty level, and this is important because if the goal is certain to be reached then there is no challenge and so there will most likely not be too much interest. These video games also provide immediate and constant feedback. These aspects of some video games are all accepted as part of the systems approach to instructional design and demonstrate that learning can be fun as well as an instructionally sound experience.

It is suggested that the increased use of systematic instructional design methods will help to "improve the overall quality and usefulness of courseware" (Roblyer, 1983, p. 23) since instructional design methods have been proven to be useful in creating effective

instruction. Systems approach instruction was found to produce greater gains in a shorter time than did other medthods.

Instructional design is important regardless of the medium and in dealing with micros "an emphasis on a more systematic approach would be a productive union of knowledge from the past with a new technological opportunity" (Roblyer, 1983, p. 24).

If relevant learning theories are combined with the knowledge of the unique educational possibilities offered by the microcomputer in the design of courseware, then perhaps the microcomputer as an educational tool will reach its full potential.

In view of the consensus that there seems to be a dearth of instructionally sound microcomputer courseware, it is the objective of this thesis equivalent to design a package to facilitate the development of computer courseware based on an instructional design model, taking into consideration the unique educational possibilities offered by the microcomputer.

2. LITERATURE REVIEW

McLuhan's "the medium is the message" should give us confidence in affirming the educational possibilities offered by the unique capabilities of the microcomputer. If these capabilities are not fully exploited, then why should one bother to use the microcomputer if any other medium will do just as well and probably not be as much of an investment in both time and money?

Faced with a medium that is potentially interactive and adaptive to the student's needs, this student can develop new learning strategies based on the use made of this flexible medium. The unique capabilities of the microcomputer can be put to the service of instructional design and in this way an exciting new door is opened to ways of learning!

2.1 Microcomputer Capabilities

2.1.1 Interactivity

The possibility of interactivity between microcomputer and student seems to be one of the most salient capabilities of the microcomputer in the learning process. It is this that sets the microcomputer (and other types of computers) apart from other learning media. The computer gives its undivided attention to the student for the whole period that the student is in front of the screen; it attends to only that student and is immediately responsive. In contrast, most teachers can only give a few minutes a day to each individual student. Interactivity is what causes programs to work; some response must be

elicited from the student--even if this is only the pressing on any key on the keyboard, or just touching the screen. Many authors refer to this capability of the microcomputer when they discuss instructional design, but generally feel that just pressing any key will not lead to higher levels of cognitive activity. Hall (1983) states that deep cognitive processes will not occur if the learner just "watches"; the student must "manipulate the content material in ways . . . not directly taught" (p. 2). In order to achieve higher level learning using a microcomputer, teachers must take a new look at computer courseware and not design it as if they were teaching a class. Bork (1984) stresses the importance of "the quality of interaction" (p. 3). Blum Cohen (1984) favours interactivity that requires a "qualitative response . . . from the student for the instruction to continue" (p. 16), as well as variety in the type of responses so as to avoid boredom.

2.1.2 *Individualization*

Interactivity is intimately linked to another unique feature of the microcomputer; this is the possibility to individualize or customize the courseware to answer to the needs of the student and to cater to the preferred learning style of the student. Jonassen (1984) suggests that through variety of the instructional process a computer-learner dialogue can be established "based upon the types of learner differences you wish to accomodate" (p. 21). These different learning styles or differences can be accomodated by learning procedures composed of "parallel and alternative learning activities" (Ferraris, Midoro, & Olimpo, 1984, p. 41), as well as different

learning strategies (drill and practice, tutorial, etc.) designed to achieve the same goal along with the incorporation of different levels of detail corresponding to the student's level of knowledge.

For learning to be efficient it should take into consideration the different characteristics of the learners (Wade, 1980). Another way to do this is to allow the students to choose the most efficient sensory input mode (visual, auditory or tactile) for them (Wade, 1980). Caldwell (1980) also advises a multisensory format where possible.

The placement of the student can also be diagnosed by a pretest or set of questions in the courseware so that the entry point or offered menu for each student will be appropriate to his/her level of knowledge or skills (Hannum & Briggs, 1982). In this way the student is challenged to move ahead and does not find him/herself doing boring exercises which are below his/her capabilities. In this case the interaction of the student causes the courseware to become customized; each student by his/her performance may create and follow a unique pathway through the material. This program diagnosis and subsequent branching is not the only method that the courseware may be designed. Another way may be a path preset by the teacher and another may be a path chosen by the student or the student may even be given the choice of having the teacher or program choose for him/her. The option to change options after beginning on a certain path is another possibility to give the student even more choice and freedom. The important thing is to give the student as many options as possible to freely choose the learning path most suited to his/her preferred learning style. Blum Cohen (1984) states that this active type of learning is desirable and "has been shown to facilitate instructional effectiveness" (p. 16), as

well as promoting higher level learning by allowing the student to organize the material according "to individual needs and his or her own internal logic-order of the subject matter" (p. 17). Future retention of the content is induced by allowing the student to organize and cluster the material in a way that is natural and logical for him/her (Flavell, 1977).

2.1.3 Branching and Modularization

Another feature of the microcomputer which can enhance the quality of interaction is to allow the student to choose or change paths (as already mentioned) through the material, or to exit or enter at any point. This branching can be done if the courseware is modularized when it is designed. The content and different options (HELP, REVIEW, POSTTEST, etc.) can be divided up into small segments that stand alone and so students may do only the segment or segments that they have time or patience for. Their score (if desired) and exit place can be monitored so they can plug into the same or another segment at a future date.[7]

The same lesson may have different levels or tasks associated with it according to the student's level, needs, or preferences as determined by choice or a placing mechanism at the beginning of the program. Caldwell (1980) suggests that the programs "be modularized and structured in coherent hierarchical patterns" (p. 8); this allows students to skip sections that they feel they have already mastered, and so avoids frustration.

Modularization assures greater flexibility of the materials. The students can move along at their own pace and take their own

individualized path through the material. It also makes the content easier to design and units can be added or deleted as required. Blum Cohen (1983) states that in this way the content may be altered by other teachers who may want to change its level or parameters.

A program may branch to two different HELP options. One may be instructions to help the student to use the program (i.e. get from one segment to another) and the other to help with the learning task itself. These two options should be called up by different names. These names should be meaningful; the first one might be called INSTRUCTIONS and the second HELP. This HELP option should be truly helpful. Simply restating instructions or the same definition over and over again will not really help the student to advance. The HELP option should be leveled, revealing more and more detailed information as the student requires it in connection with the different tasks or concepts to be learned. This function of the microcomputer makes the courseware "more user-friendly and supportive of individual needs" (Blum Cohen, 1984, p. 18).

By being allowed to choose the learning path, the HELP option and even to change the parameters of a lesson (the number of examples or problems, if and when to take a posttest, and even the mastery level required) the student takes more responsibility for learning and this creates a "richer instructional dialogue" and "promotes a greater amount of achievement" (Blum Cohen, 1984, p. 18).

2.1.4 C.A.L. Strategies

Individualizing C.A.L. courseware is "important in maximizing learning efficiency" (Wade, 1980, p. 34), but it also must not be

forgotten that, although the emphasis in C.A.L. is on the learner, the selection and use of the instructional strategy must be appropriate to the learning tasks (Hannum & Briggs, 1982) and media. Not fully utilizing the capabilities of the microcomputer has been one of the greatest defects of C.A.L. courseware. Many programs are just workbooks transposed to the screen with questions added at the end and with very little feedback other than "Great" or "Try again."

Since it is not clear from research that C.A.L. is better in all cases than other media, Leiblum (1982) feels that it is preferable to use C.A.L. for its ability to resolve certain finite instructional problems. Among others he suggests it be used to provide remedial instruction, to act as tutor in areas that often present learning difficulties to students, to aid in drill and practice and problem solving where there is inadequate teacher help available, and in situations which are likely to improve or speed up learning by using the computer's unique capabilities.

Others see gaming and simulations as part of the computer's greatest potential strengths in education, for both of these allow the "opportunity for incorporating motivational principles in order to maximize student motivation" (Spitzer, 1977, p. 67). Simulations are considered cost effective and safe (you don't have to drop a real nuclear bomb to calculate its effects). Baker (1983), however, feels that in some cases (not all) it is still better to go out and watch Mother Nature in action rather than to try to simulate her.

Isay (1983) thinks that the software in the "adventure-game formats is among the best available" (p. 10). The attraction of these games is their "ability to offer surprise and the opportunity for

mastering the unknown" (p. 10). They allow for "much creativity in accomplishing tasks, but the goals and assumptions are readily apparent" (p. 10). Malone (1983) also feels that the three main characteristics of computer games, challenge, fantasy, and curiosity can be used "to make learning with computers more interesting and enjoyable" (p. 241). Caldwell (1980) thinks that games "can stimulate motivation by capitalizing on a novelty effect" (p. 9). For Whiteside (1985-86), the context of challenge in computer-based adventure games "can foster the development of problem-solving skills" (p. 116). Although Baker (1983) does not negate that educational games are an appropriate strategy for the computer, he does caution against the indiscriminate use of games just because they exist, and wonders if the "curriculum is planned to include games at all costs or are learning games selected to fit a rationally structured curriculum?" (p. 207)

To teach higher level thinking skills, Lois Edwards (1983) feels that using the computer for simulations, educational games, and as a problem-solving tool could be especially appropriate for gifted students. Bitter and Gore (1985) also point out that the computer can be used as a problem-solving tool, and therefore suggest the use of software that encourages the trial and error method of discovery. These strategies are suitable for students as they require or encourage divergent thinking, problem finding and solving, and risk taking.

It is important to take into consideration the needs and level of the students when selecting a strategy. Although offering the same material under different strategies and allowing the students to choose may be the optimal solution, they should also have the possibility to

change their minds, and strategies, if they decide part of the way through that they are in above (or below) their heads.

Although drill and practice courseware has often been maligned because it is repetitive and its authors have shown either little imagination in its creation or have not fully used the microcomputer's capabilities to enhance its potential, there are authors who defend its use. Isay (1983) says that although this strategy has been much put down it can still be "a very useful tool" (p. 10). He states that its two greatest flaws are that "it repeats the narrowness of the workbook, and it misdirects the special qualities of the computer" (p. 10). Drills, however, that diagnose the user's weaknesses and direct him/her to remedial material are helpful. Malone (1983) thinks that "automatic difficulty adjustment" combined with the use of a fantasy goal (instead of it just being so many correct answers) as in computer games can make the drills more exciting and motivating.

The tutorial strategy can be used to teach new concepts. In this mode the computer is the repository of the knowledge and it "tutors" the student. Hall (1983) finds this mode attractive if it leads to higher levels of thinking. This he believes can be done if questioning is conducted "purposefully and systematically" (p. 4). Remedial feedback presenting the material in different ways can be an important part of this strategy.

It is not necessary to just use one strategy in one lesson. Several strategies may be combined to enhance learning. "Tutorials should be accompanied by creative drills or instructional games that

reinforce skills and information and enhance the interactive nature of instruction" (Caldwell, 1980, p. 9).

2.1.5 Feedback

Perhaps the most subtle of the computer's capabilities to aid learning is the possibilities it offers for different forms of feedback and especially for the immediacy of the feedback. Different appropriate responses have to be anticipated by the courseware designer so as not to frustrate the student. Inappropriate responses can be followed by additional help to guide the student towards the appropriate responses (Eisele, 1978).

Blum Cohen (1983) feels that the main role of feedback should not be to strengthen or reinforce correct responses but rather to locate errors and provide additional information to help in the correction of these errors. Caldwell (1980) refers to this aspect of remedial feedback as prompts. These prompts should reflect an analysis of the error and provide specific information to the learner about the nature of the error and be meaningful because they lead to the desired outcome. These also reduce learner frustration and avoid having students guess until they get the right answer.

Remedial feedback should not just return to the original presentation of the information but present it using an alternate approach (Blum Cohen, 1984) and successively reveal more information as needed. It was found that students who received only the correct answer as feedback retained significantly less than those who received more detailed feedback (Crawford, 1981). Feedback following wrong responses is more beneficial to learning than only providing positive

feedback (Blum Cohen, 1984). "It is not the reinforcing effect which primarily promotes learning but the informational content of the feedback which helps the student to locate and correct inadequacies in his cognitive processing" (Tait, 1984, p. 17).

In his study of computer games , Malone (1983) found that "to engage learners' curiosfty, the feedback . . . should sometimes be surprising" (p. 246), as well as constructive. It can "provoke curiosity by presenting a paradox or revealing an incompleteness in the learner's existing beliefs" (p. 246).

If feedback is reinforcing it is important that the feedback for an incorrect response not be more rewarding, exciting or motivating than that for a correct one (Kehrberg, 1979) and if negative feedback is offered (many feel it should not be offered), it should not be "of damage to one's self-esteem" (Malone, 1983, p. 243).

The type of reinforcement should be appropriate to the user's age and level (Blum Cohen, 1983). Users, even very young ones, are becoming very sophisticated and they easily see through and get bored with the graphics and musical reinforcement routines and prefer reactions to their errors (Isay, 1983). It is also not necessary for reinforcement to follow every correct response and it has been found that different reinforcement schedules and delaying feedback can cause learning to be retained longer (Crawford, 1981).

Feedback should motivate towards the goal (Damarin & Damarin, 1983); this appears to happen when the students can monitor their own progress. A status report should also be given at the end of each segment (Kehrberg, 1979). "Any tables which are updated as a result of student interaction should be continuously displayed on a part of the

screen" (Kehrberg, 1979, p. 108). This continuous visual representation of the score seems to be one of the ways that computer and video games attract and maintain the attention of the players. In these games, movement, sound, and colour provide feedback about the player's performance "and encourage players to seek greater and greater heights of achievement" (Lally & Macleod, 1982, p. 450).

2.1.6 Self-containment

Many view computer courseware as but a part of a whole unit made up of teacher and student manuals and the actual computer courseware lesson. Although it is a good idea to provide some written information for the teacher (with content, level etc.) it seems that the less one complicates the student's life with manuals, the better.

One must not assume that the user has access to the manual and even if the manual is available "it probably will not be read. . . .The device should document itself" (Clanton, 1983, p. 263-264). One way to simplify the use of C.A.L. is to use a familiar object as a model so that you don't need a manual or even an INSTRUCTIONS or HELP option to understand how it functions, e.g. Apple's Lisa uses the mouse to press the keys of a hand calculator (Sam Edwards, 1983).

Students do not want to read a few chapters on how to make the program work; they want to sit down in front of the computer and DO something. Beyond having to be told to slip the disk in and turn on the power, the program should be self-contained and self-explanatory. "Good software teaches you to use it as well as teaching you content. This 'lead-me-by-the-hand' quality is very important because it

demystifies the computer and makes everyone comfortable at the keyboard" (Isay, 1983, p. 10).

The screen should maintain the students' attention and guide them through the program without having to refer to a manual to see how to get to the next unit or menu. If the computer is going to be busy for a minute it should tell the student it is busy and not leave a blank screen and have the student think something is not working. A permanent coded line may appear, or be called up easily, at the top or bottom or side of the screen, so that the student may know how to get to any of the options available, e.g. HELP, REVIEW, MENU, etc.

A computer courseware unit can be completely self-contained. It may begin with an explanation of how the program works, followed by a pretest, exercises, examples and demonstrations, information presentation, practice, remediation, posttests and scorekeeping.

2.1.7 Graphics and Cueing

The computer is not a written medium and text should be kept to a minimum. It is "wise to minimize the amount of text on the screen at any period of time" (Kehrberg, 1979, p. 107). Caldwell (1980) suggests that learners be shown rather than told. "The overuse of exposition is the single biggest mistake instructional designers make" (p. 8). Even instructions and directions can be provided using the computer's capabilities to flash, erase, underscore, rewrite, and animate.

If text must be used, then research and common sense have come up with some useful guidelines:

Use larger characters for younger children.

Break up the different frames by interspersing questions.

Do not allow the screen to scroll.

Allow the student to control the rate of display.

Do not overload the screen (Kehrberg, 1979).

Do not hyphenate words (Brockman, 1982).

Double space the text (Caldwell, 1980; Hathaway, 1984).

Allow or incorporate frequent rest breaks if the text is very long.

Use upper and lower case letters.

Use a letter size that is sharp, defined, and clear (Hathaway, 1984).

In order to avoid tedium and eye fatigue there is a need for diversity in the types of formatting and for the addition of non-textual elements (Kidd & Holmes, 1982). The microcomputer's unique capabilities are ideal to furnish these. Information that is an undifferentiated mass difficults both comprehension and retention and so attention can be directed using such cueing devices as color, underlining, spacing, graphs, diagrams, and visual imagery (Kidd & Holmes, 1982).

Caldwell (1980) states that too much text can discourage the learner and so suggests using reverse highlighting and graphics to accentuate important sentences or words. Color can be used to color code feedback, provide prompts, and direct attention. Animation, graphics, and cartoon characters also create variety and interest (Caldwell, 1980).

Since Heckel (1983) feels that "software . . . is a visual medium," he states that "authors should resort to words as a last resort" (p. 144). Even cinema is a visual medium, according to him,

and he feels that he is supported by Alfred Hitchcock, whom he quotes: "When we tell a story in cinema, we should resort to dialogue only when it is impossible to do otherwise" (Heckel, 1983, p. 144).

To understand how a visual medium works, Heckel (1983) has studied Walt Disney's cartoons and states that the principles that made Disney successful can help make computer courseware successful too. Courseware designers can try to use some of the same techniques as the Disney animators:

The audience is involved - a familiar or appealing idea or character is used.

"Identify the essence of what should be communicated in a scene and determine the minimum needed to say it" (p. 147), (i.e., don't crowd the screen).

"Slow in" and "slow out" (p. 147) are used to draw the user's eye and attention.

Every scene (screen) is interesting and advances the story.

Blum Cohen (1983) concurs with this when she states that the action should occur on the screen.

Although the use of graphics can enhance learning if used appropriately, its indiscriminate use can turn learners off by frustrating them if the routine that is supposedly 'rewarding' them slows them down or bores them. The use of graphics should not distract the learner nor detract from the content. The graphics should be embedded in the content to support it and add interest (Blum Cohen, 1983).

Graphics and other cueing devices can be used to jog the memory and provide cues for new information. Cues can also slowly be

withdrawn or fade (Blum Cohen, 1983) as the learner becomes more familiar with the material.

2.1.8 Random generation

Random generation allows sets of exercises or tests to be partially or completely different each time the courseware is used either by the same student or by different students. This feature is especially helpful to keep drill and practice exercises from becoming too monotonous. Caldwell (1980) suggests that three times the number of items be put into the pool as will be used in the exercise. With a random number generator for math problems, the possibilities are infinite.

The use of the memory of the computer as a data base can help students have access to more information and can also be the source of the algorithmic generation of problems.

2.1.9 Computer-managed instruction

Complete and detailed records of every student's performance can be kept by the computer courseware program. Three things area achieved by keeping these records:

1. The teacher can monitor the student's progress and see exactly where the student is making errors so that remedial steps can be taken.

2. The computer can monitor the student's error patterns and send the student to appropriate remedial material.

3. If the student knows his/her work is being monitored it will discourage him/her from putting in unacceptable answers or names. (The program will only run if a name that matches the teacher's list is

input. A student number may also be required to keep students from practicing under someone else's name.)

2.2 Instructional Design

Dealing with the unique capabilities of the microcomputer is only part of the total design of C.A.L. courseware. These qualities are crucial as they are what separates computer courseware from other types of educational media. Sugihara (1983), the Director of Electronic Publishing for Harcourt Brace Jovanovich Inc., feels that presently courseware development reflects "the relative immaturity of the field," but "as we gain a better understanding of the 'nature' of the computer, we will be better able to make the most of its special qualities" (p. 13).

These special qualities alone will not lead to pedagogically sound courseware. They can be put at the service of an instructional design model and enhance many aspects of it; they "should not, [however], overshadow the importance of instructional concerns" (Rawitsch, 1983, p. 332).

In order to unite this new technological opportunity to instructional design, the systems design model has been chosen. Research seems to be proving the effectiveness of the instructional systems approach (Hannum & Briggs, 1982). Roblyer (1983) concurs: "Systematic instructional design methods have proven utility in creating effective, useful instruction" (p. 24).

Since this model is a theory-based one, culled from the knowledge of how humans learn, it can lead to predictable learning outcomes and if formative evaluation is practiced the effectiveness and quality of

the material can be maintained. The quality of traditionally developed instruction, however, is very uneven and usually unpredictable (Hannum & Briggs, 1982).

Hannum and Briggs (1982) define this systematic type of instruction in terms of general systems theory. "The instructional system is viewed as composed of various interrelated components functioning together to achieve a purpose" (p. IO). Roblyer (1983) expands a bit more: "The theory behind all systems approaches is that desired skills can be identified and instructional conditions can be arranged to make given students capable of learning the skills. The product of a systematic approach is a sequence of instruction designed to teach the skills efficiently and effectively" (p. 27).

Hannum and Briggs (1982) present a description of the main elements of a systematic approach to instructional design. These are:

Goals and Instructional Environment

The goals are derived from an analysis of the environment of that system. These can be based on a needs assessment.

Performance Objectives

A specific statement of the objectives of instruction is presented in terms of the observable outcomes expected from the learners.

The Learner

This approach is student centered. The general characteristics and specific capabilities of each learner (entry behaviour) before beginning the instructional sequence are identified so as to place the learner at the most appropriate point in the sequence. If the instruction is not successful it is the instruction, not the learner, that is considered ineffective and changed.

Instructional Strategies and Media

These are appropriate to the learning tasks and to the characteristics of the learners. The idea of a "best" medium is rejected.

Lesson Design

A. A learning task analysis is carried out in order to effectively sequence subordinate skills (hierarchies are established and objectives sequenced).

B. Provisions are made for desired instructional events. Selection of media and content is intended to initiate the desired events. Gagné's conditions for learning are utilized. These are:

1. Gaining or directing attention;
2. informing the learner of lesson objective;
3. stimulating recall of prior learning;
4. presenting stimuli with distinctive features;
5. guiding learning;
6. eliciting performance (student response);
7. providing informative feedback;
8. enhancing retention and learning transfer;
9. assessing performance.

These external events support the internal learning process hypothesized to occur.

Formative Evaluation

This evaluation is based on data regarding learner performance in terms of expressed objectives. It is the process of instruction, not the outcome (student progress) that is evaluated.

Student Performance Measures

Evaluation is objective based. Mastery of the objectives is measured. Students are compared to a desired standard or criterion, not to each other.

Several models for the systematic design of instruction are available. Although they all present in general the main elements discussed above, they vary in their degree of comprehension and detail. For example, Romiszowski's (1981) is perhaps the most comprehensive one, whereas Gagne and Brigg's (1979) offers greater detail for its implementation. Somewhere in between is Dick and Carey's (1978): not as comprehensive as the other two, it is, however, very explicit in the explanations for its use. This level of detail, although making it the most expedient model of the three, still requires that considerable time be spent by the user if its application is to be profitable.

One probable cause for this is the fact that several possible media are considered in the model. Another is the number of examples from different situations that are used to illustrate the steps. It was felt that adapting this model to the specific situation of the microcomputer medium, and rewriting it as a job aid, could help reduce the time needed for its application by teachers, who may or may not be acquainted with instructional design.

2.3 Conclusion

The literature review leads us to conclude that computer courseware which appropriately maximizes the use of the computer's unique capabilities is lacking. Missing from available courseware also

is a learning-theory base which effectively exploits these capabilites. Therefore it is the aim of this thesis equivalent to propose a model which will unite the capabilities of the microcomputer with the principles of instructional design.

3. THE PROPOSED MODEL

Many agree that the systems design model favours effective and efficient learning and many also believe that the microcomputer as an educational tool has great potential if instructionally sound courseware is developed. It is therefore the aim of this thesis equivalent to bring together these two elements (instructional design principles and microcomputer capabilities) in a model (instructional design aid) for computer-courseware development. This model should prove useful for the creation of instructionally sound courseware which will, at the same time, make effective use of the microcomputer medium.

At present there seems to be a lack of courseware development models that use the systems approach to design and which are succinct as well. Brevity is of great importance if a model is to be used.

Other models may offer more detail, but at the risk of scaring off potential users who are immediately intimidated by the bulk of the material they have to plow through, before even beginning to design their courseware.

Crawford's document on courseware design (1981), although very complete, is quite long giving much detail on different topics, which although 'nice' to know, are not 'necessary' to know, if what the user wants to do is immediately begin the designing process.

Mahy and Basque's work, Guide de création de didacticiels (1983) is oriented predominantly to screen design and does not deal in any substantial fashion with instructional design theory.

The Author's Guide, published by CONDUIT (1981), is more user friendly in that information is presented in small bites and is easily accessed. However, it does not get the user working by involving him/her in the creative process.

The proposed instructional design aid, in its introduction, only presents a few brief notions on what makes computer courseware successful and then, in the design section, immediately puts the user to work systematically designing the courseware, by having him/her answer pertinent questions and directly implementing the answers on an accompanying worksheet .

The specific model chosen is the one by Dick and Carey (1978). This model contains all the elements considered, either explicitly or implicitly, in the articles of Hannum and Briggs, Gagne, Wager, Caldwell, Blum Cohen, and Roblyer among others. It was felt that this model would also be easily adaptable to the creation of microcomputer courseware.

3.1 Development of the Model

Dick and Carey's model was also applied in the development of the instructional design aid. The following steps were elaborated:

A) IDENTIFICATION OF INSTRUCTIONAL GOAL

The instructional goal for the instructional design aid is that the users of the aid will be able to create courseware for the computer using instructional design principles and incorporating the specific capabilities of the microcomputer.

B) INSTRUCTIONAL ANALYSIS

The instructional analysis for this activity is provided by Dick and Carey and is better summarized in their model (see Figure 1 on page 32). This model is further simplified in the following set of subordinate skills needed by the users to achieve the instructional goal:

1) Formulate an instructional goal
2) Conduct an instructional analysis of the content
3) Identify the entry behaviours of the learners
4) Describe the general characteristics of the target population
5) Formulate performance objectives
6) Design criterion-referenced tests
7) Develop an instructional strategy
8) Develop the instructional materials
9) Become familiar with the capabilities of the microcomputer.

C) IDENTIFY ENTRY BEHAVIOURS

The target population for the use of this model are people associated with the teaching profession, who may or may not have already taken an instructional design course and who are attempting to design a piece of courseware to be used on the computer.

Since not all of the target population may be familiar with either the concepts of instructional design practice, or the different capabilities of the microcomputer, all the steps identified in the instructional analysis will be included in the instructional materials provided for the users.

Figure 1

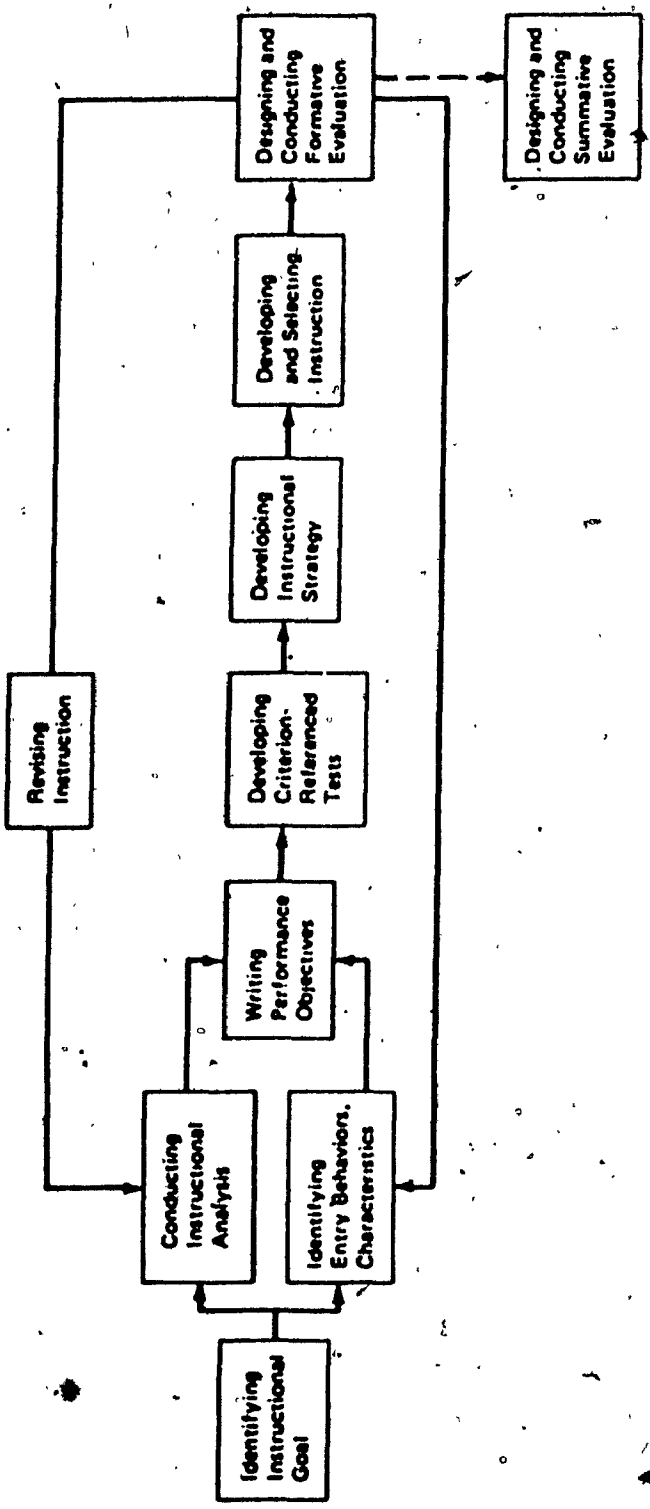

Figure 1.1 Systems Approach Model for Designing Instruction

D) PERFORMANCE OBJECTIVES

Each set of performance objectives for this instructional design aid were obtained from each step to the instructional analysis as indicated by their numeration.

1.1 Users will be able to formulate an instructional goal in general terms, which cover all the contents of the material to be presented in their courseware.

1.2 Users will not make the instructional goal as specific as their performance objectives.

2.1 Users will identify the subordinate skills or knowledge needed by their target population to use the courseware.

2.2 Users will identify subordinate skills or knowledge needed by their target population to attain their instructional goal.

3.1 Users will identify which skills their target population will already possess.

3.2 Based on these skills, the users will identify the entry point of the courseware and decide whether or not to include subordinate skills in the courseware.

4.1 Users will describe the relevant characteristics of their target population.

4.2 Users will correlate the characteristics of the target population with courseware design considerations.

5.1 Users will write performance objectives which specifically identify the skills their target population will need to learn to reach the instructional goal.

5.2 In their performance objectives, the users will identify the conditions under which their target population must perform these skills, and the criteria for successful performance.

6.1 For each performance objective specified, the users will create an assessment instrument which will measure the learner's achievement of the objective.

6.2 Users will choose among the different types of criterion-referenced tests presented. These are entry-behaviour tests, pretests, embedded tests, and posttests.

6.3 Users will decide which medium they will use to present their chosen assessment instruments.

6.4 Users will write clear instructions for these tests, as well as including examples and practice opportunities.

6.5 Users will decide whether these tests are to be speeded or not.

7.1 Users will decide upon the means to achieve their terminal objective or instructional goal, by identifying preinstructional activities, the mode of presentation of information, the type of practice and feedback, and any follow-through activities.

7.2 Users will choose which presented instructional strategy or combination of instructional strategies for the microcomputer will best lead to the achievement of their instructional goal. These are drill and practice, tutorial, simulation, and educational games.

7.3 Users will identify which parts of the courseware will be presented using which strategy.

8.1 Users will choose vocabulary, exercises, tests, and feedback which are appropriate to their target population.

8.2 Users will use feedback which is either enriching and/or remedial.

8.3 As well as the courseware itself and the criterion-referenced tests, the users, who wish to, will create a teacher's guide or manual.

9.1 Users will choose among the computer capabilities presented to develop different areas of their instructional materials.

E) CRITERIA FOR EVALUATION OF THE MODEL

No tests per se will be administered to the users of this instructional design aid. The checklist of questions used to guide them through the creation of the courseware will be compared to their finished product to see if all the appropriate steps have been included and the work corresponds to the attainment of the performance objectives of this instructional design aid.

Templates for each user will be created and the result of a comparison of the finished product with the checklist of the questions and with the performance objectives listed in D above, will be kept.

F) DEVELOPMENT OF AN INSTRUCTIONAL STRATEGY AND MATERIALS

Since many of the members of the target population are not skilled at using a computer, but have all had great practice with the use of pencil and paper, or typewriter and paper; it was decided to make this a "pen and paper" exercise. This is a portable and flexible medium. Since it is not important where this exercise is completed, this medium seems appropriate; it can be carried to the office or to the sofa; one does not have to wait for someone else to get off the computer to begin. Any free moments can be used to work on this exercise.

Since most people in our "time is money" culture are usually short of time (and probably money too) it was decided to make this into a job aid that would not require great amounts of reading or preparation in order to begin. A short review of computer capabilities will precede the actual design model. All instructional design principles and microcomputer capabilities will appear in the form of questions which will guide the user to the creation of the courseware. Guided by this checklist of questions which indicates what each step is to contain, users will write up their answers to these questions. When these questions have been answered, the courseware design will be completed.

Users will then read the sections about the design and carrying out of the formative and summative evaluations as well as about the revision of the courseware. The users are not expected to complete these parts of the instructional design aid.

The result of this instructional strategy is Appendix A.

4. EVALUATION PROCEDURE

Formative evaluation of the proposed instructional design aid was carried out following the first two steps of the method elaborated by Dick and Carey (1978). The first step was an independent evaluation obtained from three content experts. The second step was a one-to-one, or clinical evaluation, with two subjects who are typical of the target population. These represented the average group. It was not possible, at the time, to find anyone representing those who are slightly above or below the average. The final step was a small-group evaluation done with 14 subjects from the target population.

Feedback, collected at each step, was analyzed and used to modify and revise the instructional design model.

4.1 Evaluation Method

4.1.1 Expert Evaluation

A first version of this instructional design model was presented at the 4e colloque du CIPTE (Singer & Amasuno, 1983) where it received a critical review from two experts (Harold Stolovich & Jean Louis Plante, 1983). Their suggestions were taken into consideration and Appendix A presents the modified version of the model.

At the time the one-to-one evaluations were taking place, the opportunity arose to have a third expert examine the model. This third expert, a professor of Instructional Design at Concordia University, Mariela Tovar, had no problems with the model, but did have many useful

suggestions about what might be changed in order to facilitate its use by other subjects. This expert suggested that the aid be made as practical as possible; to this end the vocabulary should not be too academic in nature. This expert suggested the following:

1. The terms "mnemonic cues" and "necessary, nice, or nuts to know" should be removed.

2. In the phrase "Are the objectives achievable?", (p. 26) the last word should be changed to realistic.

3. In the Conduct Instructional Analysis step, in the question "Have you identified the learner needs?", these last words should be changed to subordinate skills.

4. In the Develop Instructional Strategy step, the question "Is each idea no longer than two sentences?" should be changed to "Is each idea expressed in as concise a manner as possible?"

5. In the Introduction to the Model, in the section on Coursewre Design, the subtitle called "Self-containment" should be changed to "Self-explanatory" and that the reference to self-containment in the text of the section be eliminated.

6. For the formative evaluation of the model the content and the target population should be given in order to make the evaluation of the finished products easier.

7. The model should be made up of two co-ordinated booklets--one containing the design guide and the other containing the corresponding worksheets.

8. Examples should be given for each step of the model to illustrate the given definitions.

9. The question about whether one wants to use Drill and Practice, or Tutorial, etc. should be removed from the Identify Instructional Goal step and be put in the Develop an Instructional Strategy step. (p. 33)

10. For emphasis, certain words and sentences should be underlined, e.g (p. 20) "Your may find that not all questions apply to what your are doing."

4.1.2 One-to-One Evaluation

In this step, two subjects were independently given the instructional design model and asked to work through it. The author of the model sat and worked with each subject on an individual basis.

The author explained to the subjects that these were new materials and asked for their reaction to them. Comments about the form, the content, the instructions, the concepts, and other pertinent information were noted, as was the time it took the subject to go through the material.

The subjects found the idea of the instructional design model to be a helpful one, as it made the task of designing computer courseware less overwhelming. These subjects suggested the following:

1. The Summative Evaluation step should be included in the model after the Revise Instruction step.

2. The two separate steps, Conduct Instructional Analysis and Identify Entry Behaviours and Characteristics, should be put together as one step called Conduct Instructional Analysis and Identify Entry Behaviours, and that a separate step be called Identify General Characteristics of the Target Population.

3. In the Write Performance Objectives, the impersonal article the should be changed to the possessive pronoun your, (e.g. "Do the objectives match the curriculum objectives?" be changed to "Do your objectives match the curriculum objectives?").

4. The expression "necessary, nice, or nuts to know," which refered to the performance objectives should be eliminated as it is too esoteric.

5. For the same reason, the phrase "mnemonic cues" should also be eliminated.

The suggestions made by the two subjects and the third expert in the one-to-one evaluation phase were taken into consideration and the model was revamped. Further study of the instructional design model by its author led to other modifications. The result of this process is the instructional design model which was given to the 14 subjects from the target population. This version can be found in Appendix B.

4.1.3 Small-Group Evaluation

After the instructional design model was revised based on the data collected from the one-to-one evaluation, a small group evaluation was carried out on members of the target population. A total of 14 subjects were asked to participate on a voluntary basis. Nine of them are teachers at the CEGEP level with no formal training in instructional design. The remaining five are currently enrolled in the Graduate Program in Educational Technology at Concordia University and have taken at least one course in instructional design. Since this model is not intended to be used in any specific location the subjects

were allowed to use it in the setting in which they would normally carry out this type of activity.

The author of the model explained to each subject individually that the materials were in the formative stage of development and that feedback would be gathered from them after they had used the model so that the materials could be improved.

In this step the aim was to find out the problems involved in the implementation of the model. To this end an attitude and difficulty questionnaire was given to all the subjects (see Appendix D), in-depth discussions were held with some of the subjects, and the completed model forms were reviewed and analyzed.

Subjects were given the revised version of the model and a problem (in which both the content and target population were specified) to work through. These can be found in Appendix E.

Students were also given a Time Log (see Appendix F) to see how much time they spent working on the model.

4.2 Results and Discussion

Two of the 14 subjects given the instructional design model did not complete it, and so were withdrawn from the sample.

In general there were no comments about the process; some of the subjects simply limited themselves to answering "yes" and "no" to the questions presented in the model to guide them. Two subjects, however, did make comments while answering the questions in the design section of the model. One subject asked for more examples of the instructional goal as she did not know "how broad to make the general statement." She also wondered, on page 27, (Appendix B,) how many were "too

many objectives" for one unit? On the same page she suggested that the word "related" in the question "Are your objectives clearly related?" be changed to "interrelated." Both subjects were unclear about the meaning of the question "Are consequences to making errors more rewarding than giving a correct answer?"

The worksheets were analyzed in the following manner: First, the performance objectives which appear on pages 33 to 35 were compared to the finished products to see if the users had indeed achieved each objective. Second, the actual checklist-guide questions which appear in the instructional aid (Appendix B) were compared to the finished product to see that these had been answered and used as a basis for the answers on the worksheets (which is the completed design of the courseware).

For the INSTRUCTIONAL GOAL the criteria are: 1) that it be a general statement, 2) that it cover all the content in that particular piece of courseware, and 3) that it not be as specific as the performance objectives. In general it was found that this criteria was followed although one subject expressed the instructional goal as a performance objective and a few others did not cover all the content. It is felt that by giving more examples and expanding on the definition of what a general goal is that these shortcomings can be overcome. These and all modifications to the model can be found in Appendix C.

For the INSTRUCTIONAL ANALYSIS AND IDENTIFY ENTRY BEHAVIOURS the criteria are: 1) that the subordinate skills or knowledge be presented in hierarchical fashion, 2) that all the subordinate skills needed appear on the hierarchy, 3) that the entry point for the target population be indicated, and 4) which of all these skills and knowledge

will be included in the courseware. Although several users had reversed their hierarchies, the skills were generally clearly identified. Not all the content skills appeared on the analyses. The entry point on all worksheets was not indicated. In order to remedy these problems, a template of a hierarchy will be presented in this section and the definition will be expanded.

For the IDENTIFY RELEVANT CHARACTERISTICS OF THE TARGET POPULATION the criteria are: 1) that the different characteristics (age, probable attention span, education, culture, physical abilities, keyboarding skills, and other special abilities or interests) of the target population be identified and 2) that these be correlated with different courseware and microcomputer considerations. This section followed the criteria quite closely, the only difference being that different users enumerated more or less characteristics and corresponding consideration than did others.

For the PERFORMANCE OBJECTIVES the criteria are: 1) that these be specific statements identifying what the target population will learn, 2) under what conditions they will perform these skills, 3) the criteria for successful performance, 4) that the objectives be interrelated and 5) faithfully reflect the content. These were generally well done, the difference being again the number of objectives presented. Only one user had a general statement as an objective. In the revisions to this section the definition will be expanded to emphasize the fact that these must be clear, detailed, and precise statements and an additional example will be given.

For the DESIGN CRITERION-REFERENCED TESTS section, the criteria are: 1) that the test items be directly related to the performance

objectives, 2) that clear instructions, examples and practice examples be provided, 3) that logical response formats be used, and 4) that feedback be provided, and that it be either remedial or enriching. The biggest problem in this area seemed to be the question of feedback. Many users did not use either remedial or enriching feedback, rather limiting themselves to either "right" or "wrong." In order to remedy this an extensive section on feedback will be moved from the following section to the beginning of this one so that the importance of these types of feedback will be clearly understood.

In the DEVELOP INSTRUCTIONAL MATERIALS section the criteria are 1) that the strategy chosen be appropriate to the content, 2) that the performance objectives correspond to the description of the contents on the screen, 3) that the computer capabilities be appropriate to the presentation of the contents, and 4) that the chosen strategy and computer capabilities be appropriate to the target population. The quantity of material presented was the major difference among the different products presented. Microcomputer capabilities were used to advantage, except for branching. A question on branching will be added to the checklist-guide questions to remind the users that this is an important computer capability. All but two of the users chose the drill and practice or tutorial strategies (the other two having chosen a game). This seems to be due to the fact that the Dick and Carey design model seems to lead logically to these types of strategies.

In this section there is provision (optional) for the design of a teacher's guide or manual. The criteria for this are: 1) that it include an overview of the courseware and 2) information on how to have it run on the computer. For the most part, the users, who completed

this section, tended to include information about the content, but not about the microcomputer. In the checklist-guide questions several explict questions will be added indicating that both these aspects of the courseware should be included in a teacher's guide or manual.

The rest of the model was presented as information for the users and was not compulsory. The few users who did fill in the worksheet for the formative evaluation seemed to have a clear understanding of what this step did.

The results for each subject, summarized in template forms, can be found in Appendix G. Each template includes considerations for modifications of the instructional design aid, based on the analysis of the criteria derived from both the performance objectives and the checklist-guide questions. A summary of these recommendations is presented in Table 1.

A summary of these results, in the form of a matrix with information of which objectives were attained per subject, can be found in Appendix H.

From this matrix it can be seen that on the whole the subjects were able to clearly formulate the instructional goal and the performance objectives, as well as identify all the relevant characteristics of their target population. Choosing and designing assessment instruments and an instructional strategy also posed no problems. Incomplete answers were due to time constraints on the part of the subjects, e.g. many performance objectives were given, but assessment instruments were not done for each one-or only a few performance objectives were detailed and assessment instruments done only for these. As previously discussed most subjects failed to use

remedial and enriching feedback. This can be clearly seen in item 8.2 of the matrix. Another area which was not mastered by the subjects, as cited above, was the creation of a teacher's guide or manual. Some chose not to include one; while others were incomplete incorporating either only computer-use instructions or microbiology considerations. This can be see in item 8.3 of the matrix.

It has been mentioned before that all but two of the users chose the drill and practice or tutorial strategies. None of the users chose to develop courseware meant for group learning. This may be due to the fact that the Dick and Carey model, as is the case with most instructional design models, was developed to promote individualized instruction. Also, the systematic approach to instruction lends itself very well to instructional stategies based on reception learning, whereas it is difficult to see its usefulness for implementing instructional strategies based on discovery learning. Thus it is easy to understand why few people would feel inclined or encouraged to choose either a simulation or a game when following the model.

Given that group and discovery learning are gaining increasing interest among the proponents of C.A.L., the need can be seen for similar job aids specifically designed having these strategies in mind, while keeping pedagogical quality and microcomputer capabilities in mind.

Table 1

Considerations for Modifications of Model

INSTRUCTIONAL GOAL:	give more examples
INSTRUCTIONAL ANALYSIS:	present template of hierarchy
PERFORMANCE OBJECTIVES:	emphasize precision of statements
TESTS:	put performance objective at top of step
FEEDBACK:	relocate to Design Tests section
INSTRUCTIONAL MATERIALS:	emphasize branching capabilites of computer
TEACHER MANUAL:	emphasize content as containing both courseware and computer considerations

Users took between two and twelve hours to complete the model, with a mean of 5.25 hours and a S. D. of 3.6 hours. Those who spent more time produced a more complete product.

The quality of the product does not seem to be related to the background of the subject: the two best completed models came from a student in the M. A. program in Educational Technology at Concordia University, with an extensive background in instructional design for training, and the other from an English teacher with no prior knowledge in instructional design and who has never taken any education courses.

The questionnaires were analyzed and the results follow. The numbers found below the answer scale indicate how many subjects gave a specific answer to each question. The comments made by subjects to each question have been summarized and included below each one.

1. Occupation: Ten of the subjects are teachers at the CEGEP level, one is a trainer at CN, and the other is a librarian who teaches at the CEGEP level.

2. If teacher, specify subject matter(s): Business related subjects (5 subjects), Spanish (2), English (3), Math/Computer Science (1), Nursing (1).

3. Degree of knowledge and familiarity with the content (microbiology):

Very High	5	4	3	2	1	None at all
	0	**1**	**0**	**2**	**9**	

It can readily be seen from question 3 that most of the subjects were not familiar with the content.

4. Background in Education: Check off pertinent options.

   9 Teaching Diploma / Certification

   5 Some background in computing science / programming

   3 M. Ed. / M.A. in Education

   6 B.A. (Specify area: General (2), English (1), Math (1), Nursing (1), Economics (1))

   4 M.A. (Specify area: Spanish (2), English (1), German (1))

   7 Other (Specify: B.Comm (3), MLS (1), MBA (1), Diploma of Institutional Administration (1), Diploma in Art History (1)

5. Degree of knowledge and familiarity with Instructional Design Terminology (e.g. pretest, entry behaviours, etc.):

Very High	5	4	3	2	1	None at all
	1	2	2	1	6	

6. Degree of knowledge and familiarity with Instructional Design Practice (e.g. Have you designed instructional materials before? etc.)

Very High	5	4	3	2	1	None at all
	1	5	2	0	4	

7. Degree of knowledge and familiarity with Educational Computing Terminology (e.g. Screen design, simulations, software, etc.)

Very High	5	4	3	2	1	None at all
	1	2	2	0	7	

8. Degree of knowledge and familiarity with Educational Computing Practice (e.g. Have you produced or used speadsheets, word processors, educational software, etc.?)

Very High	5	4	3	2	1	None at all
	0	4	0	2	6	

9a. How difficult was the model to use?

Very easy	5	4	3	2	1	Very difficult
	1	2	7	2	0	

b. Which parts did you find too easy? Why? No comments were made in this section.

c. Which parts did you find too difficult? Why? Five subjects found the content (microbiology) difficult to deal with; two knew nothing about computers; one each mentioned difficulty with the degree of generality of the Instructional Goal, composing Performance Objectives, too many options given in the Instructional Strategy, too much paper involved, and drawing up the Instructional Analysis hierarchy.

10a. How useful was the format presented to guide you?

Very useful	5	4	3	2	1	Not useful at all
	4	**5**	**3**	**0**	**0**	

b. How would you modify the format to make it more useful? One subject suggested the presentation of an algorithm of the model, one that more examples be given, and another that the worksheets be put behind the corresponding design considerations.

11a. Did you understand all the terminology used?

All	5	4	3	2	1	None
	5	**5**	**1**	**1**	**0**	

b. Which terms did you <u>not</u> understand? One subject each mentioned the terms "random calculations, algorithm, interactive, crash, summative evaluation, condense/expand time" and two "formative evaluation."

12a. Were you equipped with enough prior knowledge to be able to work with this model?

Enough	5	4	3	2	1	Not enough
	3	**5**	**2**	**1**	**1**	

b. What knowledge did you <u>not</u> possess? Five did not feel competent about the content (microbiology), three about the computer, one about the contept of punitive feedback, and one felt she had a language problem.

13a. Did you find this model made it easier for you to design computer courseware?

yes	no
10	0 and 2 no answer

b. Why or why not? Six found the model to provide an excellent outline; two stated they would not even have attempted such a project without it; three found the examples very helpful, and one suggested that the instructions for the Instructional Analysis and Instructional Goal be expanded.

14a. Did you find the model interesting to work with?

Very interesting	5	4	3	2	1	Not interesting
	4	2	3	1	1	and 1 no answer

b. Why or why not? On the negative side one subject each mentioned the following: did not know whether to answer on worksheets or on model itself, does not like to use performance objectives, does not like C.A.L., not familiar with microbiology, is not interested in design. On the positive side one felt that the model had coached her through the project and another had learned about how to design instructional materials as well as about microbiology.

15a. Did you feel frustrated at any point?

yes	no
11	0 and 1 no answer

b. At which point and why? Three felt frustrated because of the microbiology, two about constructing the tests, one had to check back to the definitions, one found it long and repetitive, one found it frustrating to try to make a coherent package, one thought the work sheets should be placed behind the design section, and one stated that until she saw the actual model, she didn't think that she could do it.

16a. Would you use this model again?

yes	no
6	3, 2 unsure, and 1 no answer

b. Why or why not? Three found the model "good, logical, and easy to follow," and one would like to use it with her own content. Of those who said they would not use the model again or were unsure, two said they do not plan to design courseware, one said she had an aversion to computers, and one said she does this process "intuitively" and so does not need a model.

17. General comments: Two subjects found that it took longer than they thought and suggested that some kind of time frame be given; one did not know how much material to include in each lesson; one felt she needed to know microbiology, computer, and education terminology to be able to do a good job, and two said they were not interested in microbiology. On the positive side, two felt that the model was "well designed," and an "excellent guide," one enjoyed the experience, one said it made the computer accessible to the layman, and two would like to use it with their own content.

As a general conclusion to the questionnaire, the model seemed to be quite useful to the subjects. Although everyone felt frustrated at some point, this seemed to be caused more by the lack of knowledge and familiarity with the content and with computers than with the model, which was found useful, interesting, and easy to use by most. Most subjects claimed little knowledge or familiarity with instructional design and educational computing terminology, and with educational computing practice, but most felt that they had had experience with instructional design practice (as it should be, as nine of them have a Teaching Diploma or Certificate and eleven of them are teachers).

The recommendations culled from this questionnaire are: putting the worksheets immediately after the design questions, giving more examples for the instructional goal, mentioning some kind of time framework, and elaborating on the concept of feedback.

5. REVISIONS AND CONCLUSIONS

Microcomputers can now be found in almost every school, yet teachers are still heard to complain that they cannot seem to find the piece of software that exactly fits their needs. Many of these teachers are neither too familiar with computer capabilities nor with formal instructional design methods. I felt that if they had a tool, that was neither too long nor too cumbersome, then some might be tempted to create the courseware that would fit their perceived needs.

A great deal of the literature on the evaluation of educational software states that much of the software available is not instructionally sound, as the designers have had no preparation in the systems approach to instructional design.

In light of these considerations, and the fact that many design guides available are very long and detailed, I decided to attempt to create an instructional design guide (using questions to guide and prompt the designer), accompanied by corresponding worksheets. It was hoped that this step-by-step approach would help neophyte courseware designers to produce a complete piece of courseware.

The model I chose to follow in general, is the model of instructional design proposed by Dick and Carey (1978). In order to evaluate my design aid, I also followed their model for formative evaluation, first carrying out one-to-one evaluations with experts, then with subjects from the target population, and finally with a small-group.

As a result of the small-group evaluation, a series of recommendations for revisions were obtained from an analysis of the worksheets, of the attitude questionnaires, and of any comments or notes made by the subjects on the design-guide itself. These revisions are: locating the worksheets immediately after the corresponding design guide questions, expanding the definition and presenting more examples for both the Instructional Goal and Performance Objectives sections, elaborating on the definition of the Instructional Analysis and presenting a template of the hierarchy in this section, relocating the performance objective at the top of the Design Criterion-Referenced Tests worksheet and guide, relocating the feedback information to the Design Criterion-Referenced Tests section from the Develop an Instructional Strategy section, emphasizing the branching capabilities of the computer on both the worksheet and guide section of the Develop Instructional Materials section, and finally emphasizing that the content of the Teacher Manual, in the Develop Instructional Materials guide section, should include considerations on both the courseware and the computer.

The target population sampled was very heterogeneous, including people with many different backgrounds (nursing, business, English, German, Spanish, math, art history), some with instructional design studies (3), but the majority without.

The lack of formal instructional design background did not seem to affect the product, as the two most complete and creative pieces of courseware were designed by one subject with, and one subject without instructional design studies; neither had any microbiology background.

Although some subjects took up to twelve hours, while others took only two hours to go through the model, all subjects showed comprehension of the different steps, by creating a piece of courseware for the computer. Those who took more time, produced a more complete product with a greater number of tests and instructional materials, than did those who took less time, and who only gave examples of the material. Although some subjects constructed their hierarchies in an upside down fashion, this had no effect on their products.

In general the instructional design model seemed to work as a job aid for the target population. Comments made by the subjects were favourable on the whole, and a few expressed interest in using the model with their own content. It is felt then, that the revised version of the model is now ready for use as an instructional job aid. The result of the present study leads us the think that it can be used with most probable success.

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APPENDIX A

THE MODEL OR INSTRUCTIONAL DESIGN AID BEFORE ONE-TO-ONE EVALUATION

Instructional Design Model

Introduction

Introduction

This model has been designed as a brief, useful tool with which to create instructionally sound courseware and which efficiently and effectively uses the capabilities of the microcomputer. To this end a brief description is given of recent trends in computer courseware design and instructional design highlighting features which you may want to take into consideration in your courseware design. This section is followed by the instructional design model itself. In the design section you may find that not all the questions apply to what you want to do. These questions are there to guide you in your courseware design task. At the end of each design step space has been provided for you to put into writing your design step content.

Courseware Design

Self-containment

Good courseware is self-contained and self-explanatory, it teaches you to use it as well as teaching you.

It documents itself. Instructions on how to use the courseware are easily accessed on the computer. Students can't always find the manual and prefer not to use it.

Entertainment value

People associate entertainment with television. Enjoyment is a powerful motivator. The computer can make learning fun. We can take a few lessons from computer video games. The goals in these games are personally meaningful and have variable difficulty levels (goals that are certain to be reached provide no challenge). Video games provide immediate and constant feedback.

Games and simulations have great potential as learning tools. Games are motivational; they offer a challenge and allow for fantasy. Drills can be presented in this guise with automatic difficulty adjustment. Simulations are especially indicated to stimulate problem solving and risk taking.

Visual medium

The computer is a visual medium. Text should be kept to a minimum. Learners should be shown rather than told. Words should be used only as a last resort. Every screen should be interesting and every screen should advance the "story." Even instructions and directions can be provided using the computer's capabilities to flash, erase, underscore, and animate.

If text is used, here are some useful guidelines:

Use larger characters for younger children;

Break up the different frames by interspersing questions;

Do not allow the screen to scroll;

Allow the student to control the rate of display;

Do not overload the screen;

Do not hyphenate words;

Double space the text;

Allow or incorporate frequent rest breaks if the text is very long;

Use upper and lower case letters;

Use a letter size that is sharp and defined and clear, and break up text and draw attention with non-textual elements, such as color, underlining, reverse highlighting, spacing, flashing, diagrams, visual imagery, animation, cartoon characters, graphs and graphics.

Graphics should be embedded in the content to accentuate and support the content; they should not detract from the content.

The most important thing to remember is:

DON'T CROWD THE SCREEN

Interactivity

The computer can create a complete learning experience. Its multisensory possibilities (visual, tactile, and auditory) can create an interactive experience. The possibility of eliciting variety in the type of responses allows the learner to manipulate the material in ways not directly taught. This active process helps to maintain the learner's attention.

Individualization

By offering parallel and alternate learning activities for the same goal, the learner can choose the most appealing way to learn.

Different levels of detail can accommodate the learner's level of knowledge for the same goal. The learner can choose a different level when s/he has mastered a lower level.

Modularization and branching

Individualization can take place by designing the courseware in small stand-alone modules. Modules extend the life of the courseware as segments can be added or deleted for future use. Modules can be created in hierarchical patterns so that learners can enter, branch to other levels, or exit with greater flexibility.

Feedback

Learners should be able to monitor their progress and receive a status report at the end.

Errors should be located and analyzed by the courseware program, and feedback should be remedial by successively revealing more information or prompts as needed. Different formats for the feedback may be used. Feedback can be surprising as well as constructive in order to engage the learner's curiosity.

Random generation

To generate different exercises and tests, three times the number of items needed should be created in the pool.

Computer-Managed Instruction (C.M.I.)

Complete and detailed records of every student's performance can be kept by the computer courseware program. Three things are achieved by keeping these records:

1. The teacher can monitor the student's progress and see exactly where the student is making errors so that remedial steps can be taken;
2. the computer can monitor the student's error patterns and send the student to appropriate remedial material; and
3. if the student knows his/her work is being monitored, it will discourage him/her from putting in unacceptable names or answers. (The program will only run if a name that matches the teacher's list is inputted. A student number may also be required to keep students from practicing under someone else's name.)

Instructional Design Model

Design Section

N.B. In the final version of this model, enough blank space (worksheets) will be provided for the users to do their work on.

The Instructional Design Model includes the following steps:

IDENTIFY INSTRUCTIONAL GOAL

CONDUCT INSTRUCTIONAL ANALYSIS

IDENTIFY ENTRY BEHAVIOURS AND CHARACTERISTICS

WRITE PERFORMANCE OBJECTIVES

DESIGN CRITERION-REFERENCED TESTS

DEVELOP AN INSTRUCTIONAL STRATEGY

DEVELOP INSTRUCTION

DESIGN AND CONDUCT THE FORMATIVE EVALUATION

REVISE INSTRUCTION

IDENTIFY INSTRUCTIONAL GOAL

Definition: An instructional goal what you want learners to do when they have completed your instruction.

The purpose of this step is to identify your instructional goal for the design of your computer courseware..

*Have you identified your instructional goal?

*What do you want to do? Drill and practice?
Tutorial method?
Problem solving?
Model building?
Simulation?
Games?
Other?
Combination of some/all of the above?

* * *

Your instructional goal is:

Possible way of achieving this is:

CONDUCT INSTRUCTIONAL ANALYSIS

Definition: This is an analysis of your instructional goal in order to identify the subordinate skills or knowledge that a learner must have in order to achieve that goal.

The purpose of this step is to identify the learner's needs in order to achieve the instructional goal.

*Have you identified the learner needs?

What previous skills or knowledge (without which it would be impossible to achieve the instructional goal) must the learner possess to more effectively and efficiently achieve the instructional goal?

*Do the learners already possess these skills or knowledge, or must they be included in your courseware?

* * *

List in hierarchical fashion the subordinate concepts, skills, tasks, etc. needed by the learner to achieve the instructional goal:

In the above hierarchy, identify the entry points for learners with different skills.

Will you include these subordinate skills or knowledge in the courseware: yes-no

If "yes" then at which point will you begin your courseware?

IDENTIFY ENTRY-BEHAVIOURS AND CHARACTERISTICS

Definition: This step identifies the general characteristics of the learners which may be important to the design of your courseware.

The purpose of this step is to specifically identify and describe the target population for whom the courseware is intended.

*Have you identified the characteristics of the target population?

What is their age?

probable attention span?

educational level?

cultural background?

physical abilities?

special interests?

keyboarding skills?

other?

* * *

The characteristics of your target population are:

WRITE PERFORMANCE OBJECTIVES

Definition: These are specific statements of what it is the students will be able to do when they complete your courseware.

The purpose of these statements, which are derived from the skills identified in the instructional analysis, is to identify the skills the target population will learn, the conditions under which they must perform these skills, and the criteria for successful performance.

*Are the objectives necessary,
nice, or
nuts to know?

*Do you want to keep all the objectives?

*Have you provided specific performance objectives of what the learner will be able to do upon completion of the courseware?

*Are the criteria and conditions (e.g. How many successfully completed in a specific time?) of testing for these objectives presented?

*Is mastery required?

*Are the objectives leveled?

*Are the objectives achievable?

WRITE PERFORMANCE OBJECTIVES(2)

*Do the objectives match the curriculum objectives?

* * *

The performance objectives are:

The criteria for successful completion are:

The conditions for successful completion are:

DESIGN CRITERION-REFERENCED TESTS

Definition: These are assessment instruments which are parallel to and measure the learner's ability to achieve what you described in the objectives. These are called criterion-referenced tests.

The purpose of this step is to create instruments that are directly related to the performance objectives.

*Do you want to create - an entry-behaviour test? (This measures skills which you have identified as being critical to beginning the courseware. These are the skills which appear below the entry point in the hierarchy of your instructional analysis.)

- a pretest? (This test is criterion referenced to objectives which you intend to teach in the courseware. These are the skills which appear above the entry point in the hierarchy of your instructional analysis.)

- embedded tests? (These are clusters of criterion-referenced test items which are interspersed throughout the module.)

- posttest? (This test is parallel and often identical to the pretest. It measures the objectives.)

DESIGN CRITERION-REFERENCED TESTS(2)

*Are the assessment instruments congruent with the performance objectives?

*Do these tests measure the learner's ability to achieve these objectives?

*If a questioning strategy is used, is it purposeful?
systematic?
and does it develop divergent thiking?
problem-solving abilities?
risk taking?

*Are test instructions clear?

*Are examples and practice examples provided?

*Are logical formats used? (e.g. y for yes and n for no)

*Are tests speeded?

*Do the test items and tests provide feedback?

*Do the tests have an adequate number and variety of items for clear diagnosis and appropriate indicators for the placement of learners at specific levels or entry points?

DESIGN CRITERION-REFERENCED TESTS(3)

ENTRY-BEHAVIOUR TEST

Test Instructions:

Examples:

Practice Examples:

Skills	Test Items

PRETEST

Test Instructions:

Examples:

Practice Examples:

Performance Objectives	Test Items

EMBEDDED TEST

Test Instructions:

Examples:

Practice Examples:

Performance Objectives	Test Items

POSTTEST

Test Instructions:

Examples:

Practice Examples:

Performance Objectives	Test Items

DEVELOP AN INSTRUCTIONAL STRATEGY

Definition: The instructional strategy is the means used to achieve the terminal objective. The strategy will be based on current knowledge of the learning process, content to be taught, the characteristics of the students and the capabilities of the microcomputer.

The purpose of this step is to identify pre-instructional activities, choose the mode of presentation of information, the type of practice and feedback, testing and follow-through activities.

*Have you chosen your instructional strategy (Drill & Practice, Game, etc.)?

*Is the instructional strategy appropriate to the task?

*Is the instructional strategy appropriate to the characteristics of the learners?

*Will the instructional strategy gain and hold the attention of the user?

*Does the instructional strategy include

clear instructions for exercises and tests?

appropriate number of examples and practice items with feedback for guidance?

DEVELOP AN INSTRUCTIONAL STRATEGY(2)

*Are test scores provided?

frequently?

at the end?

*Are the vocabulary and vocabulary level appropriate?

*Are new words defined?

*Are delays explained?

*Is feedback immediate?

varied?

remedial (provide clues, hints)?

positive (not punitive)?

enriching (provide additional information)?

*Does feedback hold greater attention than the content?

*If negative feedback is used, is it more rewarding than positive feedback?

DEVELOP AN INSTRUCTIONAL STRATEGY(3)

*Does the courseware use the specific capabilities of the microcomputer as an educational tool?

Does it condense or expand time?

Does it condense or magnify images?

Does it control for real time responses (as in simulations)?

Does the learner control the sequence?

Does the learner control the pace?

Does it use a database for information retrieval?

Does it stream to the appropriate level through branching?

Does it generate random calculations?

Does it generate algorithmic data problems?

Does it use auditory, visual and tactile capabilities in an interactive manner?

Does it hook up with other audio-visual aids?

Does it use quick, efficient editing capabilities?

Does it allow backspacing to correct responses?

Is a running score continuously displayed on part of the screen?

DEVELOP AN INSTRUCTIONAL STRATEGY(4)

*Does the courseware maximize the capability of the microcomputer when creating the screen design?

Does it use different types of formats?

Does it integrate non-textual elements?

- graphics?
- graphs?
- colour?
- maps?
- sound?
- touch?
- highlight?
- etc.?

Does the courseware limit the information per screen?

Does it use a constant format for titles, questions, etc.?

Does it present one idea at a time (per page)?

Is each idea no longer than two sentences?

Does it use appropriate spacing?

Does it use appropriate letter size for population?

Are graphics used as

- mnemonic cues?
- descriptions?
- analogies for abstract ideas?

DEVELOP AN INSTRUCTIONAL STRATEGY(5)

Is colour used to highlight?

code?

differentiate?

direct attention?

provide prompts?

Is the courseware "friendly"?

Is it self-explanatory?

Is there easy and ready access to a HELP or INFORMATION option?

Is the HELP option really helpful or revealing new information each time or does it always repeat the same definition?

Is there a permanent coded line on the screen which shows which options are available?

Does it inform the learner when it is going to be busy?

Can the learner exit and enter at different places?

Can the learners get their score?

Is there a pretest to establish the entry point?

DEVELOP AN INSTRUCTIONAL STRATEGY(6)

STRATEGY	DESCRIPTION	MICRO CAPABILITIES TO BE USED

DEVELOP INSTRUCTION

Definition: The courseware package includes the instructional materials, tests, and a teacher's guide or manual.

The purpose of this step is to produce the courseware package or module based on the instructional strategy.

*Are the instructional materials appropriate to the objectives?

*Are the instructional materials appropriate to the target population?

*Is there a pretest and a posttest?

*Does the pretest effectively diagnose the learner's entry level?

*Does the posttest effectively verify the process?

*Does the courseware improve learning?
improve instruction?
improve the evaluation of instruction?
build on learning/instructional theory?

DEVELOP INSTRUCTION(2)

*Should you include a teacher's guide or manual?

Does the manual provide an overview of the courseware?

describe the target population?

specify inputs, throughputs, and outputs?

explain how to keep records?

provide simple trouble-shooting procedures?

provide technical information about running the materials?

* * *

Lesson Sequence and Content: (including tests)

Teacher Manual Content:

DESIGN AND CONDUCT THE FORMATIVE EVALUATION

Definition: Formative evaluations are conducted to determine how effectively the courseware works and may be done on a one-to-one basis, with a small group, or as a field evaluation.

The purpose of this step is to collect data which may be used to identify how to improve the courseware.

*Does the courseware meet the stated instructional goal?

*Are revisions in the documentation congruent with revisions in the courseware?

*Can all segments be worked through without branching in order to verify all the materials?

*Have all technical bugs been worked out?

*Has the courseware been tested with individuals from various levels?

DESIGN AND CONDUCT THE FORMATIVE EVALUATION(2)

*Has the courseware been verified for

- values?
- unintended learning?
- cultural bias?
- language level?
- grammar?
- spelling?

* * *

Evaluation Comments **Proposed Improvements**

REVISE INSTRUCTION

Definition: Data from the formative evaluation is used to re-examine the validity of the instructional analysis and the assumptions about the entry behaviour of the learners. It is necessary to re-examine the performance objectives, test items, and instructional strategy in light of the collected data.

The purpose of this step is to incorporate the above information into revisions of the courseware to make it a more effective instructional tool.

*Is there provision in the design of the courseware for revision?

*Does this provision exist for individual segments of the courseware?

*Are these provisions explained in the teacher's manual?

*Does the courseware allow for future instructional needs? (life span of the material)

* * *

Revisions to be made:

APPENDIX B

THE MODEL OR INSTRUCTIONAL DESIGN AID AFTER ONE-TO-ONE EVALUATION

INSTRUCTIONAL DESIGN MODEL

BY

CLAUDIA AMASUNO

INSTRUCTIONAL DESIGN MODEL

INDEX

GENERAL INSTRUCTIONS

for the use of the

INSTRUCTIONAL DESIGN MODEL

The object of this study is to conduct a formative evaluation of a model to produce specifications for computer courseware.

The specific form of this courseware is a frame-based lesson to be implemented on a computer. You are only asked to produce the specifications for this lesson using the model provided; the actual implementation of this lesson on the computer is not part of this study. The specific content you will work with is given on pages 5 to 10 which follow.

The target population is described on page 11 which follows. Read the General Instructions for the Model which begin on page 3 and then the Introduction on page 13 which precedes the Design Section.

Go through the Design Section (pages 19 to 44) which is there to guide you. Answer any questions which you find are relevant and make any comments that you wish on these sheets.

Use the Work Sheets (pages 45 to 53), which follow the Design Section, to record the specifications for developing the actual lesson.

Work on this project in as many periods as you want. The duration of each period is left up to you but please try not to work for less than half an hour at a time and please stop when you feel tired. Please record on the Time Log (page 12) the starting and finishing time of every working session. It is very important to know how and for how long you worked on this model.

If at any moment there is something you do not understand or if you have any questions please stop and consult me.

My home phone number is: 692-4240

My office number is : 935-8401

Please return the Design Section (with whatever comments and queries you have written on them) along with the Work Sheets to me when you have finished with them.

Thank you very much for your co-operation.

INSTRUCTIONAL DESIGN MODEL

Introduction

Introduction

This model has been designed as a brief, useful tool with which to create instructionally sound courseware and using the unique capabilities of the microcomputer. To this end, a brief description is given of recent trends in computer courseware design and instructional design, highlighting features which you may want to take into consideration in your courseware design. This section is followed by the instructional design model itself which is accompanied by corresponding Work Sheets.

Courseware Design

Self-explanatory

Good courseware is self-explanatory; it teaches you to use it as well as teaching you.

It documents itself. Instructions on how to use the courseware are easily accessed on the computer. Students can't always find the manual and prefer not to use it.

Entertainment value

People associate entertainment with television. Enjoyment is a powerful motivator. The computer can make learning fun. We can take a few lessons from computer video games. The goals in these games are personally meaningful and have variable difficulty levels (goals that are certain to be reached provide no challenge). Video games provide immediate and constant feedback.

Games and simulations have great potential as learning tools. Games are motivational; they offer a challenge and allow for fantasy. Drills can be presented in this guise with automatic difficulty adjustment. Simulations are especially indicated to stimulate problem solving and risk taking.

Visual medium

The computer is a visual medium. Text should be kept to a minimum. Learners should be shown rather than told. Words should be used only as a last resort. Every screen should be interesting and every screen should advance the "story." Even instructions and directions can be provided using the computer's capabilities to flash, erase, underscore, and animate.

If text is used, here are some useful guidelines:

Use larger characters for younger children;

Break up the different frames by interspersing questions;

Do not allow the screen to scroll;

Allow the student to control the rate of display;

Do not overload the screen;

Do not hyphenate words;

Double space the text;

Allow or incorporate frequent rest breaks if the text is very long;

Use upper and lower case letters;

Use a letter size that is sharp and defined and clear, and break up text and draw attention with non-textual elements, such as color, underlining, reverse highlighting, spacing, flashing, diagrams, visual imagery, animation, cartoon characters, graphs and graphics.

Graphics should be embedded in the content to accentuate and support the content; they should not detract from the content.

The most important thing to remember is:

DON'T CROWD THE SCREEN

Interactivity

The computer can create a complete learning experience. Its multisensory possibilities (visual, tactile, and auditory) can create an interactive experience. The possibility of eliciting variety in the type of responses allows the learner to manipulate the material in ways not directly taught. This active process helps to maintain the learner's attention.

Individualization

By offering parallel and alternate learning activities for the same goal, the learner can choose the most appealing way to learn.

Different levels of detail can accommodate the learner's level of knowledge for the same goal. The learner can choose a different level when s/he has mastered a lower level.

Modularization and branching

Individualization can take place by designing the courseware in small stand-alone modules. Modules extend the life of the courseware as segments can be added or deleted for future use. Modules can be created in hierarchical patterns so that learners can enter, branch to other levels, or exit with greater flexibility.

Feedback

Learners should be able to monitor their progress and receive a status report at the end.

Errors should be located and analyzed by the courseware program, and feedback should be remedial by successively revealing more information or prompts as needed. Different formats for the feedback may be used. Feedback can be surprising as well as constructive in order to engage the learner's curiosity.

Random generation

To generate different exercises and tests, three times the number of items needed should be created in the pool.

Computer-Managed Instruction (C.M.I.)

Complete and detailed records of every student's performance can be kept by the computer courseware program. Three things are achieved by keeping these records;

1. The teacher can monitor the student's progress and see exactly where the student is making errors so that remedial steps can be taken;
2. the computer can monitor the student's error patterns and send the student to appropriate remedial material; and
3. if the student knows his/her work is being monitored, it will discourage him/her from putting in unacceptable names or answers. (The program will only run if a name that matches the teacher's list is inputted. A student number may also be required to keep students from practicing under someone else's name.)

INSTRUCTIONAL DESIGN MODEL

Design Section

This Instructional Design Model includes the following steps:

IDENTIFY INSTRUCTIONAL GOAL

CONDUCT INSTRUCTIONAL ANALYSIS AND IDENTIFY ENTRY BEHAVIOURS

IDENTIFY GENERAL CHARACTERISTICS OF THE TARGET POPULATION

WRITE PERFORMANCE OBJECTIVES

DESIGN CRITERION-REFERENCED TESTS

DEVELOP AN INSTRUCTIONAL STRATEGY

DEVELOP INSTRUCTIONAL MATERIALS

DESIGN AND CONDUCT THE FORMATIVE EVALUATION

REVISE INSTRUCTION

CONDUCT SUMMATIVE EVALUATION

This is a tool intended to help you design computer courseware following instructional design principles.

It is divided into two sections:

The first section is the Instructional Design Model which will ask you questions to guide you through the design of the courseware. You may find that not all questions apply to what you are doing. Refer to your answers to these questions when you use the second section.

The second section is a series of Work Sheets. Not each of the above steps of the Instructional Design Model has a corresponding Work Sheet. When you have filled in the Work Sheets you will have your completed courseware design.

Please use additional sheets of paper when the provided Work Sheets for a particular step have been used up.

IDENTIFY INSTRUCTIONAL GOAL

Definition: An instructional goal is a general statement of what you want learners to do when they have completed your instruction on the computer.

Example: The target population will learn about Roman numerals.

CONDUCT INSTRUCTIONAL ANALYSIS AND IDENTIFY ENTRY BEHAVIOURS

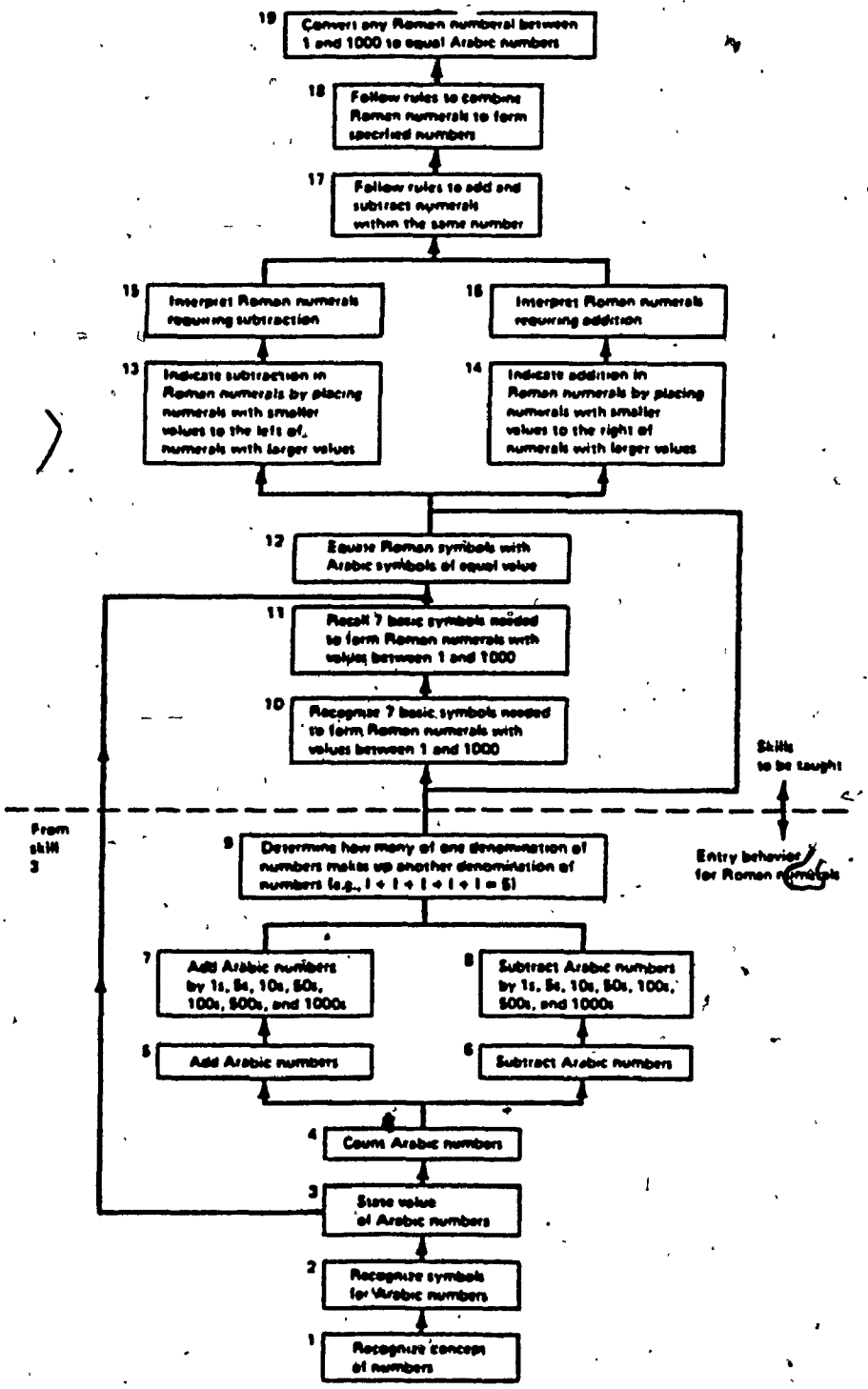
Definition: This is an analysis of your instructional goal in order to identify the subordinate skills or knowledge that must be possessed to more effectively and efficiently achieve the instructional goal. The entry point for each learner is the entry behaviour.

Example: On the next page is a hierarchical analysis of Roman numeral objectives (Dick and Carey, 1978).

The subordinate skills for learning Roman numerals are numbers 1 to 9 in the following hierarchy.

The entry behaviour for learning Roman numerals is before 10.

CONDUCT INSTRUCTIONAL ANALYSIS AND IDENTIFY ENTRY BEHAVIOURS(2)



CONDUCT INSTRUCTIONAL ANALYSIS AND IDENTIFY ENTRY BEHAVIOURS(3)

Have you identified the subordinate skills needed to achieve your instructional goal?

Do all the learners already possess these skills or knowledge, or must they be included in your courseware?

IDENTIFY GENERAL CHARACTERISTICS OF THE TARGET POPULATION

Definition: This step identifies and describes the general characteristics of the target population. These characteristics may be important to the design of the courseware.

Have you identified the characteristics of the target population?

Have you considered their age?

probable attention span?

educational level?

cultural background?

physical abilities?

special interests?

keyboarding skills?

other?

Example:

Characteristics of your target population are:	Corresponding courseware design considerations are:
Grade one students	Use large letters, limit text
Residents of Hawaii	Avoid examples with snow, scarves, etc.
Cannot type	Just hit one key to answer on computer; use audio instructions.

WRITE PERFORMANCE OBJECTIVES

Definition: These are specific statements of what it is the target population will be able to do when they complete your courseware. These statements identify the skills the target population will learn, the conditions under which they must perform these skills, and the criteria for successful performance.

Example: Performance objective: The learner will be able to identify Roman numerals.

Conditions for successful completion: Given a number, the learner will be able to say* the name of the matching Roman numeral and, given a Roman numeral, the learner will be able to say* the matching number.

Criteria for successful completion: Until no mistakes are made.

Do your objectives match the curriculum objectives?

Are your objectives realistic?

*The objectives should be either measurable or observable.

WRITE PERFORMANCE OBJECTIVES(2)

Do you want to keep all the objectives? (Are there too many for one unit?)

Are your objectives clearly related?

Have you provided specific performance objectives of what the learner will be able to do upon completion of the courseware?

Are the criteria and conditions (e.g. How many successfully completed in a specific time?) of testing for these objectives presented?

DESIGN CRITERION-REFERENCED TESTS

Definition: These are assessment instruments which measure the learner's ability to achieve what you described in the objectives. They must be directly related to the performance objectives.

There are four types of criterion-referenced tests:

Entry-behaviour test: This measures the skills which the learners bring with them and which you have identified as being critical for the learners to begin the courseware. These skills appear below the entry point in the hierarchy of your instructional analysis.

Pretest: Each item in this test is matched (criterion referenced) to objectives which you intend to teach in the courseware. The purpose of this test is to find out how much the student knows and also to send the student to the appropriate entry point; in this way the learner does not get frustrated repeating what is already known. These are the skills which appear above the entry point in the hierarchy of your instructional analysis. This test may establish different entry points for different learners.

Embedded tests: These are clusters of criterion-referenced test items which are interspersed throughout the module. When completed, these will guide the learner to an appropriate section of the material.

DESIGN CRITERION-REFERENCED TESTS(2)

Posttest: This test is parallel and often identical to the pretest. It measures the attainment of the objectives. This can be a formal test at the end of the unit or the embedded tests can serve this function throughout the unit.

Do you need or want to use all these tests?

Which ones will you use?

Are your test instructions clear?

Are examples and practice opportunities provided?

Are logical formats used? (e.g. y for yes and n for no)

Are test time limits imposed?

Can learners choose their own pace for the tests?

Do the tests have an adequate number and variety of items for clear diagnosis and appropriate indicators for the placement of learners at specific levels or entry points?

DESIGN CRITERION-REFERENCED TESTS(3)

Do you provide feedback for each test item?

Do you provide feedback analysis of the learner's results for each test as a whole?

Do you provide an overall summary of the test results?

Are the tests part of the computer courseware or will they be given using a paper and pencil, orally, or by some other method?

DESIGN CRITERION-REFERENCED TESTS(4)

Sample test format

Test instructions

Examples with answers

Practice opportunities with feedback

Test items which correspond to performance objectives

For each test type that you have decided to use, fill in a form like the Worksheet. This will give you your completed test.

Example:

Test type (This will not appear on the test): Embedded test

Test instructions:

PUT THE LETTER OF THE ROMAN NUMERAL NEXT TO THE CORRESPONDING ARABIC NUMBER. ANSWER WHEN THE CURSOR (-?-) APPEARS.

Examples with answers:

(c) -?- 51 a XV

(a) --- 15 b VIII

(b) --- 8 c LI

DESIGN CRITERION REFERENCED TESTS(5)

Practice examples:

(b)	--- XXX	a	30
( )	--- IV	b	150
( )	--- CL	c	4

Feedback comments for correct or incorrect responses:

R: THAT'S RIGHT.

W: REMEMBER THAT X IS EQUAL TO TEN AND THERE ARE THREE TENS HERE. TRY AGAIN.

PERFORMANCE OBJECTIVES

(These are found in your hierarchy of objectives on your CONDUCT INSTRUCTIONAL ANALYSIS AND IDENTIFY ENTRY BEHAVIOURS' Worksheet.)

Given both Roman numerals and Arabic numbers, the learner will equate one with the other by matching the numerals with the numbers until all are matched correctly.

TEST ITEMS

-?-	XVIII	a	919
---	CDL	b	450
---	XLIV	c	136
---	CXXXVI	d	44
---	CMXIX	e	18

FEEDBACK for each of the above test items may be included as in the practice examples if the tests are to be given on the computer.

DEVELOP AN INSTRUCTIONAL STRATEGY

Definition: The instructional strategy is the means used to achieve the terminal objective. The strategy will be based on current knowledge of the learning process, content to be taught, the characteristics of the target population and the capabilities of the microcomputer.

The purpose of this step is to identify preinstructional activities, choose the mode of presentation of information, the type of practice and feedback, testing and follow-through activities.

The most common Computer-Assisted Learning modes are:

Drill and Practice: Intensive, repetitive drill to reinforce learning. Exercises and problems are presented on the computer for solution.
e.g. Rote drill on chemical nomenclature.

Tutorial Method: Presents material in statements and questions. Comprehension is measured and monitored; progress through a program cannot be made without questions being correctly answered.
e.g. Tutorial on taxonomic terms in biology.

DEVELOP AN INSTRUCTIONAL STRATEGY(2)

* Simulation: The functioning of a physical or social system is imitated. Probabilities or variables within the real-world systems can be changed, allowing learners to observe how these changes affect the system.

e.g. Flight simulation or physics lab experiments.

Educational Games: Instructional material presented in a competitive framework. The computer can act as the competition or can facilitate the game for competing players.

e.g. Hangman for spelling tasks.

* You may want to answer these questions on these sheets as you may find it helpful when you develop your instructional materials on the Work Sheets in the following section.

Which C.A.L. mode do you want to use?

Do you want to use a combination of some or all of them?

If yes, then which ones?

For which parts of the courseware?

DEVELOP AN INSTRUCTIONAL STRATEGY(3)

Is the chosen mode appropriate to the objectives?

Why?

Is the chosen mode appropriate to the characteristics of the target population?

How?

Will the chosen mode gain and hold the attention of the user (motivational devices)?

Does the instructional strategy include instructions?
exercises?
tests?
examples?
practice items?
feedback for guidance?

Is feedback provided?
frequently?
at the end?
continuously (a score appears on screen)?
immediate?
varied?

DEVELOP AN INSTRUCTIONAL STRATEGY(4)

Is feedback remedial (provide clues, hints)?

positive (not punitive)?

enriching (provide additional information)?

Are consequences to making errors more rewarding than giving a correct answer?

Is the vocabulary level appropriate?

If new words are used, are they defined?

Which of the following computer capabilities do you think your courseware can use most effectively considering your objectives?

Does it condense or expand time?

Does it condense or magnify images?

Does it control for real time responses (as in simulations)?

Does the learner control the sequence?

Does the learner control the pace?

Does it use a database for information retrieval?

Does it stream to the appropriate level through branching?

Does it generate random calculations?

Does it generate algorithmic data problems?

Does it use auditory, visual and tactile capabilities in an interactive manner?

Does it hook up with other audio-visual aids?

DEVELOP AN INSTRUCTIONAL STRATEGY(5)

Computer capabilities cont'd:

Does it use quick, efficient editing capabilities?

Does it allow backspacing to correct responses?

Is a running score continuously displayed on part of the screen?

Does the courseware use some of the following capabilities of the microcomputer when creating the screen design?

Does it use different types of formats?

Does it integrate non-textual elements?

- graphics (graphs, maps, illustrations)?
- color?
- flashing?
- underlining?
- highlight?
- sound?
- touch?
- etc.?

Are graphics used

- to jog the memory?
- as descriptions?
- as analogies for abstract ideas?

Does the courseware limit the information per screen page?

Does it use a constant format for titles, questions, etc.?

Does it present one idea at a time?

Is each idea expressed in as concise a manner as possible?

DEVELOP AN INSTRUCTIONAL STRATEGY(6)

Does it use appropriate spacing?

Does it use appropriate letter size for the target population?

Is colour used to highlight?

code?

differentiate?

direct attention?

provide prompts?

Is the courseware "user friendly"?

Is it easy to "crash" the program?

Do you need a manual to use the program or is it self-explanatory?

Is there easy and ready access to a HELP option for

information about the use of the courseware?

explanation of courseware content?

Is there a permanent coded line on the screen which shows which options are available?

Are computer delays explained?

Can a menu (index) be easily called up so that users can go directly to different units of the courseware?

Can the learner exit and enter at different places?

Can the learners get their score at any time?

Is material organized in a hierarchical fashion so that the learner can go to a different level if so desired?

DEVELOP INSTRUCTIONAL MATERIALS

Definition: As well as the computer component, the courseware package includes other instructional materials, such as tests and a teacher's guide or manual.

The purpose of this step is to produce the components of the courseware package based on the instructional strategy. Don't forget that your tests have already been designed on the DESIGN CRITERION REFERENCED TESTS Worksheets.

Is the instruction appropriate to the objectives?

Is the instruction appropriate to the target population?

Will you include a teacher's guide or manual?

Will the manual
- provide an overview of the courseware?
- provide suggestions for use of the courseware?
- provide suggestions for the integration of the courseware into the curriculum?
- describe the target population?
- describe the entry behaviours?
- explain how to keep records?
- provide simple trouble-shooting procedures?
- provide technical information about running the materials?

DEVELOP INSTRUCTIONAL MATERIALS(2)

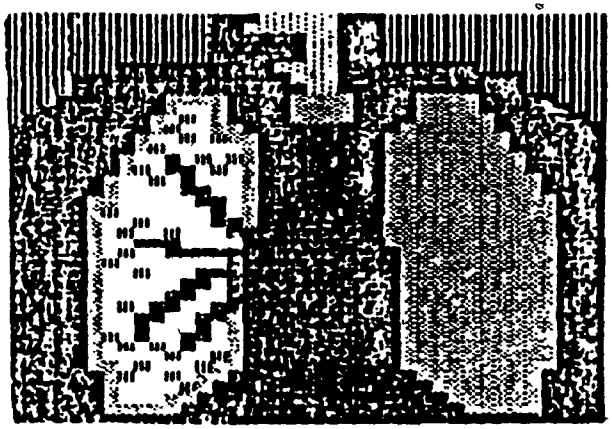
For each Performance Objective select an appropriate Computer-Assisted Learning mode and then fill in the tables on the Work Sheet.

Model

Example:

PERFORMANCE OBJECTIVE: After the presentation of information about the respiratory system the learner will correctly answer all questions based on that information.

C.A.L. MODE: Tutorial

LEARNER RESPONSE	COMPUTER SCREEN DISPLAY	COMPUTER CAPABILITIES UTILIZED
(The response is only put in this column when there is one from the learner.)	 ""LUNGS""	-Graphics capability. -Use of different colours. -As each organ appears on the screen, its name flashes below it.

Example continued:

LEARNER RESPONSE	COMPUTER SCREEN DISPLAY	COMPUTER CAPABILITIES UTILIZED
	HIT THE SPACE BAR TO MOVE THE FLASHING CURSOR UNTIL IT IS UNDER THE FIRST LETTER OF YOUR ANSWER.	
	YOUR RESPIRATORY SYSTEM HELPS YOU -?-*	
	EAT BREATHE THINK	Words appear one after the other.
BREATHE	-?-	
	(Right) GOOD THINKING. IT GETS OXYGEN INTO THE BLOOD AND CARBON DIOXIDE OUT.	A sound is heard when there is a Right response.
	(Wrong) TRY AGAIN. TYPE ANY LETTER TO CONTINUE. -?-	

*-?- means that the computer is waiting for a response from the learner.

The Instructional Design Process is completed with the following three sections. However, at the present state of use of this job aid for computer courseware design, you are not requested to use them but you are asked to read them and refer to them when you do actually design courseware for use.

DESIGN AND CONDUCT THE FORMATIVE EVALUATION

Definition: Formative evaluations are conducted to determine how effectively the courseware works. The courseware is first used with one member of the target population at a time, then with a small group, or as a field evaluation. Data collected at each evaluation is used to identify how to improve the courseware and this is done before moving on to the next evaluation.

Have you verified the courseware for values?

unintended learning?

cultural bias?

language level?

grammar?

spelling?

REVISE INSTRUCTION

Definition: Data from the formative evaluation is used to re-examine the validity of the instructional analysis and the assumptions about the entry behaviour of the learners. It may be necessary to re-examine the performance objectives, test items, and instructional strategy in light of the collected data. Revisions are then made to the courseware to make it a more effective instructional tool.

Is there provision in the design of the courseware for revision?

Does this provision exist for individual segments of the courseware?

Are these provisions explained in the teacher's manual?

Does the courseware allow you to add to or change the contents? (life span of the material)

CONDUCT SUMMATIVE EVALUATION

Definition: The summative evaluation is the culminating evaluation of the effectiveness of instruction. It occurs after the formative evaluation.

This step is not part of the design process. It is usually conducted by individuals other than the designer of the materials and so is seen as outside this design model.

INSTRUCTIONAL DESIGN MODEL

Worksheets

IDENTIFY INSTRUCTIONAL GOAL

(Worksheet)

Your instructional goal is:

CONDUCT INSTRUCTIONAL ANALYSIS AND IDENTIFY ENTRY BEHAVIOURS

(Worksheet)

List in hierarchical fashion the subordinate concepts, skills, etc. needed to achieve your instructional goal:

In the above hierarchy, identify the entry points for learners with different skills.

Will you include these subordinate skills or knowledge in the courseware: yes-no

If "yes" then at which point will you begin your courseware? Mark this point on your hierarchy.

IDENTIFY GENERAL CHARACTERISTICS OF THE TARGET POPULATION

(Worksheet)

Characteristics of your target population are:	Corresponding courseware design considerations are:

WRITE PERFORMANCE OBJECTIVES

(Worksheet)

Your performance objectives are:	Conditions for successful completion:	Criteria for successful completion:

DESIGN CRITERION REFERENCED TESTS

(Worksheet)

Test type:

Test instructions:

Examples with answers:

Practice examples:

Feedback comments for correct or incorrect responses:

PERFORMANCE OBJECTIVES

TEST ITEMS

DEVELOP INSTRUCTIONAL MATERIALS

(Worksheet)

For each Performance Objective select an appropriate Computer-Assisted Learning mode and then fill in the tables.

PERFORMANCE OBJECTIVE:

C.A.L. MODE:

LEARNER RESPONSE	COMPUTER SCREEN DISPLAY	COMPUTER CAPABILITIES UTILIZED

DEVELOP INSTRUCTIONAL MATERIALS

(Worksheet)

Teacher Manual Content:

FORMATIVE EVALUATION

(Worksheet)*

Points to be observed in a one-to-one evaluation:

Points to be observed in a small group evaluation:

*This is not part of this model but may be useful when a formative evaluation is actually done.

APPENDIX C

REVISIONS TO THE MODEL

OR INSTRUCTIONAL DESIGN AID AFTER SMALL GROUP EVALUATION

REVISIONS TO THE MODEL

OR INSTRUCTIONAL DESIGN AID AFTER SMALL-GROUP EVALUATION

1. Worksheets: The worksheets (pages 116 ~~– 123~~)*, which in the model were a separate booklet, will be integrated into the guide itself. Each worksheet will immediately follow the corresponding design-guide questions.

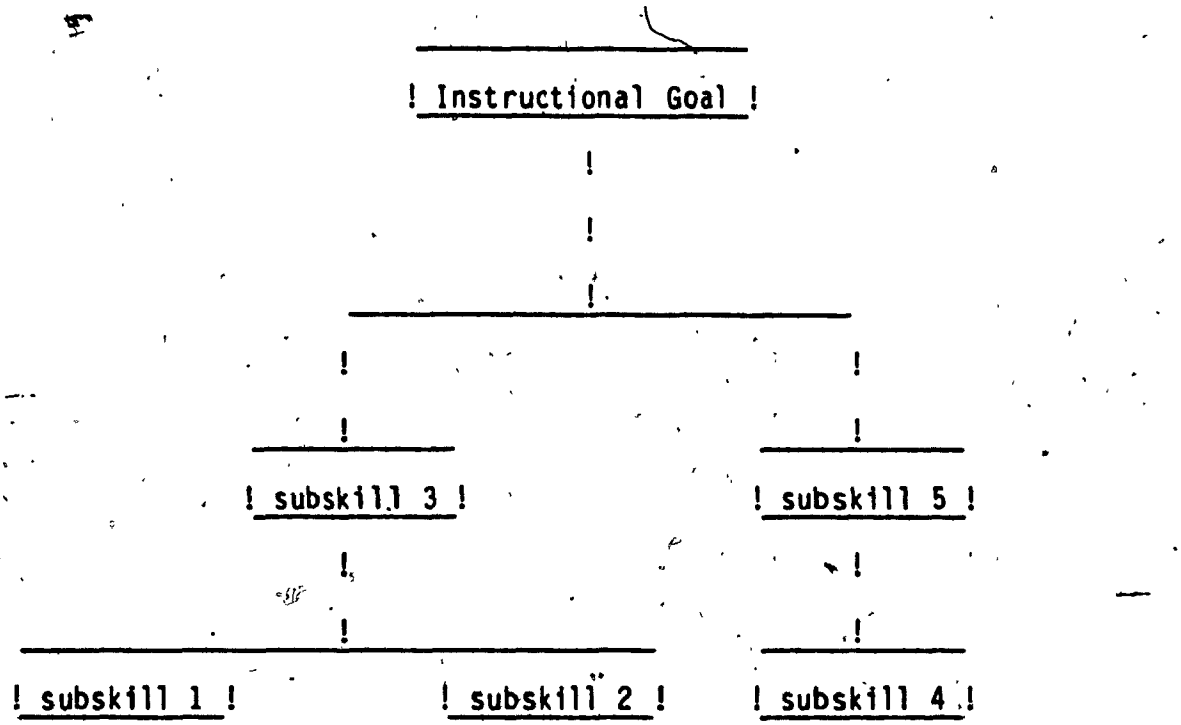
2. Identify Instructional Goal: The new definition (page 91) will read: An instructional goal is a general statement of what you want learners to do when they have completed your instruction. It should reflect the terminal skill of the learners with regard to the module. It should not involve behaviours which are too large and complex for one module or for one area of instruction.
Additional examples are:
The target population will punctuate paragraphs.
The target population will bake a cake.

3. Conduct Instructional Analysis and Identify Entry Behaviours: The new definition (page 92) will read: This is an analysis of your instructional goal in order to identify the subordinate skills or knowledge that must be possessed by the learners before it is possible for them to learn to perform skills in a higher position in the hierarchy, and ultimately to perform the instructional goal. The entry point for each learner is the entry behaviour.

*All page numbers refer to Appendix B.

A template of the hierarchy will be inserted in this section.

TEMPLATE FOR HIERARCHICAL ANALYSIS



ENTRY-BEHAVIOUR LINE

Below this line are the skills that must be possessed before the learner can initiate the module

4. Write Performance Objectives: The definition (page 96) will be changed to the following: A performance objective is a very clear, detailed, and precise statement for each of the skills which has been identified in the instructional hierarchy, including the instructional goal. At least one or more objectives can be written for each of the

skills identified in the instructional hierarchy. A performance objective is the basis for developing testing instruments used to guage the effectiveness of instruction. These statements identify the skills the target population will learn, the conditions under which they must perform these skills, and the criteria for successful performance. An additional example, including the conditions is: Given a paragraph which includes both description and dialogue, the learner will be able to insert all the appropriate punctuation marks.

On page 97 in the question "Are your objectives clearly related?, the word "related" will be changed to interrelated.

5. Design Criterion-Referenced Tests: The place where the target population writes the Performance Objective will be moved in the guide from page 102 to page 101, before the Test Type is chosen. The corresponding change will be made on the worksheet (page 120).

Feedback: The guide questions about feedback will be moved to page 100 of this section from page 106 of Develop an Instructional Strategy. The following will be added to the feeback commentary in the Introduction to the Model (page 87): Punitive or punishing feedback should be avoided and remedial feedback encouraged. Feedback for incorrect responses should not be more rewarding or exciting than feedback for correct responses, so that learners are not motivated to commit errors in order to receive the feedback for the incorrect responses.

6. Develop Instructional Materials: On page 108 the following question will be added: Does the program branch based on the learner's

responses, automatically going to an appropriate level?

On page 110, the following word will be added under Computer Capabilities Used: -Branching.

Teacher Manual: On page 109 parts of the last question will be changed as follows:

Will the teacher's manual provide information about BOTH the courseware and the computer?
provide simple computer trouble-shooting procedures?
provide technical information about running the materials on the computer?

APPENDIX D

ATTITUDE QUESTIONNAIRE

INSTRUCTIONAL DESIGN MODEL

Attitude Questionnaire

INSTRUCTIONAL DESIGN MODEL

ATTITUDE QUESTIONNAIRE

Please answer the following questions. The information that you give will be used to improve the instructional design model that you have just used.

Please circle the appropriate response and include any remarks that you think can help to improve the efficacity of the model.

Thank you for your cooperation.

1. Occupation: _____

2. If teacher, specify subject matter(s): _____

_____

3. Degree of knowledge and familiarity with the content (microbiology):

Very High 5 4 3 2 1 None at all

4. Background in Education: Check off pertinent options.

_____ Teaching Diploma / Certification

_____ Some background in computing science / programming

_____ B. Ed.

_____ M. Ed. / M.A. in Education

_____ B.A. (Specify area: _____)

_____ M.A. (Specify area: _____)

_____ Other (Specify: _____)

5. Degree of knowledge and familiarity with Instructional Design Terminology (e.g. pretest, entry behaviours, etc.):

Very High 5 4 3 2 1 None at all

Explain: _____

_____

6. Degree of knowledge and familiarity with Instructional Design Practice (e.g. Have you designed instructional materials before? etc.)

Very High 5 4 3 2 1 None at all

Explain: _____

_____

7. Degree of knowledge and familiarity with Educational Computing Terminology (e.g. Screen design, simulations, software, etc.)

Very High 5 4 3 2 1 None at all

Explain: _____

_____

8. Degree of knowledge and familiarity with Educational Computing Practice (e.g. Have you produced or used speadsheets, word processors, educational software, etc.?

Very High 5 4 3 2 1 None at all

Explain: _____

_____

9a. How difficult was the model to use?

Very easy 5 4 3 2 1 Very difficult

b. Which parts did you find too easy? Why? _____

_____

c. Which parts did you find too difficult? Why? _____

_____

10a. How useful was the format presented to guide you?

Very useful 5 4 3 2 1 Not useful at all

b. How would you modify the format to make it more useful? _____

_____

_____

11a. Did you understand all the terminology used?

All 5 4 3 2 2 1 None

b. Which terms did you not understand? _____

_____

_____

12a. Were you equipped with enough prior knowledge to be able to work with this model?

Enough 5 4 3 2 1 Not enough

b. What knowledge did you not possess? _____

_____

_____

13a. Did you find this model made it easier for you to design computer courseware?

yes no

b. Why or why not? _____

_____

_____

14a. Did you find the model interesting to work with?

Very interesting 5 4 3 2 1 Not interesting

b. Why or why not? _____

_____

_____

15a. Did you feel frustrated at any point?

yes no

b. At which point and why? _____

_____

_____

16a. Would you use this model again?

yes no

b. Why or why not? _____

_____

_____

17. General comments: _____

_____

_____

APPENDIX E

CONTENTS AND TARGET POPULATION USED IN THE EVALUATION

INSTRUCTIONAL DESIGN MODEL

CONTENT FOR COURSEWARE

Microbiology is the name given to the branch of science that studies forms of life which are microscopic, or not visible to the naked eye. These microscopic forms of life are called microorganisms. Microbiology studies how microorganisms live and die, and the helpful and harmful effects microorganisms have on other living things, including man.

One useful way of studying microscopic forms of life is to group them into general classifications. Four general classifications will be discussed here:

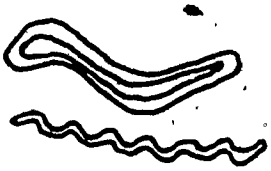
1. Bacteria
2. Viruses
3. Fungi
4. Protozoa

Bacteria are very small microscopic plants that are unicellular, which means that they are composed of only one cell. Bacteria have a rigid cell wall, are usually transparent, and are no larger than 1/50,000 of an inch in size. If bacteria were large enough to see with the naked eye you would find that there are three different shapes:

1. spheres called cocci:

2. rods called bacilli:

3. spirals called spirochetes, vibrios, or spirillum:



Viruses are submicroscopic, or even smaller than bacteria. Viruses exist in several shapes and sizes, but the viruses affecting man and animals are usually spherical in shape.

Fungi are usually larger than either viruses or bacteria, but many are still microscopic. Fungi are plant-like microorganisms such as molds and yeasts.

Protozoa are the largest of the four types of microorganisms. They are usually unicellular and are sometimes large enough to see with the naked eye.

Most organisms studied in microbiology are so small that they cannot be seen by the naked eye. Therefore, the scientist must use special instruments and special techniques to study microorganisms. One instrument used is the microscope. The microscope is a precision instrument used to magnify or enlarge the microorganism to many times its normal size so that it can be readily studied. Magnification by the microscope can be as little as two times or as much as 3,000 times the normal size of the microorganism.

Frequently the microorganism must be prepared in a special way so that it may be viewed with the microscope. Sometimes it is placed in water so that it can be viewed alive. At other times, the microorganism or parts of its structure are difficult to see, so it is stained with a special solution to make it more clearly visible.

For example, gram stain is a commonly used staining technique. It differentiates between bacteria by dividing them into two groups, Gram Positive or Gram Negative.

Another technique used by scientists to study microorganisms is known as culturing. In this technique, scientists in the laboratory

observe the growth of microorganisms on specially prepared plates, dishes, or in test tubes. A special food known as a culture medium is placed in the dishes. The microorganisms are then placed in the culture medium and allowed to grow. By using different culture media and exposing the dishes to different environmental factors, the scientists learn about the microorganisms.

Another way to study microorganisms is through the use of different biochemical tests. Such tests demonstrate the presence of different systems within the cell. One such test is fermentation, in which the microorganism changes sugar into alcohol.

Another technique used to study microorganisms is to introduce them into laboratory animals such as mice or rats and observe the animals for changes. This is known as animal innoculation. Sometimes the animal is killed and examined for the presence of internal reactions to the microorganism.

The environmental conditions which affect the growth and multiplication of microorganisms include:

1. type of food available
2. moisture
3. temperature
4. oxygen requirements
5. amount of light present

It is important to realize that different microorganisms require varying environmental conditions for optimal growth. These conditions become especially important in relation to sterilization and disinfection.

It is essential to know which of these environmental conditions can be controlled to destroy harmful microorganisms and attain sterilization. For example, if we know a certain microorganism requires a temperature of 98 to 100 degrees Fahrenheit to live, then raising the temperature several degrees above that level may kill it. This is essentially what is done during the sterilization process.

A program to control harmful microorganisms in the dental office environment consists of those sterilization methods which kill the most resistant and harmful microorganisms.

Microorganisms each have their own specific requirements for these environmental conditions. Much research has been conducted to determine the combinations of these conditions necessary to maintain the life of harmful microorganisms. Sterilization often changes one or all of these conditions to kill the microorganism and thus make it harmless.

Oxygen

Microorganisms also differ in their need for oxygen. Aerobic microorganisms require oxygen in their environment in order to grow and multiply. Anaerobic microorganisms require an absence of oxygen in their environment in order to grow. In other words, if any oxygen is present in the environment, the anaerobic microorganisms will die.

Light

Microorganisms also differ in the amount of light they require to grow and multiply. Some require a great deal of light while others actually require darkness to promote growth.

Viruses have varying requirements for environmental conditions in which to grow and multiply. Specific viruses require specific

conditions. One thing that is essential to the growth of any virus is the presence of some living tissue.

Some microorganisms are helpful to man and some are harmful. It is possible that in some quantities some microorganisms have no effect on the body, but in larger quantities may produce disease. The body varies in its response to the presence of microorganisms.

Some microorganisms are normally present within the body. These are known as resident microorganisms. The oral cavity is a good example of a part of the body where resident microorganisms may be found. It is important to understand that the resident microorganisms normally found in one person's mouth may be different from those microorganisms found in someone else's mouth. The resident microorganism found in the mouth may not be normally present in other parts of the body.

Transient microorganisms are not normally present in the body. They are transient, or present temporarily, in the body. These microorganisms may be present in the environment or be the resident microorganisms from someone else's body. In addition, microorganisms which are resident to one area of the body may be transient to another area of the body. For example, certain microorganisms are normally found on the finger or are resident there. If you rub your eye with your finger, some of the resident microorganisms may be transferred to the eye, where they are not normally found. They would then be called transient microorganisms and in some instances could cause disease.

Infection: When a microorganism enters the body, multiplies, and causes a reaction, this process is known as an infection.

Autogenous infection: An infection is known as an autogenous infection when it is caused by a resident microorganism. It is usually the result of resident microorganisms penetrating into an area where they do not normally reside. For example, if resident microorganisms in the mouth penetrate the oral tissues during an injection of local anesthesis and cause an infection, this would be known as an autogenous infection.

Cross infection: An infection is known as a cross infection when it is caused by microorganisms transferred from one person to another. For example, if you did not wash your hands properly (or wear gloves) and a microorganism from your hand entered a patient's mouth and caused an infection, it would be known as a cross infection.

Carrier of infection: A "carrier" is a person who carries or has present in the body a disease-producing microorganism, but does not exhibit observable symptoms of the disease. However, the carrier can transmit the disease-producing microorganism and the disease to any other individual who may be susceptible to the particular microorganism. For example, an individual may carry the microorganism that causes hepatitis and yet never exhibit the symptoms of the disease or ever have hepatitis. When the carrier comes into contact with others s/he can transmit the actual disease to the other individuals.

INSTRUCTIONAL DESIGN MODEL

TARGET POPULATION

You are attempting to create a computer courseware for use in institutions which train dental assistants (e.g. CEGEPS, Community or junior colleges, etc.). The curriculum will treat both skilled procedures, such as instrumentation procedures, and underlying background knowledge, such as microbiology, so as to train a "thinking technician." Your assignment is to design a lesson which deals with microbiology.

The learner is defined in the following manner:

1. Engaged in a full-time program of study (typically one year) which terminates in provincial certification as a dental assistant.
2. Typically 18-21 years of age although older learners are increasingly in evidence.
3. No formal education above the last year of high school is assumed.
4. May be either sex, although by tradition this course of study leads to a female-dominated profession.
5. Reading level of learners will vary between 10th- and 13th-grade equivalents. Intelligence can be assumed to be normal.
6. Learners are typically highly motivated because of the high correlation between the training curriculum and requirements of the profession.
7. You may add other characteristics if you wish.

APPENDIX F

TIME LOG

INSTRUCTIONAL DESIGN MODEL

TIME LOG

Starting Time	Starting Page	Finishing Time	Finishing Page
Example:			
14:30	22	15:30	35

APPENDIX G

SUBJECT TEMPLATES WITH DATA

SUBJECT #: 1 BACKGROUND IN INSTRUCTIONAL DESIGN: yes

TIME SPENT: 8½ hours

WORKSHEETS:

Instructional Goal: more like performance objectives

Instructional Analysis: 7 general levels above entry level; good although not every facet of the content was included; specific pre-entry subordinate skills specified.

Target Population: added seven complementary chacteristic to what was given; good correlation between the population and computer considerations.

Performance Objectives: 7 very detailed objectives; only one to be done on the computer.

Tests: performance objective corresponds to multiple choice testing items; good remedial feedback.

Instructional Materials: performance objective corresponds to the description of the contents of the screen; good use of computer capabilities.

Teacher Manual: Suggestions re the subject matter; no computer help.

Formative Evaluation: clear understanding of what this does.

CONSIDERATIONS FOR MODIFICATIONS

In the Instructional Goal it can be pointed out that there is a step in which performance objectives will be written down and so it is not necessay to be too specific at this point.

In the Teacher Manual step it can be noted that the manual should refer not only to the subject matter but also give hints on how to use the computer in class as well as how to trouble-shoot.

SUBJECT #: 2 BACKGROUND IN INSTRUCTIONAL DESIGN: yes

TIME SPENT: 6 hours 10 minutes

WORKSHEETS:

Instructional Goal: two general statements covering the content.

Instructional Analysis: excellent--42 items covering all the content; clear understanding of role of subordinate skills needed for entry.

Target Population: very good correlation between seven characteristics of population and design considerations.

Performance Objectives: excellent and exhaustive corresponding to the 42 items in the instructional analysis hierarchy.

Tests: oral pretest for computer use skills and tests corresponding to the items in the instructional analysis; remedial and enriching feedback.

Instructional Materials: has designed 14 screens using different C.A.L. modes, with detailed computer-capability descriptions.

Teacher Manual: not done.

Formative Evaluation: not done

CONSIDERATIONS FOR MODIFICATIONS

In the Instructional Materials section this subject volunteered the suggestion that the branching capability of the computer be mentioned.

He also volunteered that on the worksheet corresponding to Design Criterion-Referenced Tests that the order be changed so that the performance objective appears before the Test Type.

SUBJECT #: 3 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 2 hours

WORKSHEETS:

Instructional Goal: general two-part statement

Instructional Analysis: good, but reversed; content included with different entry points; no pre-entry behaviour specified.

Target Population: good correlation between five characteristics and design considerations.

Performance Objectives: 5 good performance objectives.

Tests: feedback limited to "Try again."

Instructional Materials: one example given; good use of computer capabilities.

Teacher Manual: not done.

Formative Evaluation: a few items showing that concept understood.

CONSIDERATIONS FOR MODIFICATIONS

Although a sample hierarchy is given, the necessity of establishing pre-entry skills should be emphasized in the Instructional Analysis section.

Emphasis on different types of feedback (remedial and enriching) should also be made.

SUBJECT #: 4 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 11¼ hours

WORKSHEETS:

Instructional Goal: general statement

Instructional Analysis: 8 levels, broken down into different parts; specific considerations of subordinate pre-entry skills needed.

Target Population: good design considerations for the population characteristics.

Performance Objectives: 6 very detailed performance objectives.

Tests: one entry-behaviour and one embedded test samples; feedback neither remedial nor enriching.

Instructional Materials: 6 screens corresponding to the 6 performance objectives; uses examples of different C.A.L. modes; only one example of remedial feedback.

Teacher Manual: good ideas for C.A.L. implementation and computer maintenance.

Formative Evaluation: not done.

CONSIDERATIONS FOR MODIFICATIONS

Emphasis on feedback types could be done in Design Criterion-Referenced Tests section rather than in the Develop Instructional Strategy section.

In the Instructional Materials section, this subject wonders about the feasibility of branching. This could be mentioned in the Instructional Strategy guide section, as well as in the given example.

SUBJECT #: 5 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 3½ hours

WORKSHEETS:

Instructional Goal: general, but only about one part of the content.

Instructional Analysis: two subordinate skills specified below the entry point which is a general statement that is not broken down.

Target Population: six considerations related to population characteristics.

Performance Objectives: One performance objective with detailed conditions (This related to fact that only one aspect of the content was chosen to do this project by this subject.)

Tests: example of embedded test with good performance objective and remedial feedback.

Instructional Materials: three modes and screen displays described; good use of computer capabilities and enriching feedback.

Teacher Manual: considerations on contents, none on computer.

Formative Evaluation: not done.

CONSIDERATIONS FOR MODIFICATIONS

Emphasize the importance of breaking down the content above the entry point, in the Instructional Analysis section.

Emphasize that the Teacher's Manual should contain considerations on both the courseware and on the computer.

SUBJECT #: 6 BACKGROUND IN INSTRUCTIONAL DESIGN: yes

TIME SPENT: 3½ hours

WORKSHEETS:

Instructional Goal: general statement

Instructional Analysis: reversed; five general levels with two subordinate skills.

Target Population: six characteristics with corresponding considerations.

Performance Objectives: four done.

Tests: entry-behaviour test with examples but without enriching or remedial feedback.

Instructional Materials: One screen with good use of computer capabilities but feedback just "Right, try again," or "Wrong, try again."

Teacher Manual: courseware considerations; no computer considerations.

Formative Evaluation: not done.

CONSIDERATIONS FOR MODIFICATIONS

For Teacher Manual conclusions see subject # 1.

For Feedback conclusions see subject # 4.

SUBJECT #: 7 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 2 hours

WORKSHEETS:

Instructional Goal: general statement

Instructional Analysis: seven levels; points out what would be lab work and what would be computer work; no pre-entry skills specified.

Target Population: two characteristics with corresponding considerations.

Performance Objectives: five performance objectives

Tests: pretest with performance objective, but feedback neither remedial nor enriching.

Instructional Materials: describes four screens with corresponding computer capabilities.

Teacher Manual: considerations for courseware; none for computer.

Formative Evaluation: a few notes.

CONSIDERATIONS FOR MODIFICATIONS

For Feedback conclusions see subject # 4.

For Teacher Manual conclusions see subject # 1.

SUBJECT #: 8 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 2 hours 20 minutes

WORKSHEETS:

Instructional Goal: general two part statement.

Instructional Analysis: reversed with eleven levels, four of which are pre-entry skills.

Target Population: six characteristics with corresponding considerations.

Performance Objectives: two done; specifies that the rest of the material will only refer to one of these.

Tests: pretest with remedial feedback.

Instructional Materials: excellent description of material with performance objective; good knowledge of computer capabilities.

Teacher Manual: confuses this with student manual content.

Formative Evaluation: not done.

CONSIDERATIONS FOR MODIFICATIONS

This subject is Francophone and although she seemed to see this as a major obstacle, she managed to produce one of the better products. The reason she may have confused Teacher Manual with Student Manual may be due to this language difficulty. However, in the Develop Instructional Materials, it may be emphasized that this manual is intended to help the teachers.

SUBJECT #: 9 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 2 hours

WORKSHEETS:

Instructional Goal: general statement

Instructional Analysis: reversed and presented as four statements representing the general goals of the courseware; one pre-entry skill specified.

Target Population: seven characteristics with corresponding considerations.

Performance Objectives: one performance objective which is very general with four conditions which are really the performance objectives.

Tests: three examples with good performance objectives; feedback is neither remedial nor enriching.

Instructional Materials: has students read a chapter then answer questions on the computer; feedback is not adequate nor are the capabilities of the computer exploited.

Teacher Manual: content and computer considerations.

Formative Evaluation: a few considerations showing that this concept is understood.

CONSIDERATIONS FOR MODIFICATIONS

In the Instructional Analysis hierarchy it should be emphasized that the breakdown of content is how this material will actually be organized for learning purposes and so it is important to be very specific in this hierarchy.

SUBJECT #: 9 (continued)

For Feedback conclusions see subject # 4.

In answer to question #16a of the Attitude Questionnaire ("Would you use this model again?), this subject answered NO and continued by saying "I have an aversion to computers. I would prefer studying or teaching without the use of computers." It may be for this reason that in designing the Instructional Materials this subject did not exploit the capabilities of the computer.

Emphasize that the performance objectives determine the actual behaviour/response of the learner and so should be very precise statements on what the learner should be able to do.

SUBJECT #: 10 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 5¼ hours

WORKSHEETS:

Instructional Goal: general statement

Instructional Analysis: using pretest and background has five different entry levels but does not include the content itself.

Target Population: four characteristics corresponding to very detailed considerations.

Performance Objectives: two levels of performance objectives depending on the entry level--3 objectives for each level.

Tests: embedded test with three examples, performance objective, and remedial feedback.

Instructional Materials: description of a simulation with good use of computer capbilities.

Teacher Manual: description of contents and computer considerations.

Formative Evaluation: considerations show understanding of this step.

CONSIDERATIONS FOR MODIFICATIONS

A hierarchy template is needed so that all parts of the instructional analysis are included.

SUBJECT #: 11 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 12 hours

WORKSHEETS:

Instructional Goal: general statement

Instructional Analysis: because of heterogeneous population, has all subordinate skills included in a 12 level hierarchy.

Target Population: 6 characteristics with corresponding considerations.

Performance Objectives: chose to do two with multiple conditions.

Tests: embedded test with performance objective and examples; feedback not specified.

Instructional Materials: describes three different modes for one performance objective with different screen descriptions.

Teacher Manual: six suggestions for courseware use; none about computer trouble shooting.

Formative Evaluation: not done.

CONSIDERATIONS FOR MODIFICATIONS

For Feedback conclusions se subject # 4.

For Teacher Manual conclusions see subject # 1.

SUBJECT #: 12 BACKGROUND IN INSTRUCTIONAL DESIGN: no

TIME SPENT: 5 hours

WORKSHEETS:

Instructional Goal: general statement

Instructional Analysis: upside down; 8 levels ithe specific pre-entry behaviour.

Target Population: 4 characteristics and corresponding considerations.

Performance Objectives: 4 performance objectives.

Tests: Embedded with remedial feedback (learner sent to review if answer is incorrect), but no enriching feedback.

Instructional Materials: performance objective with description of screen and detailed use of computer capabilities; feedback neither enriching nor remedial.

Teacher Manual: refers only to courseware, does not give computer help.

Formative Evaluation: not done.

CONSIDERATIONS FOR MODIFICATIONS

For Feedback conclusions see subject # 4.

For Teacher Manual conclusions see subject # 1.

APPENDIX H

SUMMARY OF OBJECTIVES ATTAINED BY SUBJECTS

OBJECTIVE	SUBJECT #	1	2	3	4	5	6	7	8	9	10	11	12
	Y=YES N=NO I=INCOMPLETE												
1.1	Formulation of instructional goal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1.2	Instructional goal not as specific as performance objectives	N.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2.1	Identification of target population's subordinate skills or knowledge for courseware use	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
2.2	Identification of target population's subordinate skills or knowledge to attain instructional goal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3.1	Identification of skills possessed by target population	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
3.2	Identification of entry point	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4.1	Description of relevant target population's characteristics	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

OBJECTIVE	SUBJECT #	1	2	3	4	5	6	7	8	9	10	11	12
4.2 Relating target population's characteristics to courseware design specifications		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.1 Writing appropriate performance objectives		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.2 Including conditions and cirteria for objectives		Y	Y	Y	Y	Y	Y	Y	Y	I	Y	Y	Y
6.1 Creating assessment instruments for each objective		Y	Y	I	Y	Y	I	Y	Y	Y	Y	Y	Y
6.2 Choosing among criterion-referenced tests		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.3 Choosing medium for tests		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.4 Writing clear instructions for tests		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.5 Deciding to speed tests or not		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

OBJECTIVE	SUBJECT #	1	2	3	4	5	6	7	8	9	10	11	12
7.1 Identification of preinstructional activities, presentation mode of information, type of practice and feedback, and follow-through activities		Y	Y	I	Y	Y	I	I	Y	I	Y	I	I
7.2 Choosing instructional strategy		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.3 Relating parts of courseware with an instructional strategy		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.1 Choosing vocabulary, exercises, tests, and feedback appropriate to target population		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.2 Choosing enriching or remedial feedback		Y	Y	N	I	Y	N	N	Y	N	Y	N	N
8.3 Inclusion of teacher's guide or manual		I	N	N	Y	I	I	I	N	Y	Y	I	I
9.1 Choosing computer capabilities		Y	Y	Y	Y	Y	Y	Y	Y	I	Y	Y	Y