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Effects of Post-Questioning, Concept Mapping
and Feedback on Cognitive Performance
in Distance Education

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A Thesis

in

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ABSTRACT

Effects of Post-Questioning, Concept Mapping
and Feedback on Cognitive Performance
in Distance Education

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Concordia University, 1991

This study examined the effects of post-questioning, concept mapping and feedback on cognitive performance in a twenty week, undergraduate nursing distance education course. Post-questioning without feedback was the control condition, and both strategies were presented in a combined format. The dependent measures included achievement scores of subjects on multiple choice and essay-type questions in the midterm and final course examinations and subjects' attitudes towards various methods of studying.

The omnibus MANCOVA performed on achievement data produced a significant main effect for the independent variables on the set of DVs. In the univariate analysis, with α set at .05, treatment group differences were observed on six of the ten DVs in the design. In the stepdown analysis, with a more conservative α set at .005, only one of these six variables was significant. This was recall of key idea units on essay questions in the final examination that were cued to content with mapping exercises.

The omnibus MANOVA carried out on attitudinal data produced a significant main effect for the factor variables. Significant group difference was observed on only one of the factors which revealed a preference for visual and graphical learning aids. The source of this difference was between the low and high persistence concept mappers. According to the direction of means, low mappers (i.e., subjects who completed an average of 3 out of 12 sets of mapping exercises) held a negative attitude towards visual and graphic learning aids, while high mappers (i.e., those who completed an average of 11 out of 12 sets of mapping exercises) were more positively disposed towards them.

ANOVA tests were carried out on subjects' responses to questions on concept mapping and post-questioning strategies. Significant differences were found between the high and low persistence mappers on several issues concerning mapping. In comparison with high persistence mappers, the low persistence mappers found concept mapping exercises more difficult, more time-consuming and less useful as a method of studying. No significant differences were observed for post-questioning strategy with regard to difficulty level, usefulness or time taken to do them.

ACKNOWLEDGMENTS

To my parents,

from whom I learned most.

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CHAPTER ONE

Introduction

Most definitions of educational technology assert that it is concerned with the solution of educational problems, and that educational technologists, are those who are engaged in developing instructional systems or materials that address such problems. Consequently, we have a variety of "expert" or "intelligent" tutoring systems, multi-media or computer-based instruction, and distance education systems, all of which attempt to address educational problems and challenges that have been posed by particular contexts and learners.

This does not suggest that educational technology and its practitioners do not have a place in conventional face-to-face educational settings, indeed, both serve a variety of important functions in such contexts. However, in face-to-face instructional settings, participants in the educational process are present in a particular location for an extended period of time. Teaching is the responsibility of the instructor who is considered to be an expert in the subject matter as well as in its delivery. Learning is facilitated by the presence of student peers and a range of institutional resources such as classroom time, instructor-student contact, libraries and laboratories.

In educational settings where this form of participant contact is not possible, or where a similar level of institutional support cannot be provided, the instructional

challenges are different and more intensified, and so is the function of educational technology, which is manifested in several ways. For example, instruction must be considered in advance of its actual delivery, and a variety of learner support structures within the instructional materials and also without it have to be conceived to cater for the range of individual learner characteristics that could be expected. As Winn (1989) would like it, the role of the educational technologists in such contexts is more than to simply attempt to emulate human teaching, "they must strive to discover, or perhaps even invent a pedagogy that is most appropriate to instruction using non-human teachers" (p. 150).

In order to be able to do this, educational technologists must apply themselves to an understanding of the structure of knowledge and instructional systems, and also to an understanding of learners and learning styles, and their development. The research described in this document is a contribution in this regard in that it comprises a study of the influence of selected instructional strategies on cognitive performance in a print-based distance education environment.

In the following sections of this chapter, distance education activity is described, and the nature of teaching and learning in such settings is examined. The implications of research such as the one embodied in the current study for distance education applications, as well as its theoretical foundations, are also discussed.

Distance Education

Distance education refers to various forms of educational activity in which the learners are physically apart from the teacher or the teaching institution for much of the teaching and learning process (Rumble, 1989). It is this feature of distance education that distinguishes it from conventional classroom-based educational activity. Distance education places much greater emphasis on guided independent study on the part of the learner, without eliminating the possibility of some face-to-face contact, either between the teacher and the learners, or the learners themselves. Hence, the more face-to-face contact there is in distance education programs, the "less distant" they are called, and conversely the less face-to-face contact there is in such programs, the "more distant" they are called. In this manner, certain forms of computer-based and computer-managed instruction can be considered distance education activity.

Distance education (hereafter — DE) represents a distinctly different approach, not only from the learner's perspective but also from that of the teacher or the teaching institution. Whereas in conventional educational institutions it is the teacher who usually teaches, in DE institutions, instruction takes on a life that is quite independent of any particular teacher. Conventional classroom-based students are in an environment that the teacher controls. DE students, on the other hand, are not in an environment that the teacher or the institution controls and however well an institution may

organize the teaching process, it must rely on the learner(s) to set aside time for study and to follow instructions and guidelines without frequent and immediate responses to all their questions. DE involves mostly home-based independent study with occasional work in class and in groups, while conventional education requires mostly classroom or group-based study with occasional independent work at home.

Nature of DE activity. The nature of DE activity has been best illustrated by Peters (1971; 1983) with its comparison with industrial phenomena. In drawing parallels between characteristics of DE activity and the processes of industrial production, Peters pointed out that:

> Neither process can start without a previous period of careful planning by experts, and without specialization by division of labor, that is, by dividing the many functions of the teacher or the worker and assigning them to a number of specialists or machines. Both processes rely on the use of technical devices, machines, and even computers, both apply the principles of the assembly line and of mass production, and both need and use scientific methods of control in order to improve the teaching or production process while in operation (Mackenzie & Christensen, 1971, p. 225).

Peters argued that conventional classroom-based instruction was a pre-industrial process and that the teacher in the classroom was an artisan, as his teaching resembled the work of an artisan where there was still the unity of

person, time and place. On the other hand, industrialization was the symbol of a new epoch in the development of man which had effected fundamental changes in most spheres of human existence. Conventional classroom-based instruction, alone, seemed to have remained unaffected by industrialization with the exception, of course, of correspondence education. Correspondence education (later called distance education) was more progressive than conventional classroom-based instruction and consistent with the basic principles and tendencies of industrial processes, namely: division of labor, rationalization of production process, systematic planning and organization, automation, scientific control, mass production and centralized administration.

The notion of division of labor in DE was apparent when the conventional functions of the teacher/instructor — that of single-handedly imparting knowledge, providing counselling and assessing student learning was shared among a team of content experts, instructional designers, media specialists, counsellors and local tutors. With this division of labor and the economic implications of the mass production of course materials came the need for a rationalization of the production process, some degree of collective and objective decision-making, and also standardization in the choice and presentation of content.

It must be said here, however, and especially as Peters himself has acknowledged, that this interpretation of DE activity in terms of industrial phenomena is purely heuristic

and that the teaching and learning processes in DE are not
necessarily being equated in any way with industrial
processes (Sewart, Keegan, & Holmberg, 1983). In fact, there
has been some disagreements with Peters in more recent times,
on whether several forms of contemporary DE activity, such as
more decentralized systems and others with a greater degree
of two-way communication between students and teachers, could
be satisfactorily interpreted in this manner (Bååth, 1981;
Garrison & Shale, 1987).

Implications for the Educational Process

The greatest challenge for DE institutions therefore, is
the variety of functions they must conduct, which call for an
equally large number of organizational styles. While running
printing presses and operating course materials warehouses
may be best done through the rigor of industrial processes,
functions such as the creation of DE course materials by
course teams, as well as by individuals, require the most
modern forms of project and personnel management and skill in
systematic instructional materials design. In the same
manner, planning and organizing the information flows
necessary to support effective tutoring and counselling for
DE learners is also a complex task.

In the following sections of this chapter, these
implications of DE activity on its teaching and learning
processes, instructional materials design and development,
and DE learners are discussed.

Teaching and learning. At the heart of the educational process lies the quality of teaching and learning activity that goes on. In conventional face-to-face instruction this is facilitated by the presence of the teacher, student peers on-site and the feasibility of classroom-based interaction. Oakeshott (1967) has referred to the act of teaching as the deliberate and intentional initiation of learners into the world of human achievement, and learning as the result of communication from the teacher. In this manner teaching is viewed as a reciprocal act that is impossible in the absence of learners. In conventional educational systems, this reciprocity is obviously possib'.e and evident — because if students are not present in classrooms then teaching cannot occur.

In DE institutions, this sort of facility for interface between students(s) and teacher, and among students does not occur naturally. Oakeshott's notion of teaching and learning is therefore, inappropriate in DE, where the teaching acts are separated in time and place from the learning acts. The learning materials being used by students could have been developed several years ago, and perhaps in another part of the world. Moreover, the developers of the study materials and those who may be using it to teach, or who may be evaluating students' learning from it are not necessarily the same persons. The design and development of DE study materials, and sometimes the choice of content is in the hands of persons other than those who will be teaching with

it. The study materials that are developed belong to the institution and teaching becomes institutionalized. Learning is the responsibility of the learner, although part-time staff are usually available to support their learning process.

Materials development. Since many of the instructional activities commonly associated with conventional face-to-face instruction, such as classroom discussion and immediate and direct feedback, are not easy to provide in the DE context, the role of the instructional materials that are prepared in advance of the learning activity is especially important. Indeed the quality of the teaching and learning process in DE is dependent on the quality of the study materials.

Good distance education course materials are multi-media packages and often include print materials, audio components, face-to-face sessions and correspondence instruction. The development of high quality instructional materials for DE is a labour intensive and costly affair, and draws upon a wide range of expertise that is normally not available within the repertoire of skills of any one person. Consequently some variation of a team approach to the process is strongly recommended and often adopted (Shaw & Taylor, 1984). Several approaches to course teams to suit different organizational circumstances have been proposed in the DE arena, and discussed by Holmberg (1983), Mason and Goodenough (1981) and Smith (1980).

The dynamics of developing study materials within the context of a team has numerous implications for its members. These range from faculty concerns about losing their academic control of course content to the day-to-day management of the developmental task by the team chairperson. These and many other concerns of DE course development teams have been discussed extensively in the distance education literature (Hawkridge, 1979; Lewis, 1971a, 1971b, 1971c; Riley, 1984a, 1984b, 1984c). Training of staff engaged in the development of DE course materials is necessary. Concerns of staff in this regard, and some possibilities for coping with them, have been explored by Naidu (1987; 1988), and Kember and Mezger (1990). Jenkins (1990) argues that DE study materials replace the teacher in more than the subject matter alone. Therefore, the materials must be designed in such a way that they provide a substitute for the dialogue possible in the conventional classroom situation, and that it is not just a matter of possessing a good writing style.

The materials once developed, are considered self-instructional, and upon receipt of these packages students are expected to be able to progress with their study independently with the least amount of additional support. Faced with this notion of minimal or no direct contact with students, once the course materials are developed and out in the hands of the students, DE course developers are forced to preconceive the entire teaching and learning process, as well as possible long before any of it takes place. That process

is often very labor-intensive and includes a consideration of various aspects of the presentation of content, activation of the learning process and the evaluation of learning. It incorporates a reproduction of as much as possible that is part of the dynamics of one-to-one tutorial instruction, for teaching at a distance is essentially a form of one-to-one tutorial instruction, although through non-contiguous means.

Distance learners. Distance learners are also implicated in the separation of the teaching and learning activities as described above. DE learners, by and large, are isolated or semi-isolated students whose concept of going to school is limited to their study materials, their study space, mailbox and/or their telephone (Moore, 1986; Wedemeyer, 1981). As such, their opportunities for developing study skills and cognitive strategies, that are appropriate for an efficient and effective learning process are limited. For many students the result is disenfranchisement, frustration and in many cases, dropout (Sweet, 1986).

The separation of the teaching acts from the learning acts means that for the most part of their learning activity, learners do not have to be present at any one place or time. As such, learners have greater control over their learning and the choice to manage it in a manner that best suits them. As a result, especially for those already in the workforce, learning is more easily accommodated into an already full, daily program of activities. The disadvantage, however, of this kind of flexibility with one's learning activity is that

the learning task usually suffers from: (a) procrastination; (b) lack of peer group support; (c) lack of access to bookstores and library facilities; (d) lack of support from tutors and instructors; and (e) lack of feedback. Moreover, not all persons who choose to seek education and training via the DE mode, have all that it takes to manage and conduct a successful learning experience on their own, especially when trying to combine it with paid employment and/or homemaking.

Among the major woes of most DE programs is student dropout. As a result, practice and research in DE has always been concerned with understanding and saving student dropout through a variety of ways, notably, by reducing turn-around times for feedback to students (Rekkedal, 1983), and also with the provision of tutor and peer group counselling services (Amundsen & Bernard, 1989; Sewart, 1983). Practice and research in DE is also concerned with providing learners with as rich and complete a learning experience as is possible to eliminate notions of learning at a distance as "learning through the backdoor" (Wedemeyer, 1981). This has been made possible most commonly through local tutorial and counselling services, study center facilities, library resources and science laboratories, and also through periods of residential face-to-face sessions where necessary.

The current research is focussed on the implications for instructional materials design for DE applications. While consideration of aspects of instructional materials design necessarily implicates the processes of teaching and learning

and learners, this study has been specifically concerned with the role of different instructional strategies on cognitive performance in a print-based DE environment. In the following section, the orientation of the research is discussed and the need to conduct research on these lines is explained.

Statement of the Issue

The importance of quality instructional materials in DE settings, or for that matter, in any self-instructional system cannot be overstated. Distance educators appreciate this role of instructional materials in their business and are concerned about ways of developing sound instructional materials in order to optimize learner performance.

Irrespective of the theoretical orientations adopted by course developers, much of the course development activity is primarily concerned about three things: (a) the content, (b) the instructional strategies that are employed to facilitate learning, and (c) the processes of learning (i.e., behaviors in which learners will engage). In most contexts, the content is provided by the subject matter expert. The determination of how that content may be presented and what the learners will be expected to do, is the responsibility of educational technologists or instructional designers in the system. In most cases, however, the tasks outlined here are not always as clearly defined. Often, there is collaborative effort among subject matter experts, media specialists and

instructional designers in the process, as exemplified in the team approaches to course development referred to earlier.

The determination of what the educational technologist does to present the content, and what the learner does with the study material once it is delivered, is the focus of this study. Often, these decisions are governed by a variety of factors, some of which have to do with the logistics and the costs of their implementation. Not all that is theoretically sound may be practicable and educational technologists cannot be oblivious to learner characteristics either, if they are to design materials to compensate for deficiencies in learner characteristics and optimize their proficiencies.

The pervasiveness of differences in learner performance in most instructional settings is evidence of the fact that there are different ways of going about learning. These ways of going about learning have been variously referred to as learning strategies, cognitive strategies, study habits and approaches to studying. If particular learning strategies tend to be more effective for some learners and with certain kinds of subject matter, then it would seem appropriate to investigate if better learning and retention techniques can be taught.

Rigney (1978) describes a learning strategy as embodying the operations and procedures that learners use to acquire, retain, and retrieve different kinds of information. A learning strategy, therefore, may be conceptualized into two parts: (a) an orienting task for inducing learners to perform

particular kinds of operations, and which may be either prescribed by the instructional system or embedded in the instructional materials, and (b) one or more representational or self-directional learning capabilities which may also be either prescribed by an instructional system or generated by the learner.

Rigney proposed that if learning strategies can be considered as either designer-imposed or learner-generated, then there are two ways in which cognitive processes can be enhanced with the help of instructional strategies to ensure maximum benefit for the learners. These are as *embedded* strategies and *detached* strategies. Embedded strategies are not explicitly identified independently of the content. Instead, the instructional materials are designed to coerce learners into using particular processing resources in order to accomplish the orienting tasks that have been specified. Examples of these kinds of strategies would be factual or higher-order inserted and post-questions, instructional activities such as peer group discussions and writing and/or reading homework assignments. These would engage and direct learners into mental processing of specific aspects of their subject matter. These kinds of instructional strategies are commonly used in the design of print-based instructional materials in most DE settings and they have been found to positively influence cognitive processing capabilities of learners.

Detached instructional strategies, on the other hand, are applied independently of the subject matter and designed to teach learners or encourage them to use one or more learning activities in the process of learning. Examples of these would be instructions to use mental imagery, to think of examples and analogies of concepts represented in the course content, or to engage in concept or cognitive mapping. The instructional materials are designed in such a manner that features induce learners to apply particular cognitive processing resources in order to perform the tasks specified in them. These kinds of strategies are somewhat harder to teach and may require extensive practice before their effects are transferable to other situations. As such they are less frequently applied in DE settings although their effects on cognitive performance have reportedly been quite high.

The underlying premise of these approaches is that it is desirable and also possible to teach students how to be more effective as learners in the acquisition, retention, and retrieval of information, as well as in the performance of given tasks in their materials. This is certainly not to imply that embedded or detached instructional strategies will work for all learners, all the time. It does, however, say that teaching learners how to learn and to retrieve what has been learned ought to be the primary concern of instructional systems and educational technologists.

Rigney has suggested that the application of instructional strategies in such a manner could compensate

for a lower capacity for the acquisition, retention, and retrieval of information. Higher performers naturally tend to use more effective learning strategies than lower performers do. Therefore, in theory at least, training lower performers to acquire more effective learning strategies should enhance their acquisition, retention and retrieval capabilities. Thus, detached instructional strategies may be more beneficial to higher achievers who are more likely to be able to direct themselves through their tasks, and embedded strategies may be more useful to lower achievers as they are more likely to need more direct orienting tasks and greater support from the instructional systems. The best application scenario would seem to be to use both embedded and detached instructional strategies together, and selectively with different kinds of content so that, as necessary, learner deficiencies are compensated and their proficiencies optimized.

Purpose of Current Study

The current study investigated the potential of both types, embedded (post-questioning) and detached (concept mapping) instructional strategies for enhancing cognitive performance in a DE setting. Existing work on the application of instructional strategies in DE has tended to emanate from different philosophical and psychological viewpoints. For instance, Spencer (1980), Elton (1980) and Coldeway and Spencer (1982), have argued that Keller's Personalized System

of Instruction has potential and clear advantages for designing and managing DE systems. Coldeway and Coldeway (1986), and Coldeway (1987) propose, in addition, that Keller's Personalized System of Instruction, distance learning, Instructional Systems Design (as an instructional planning model), and behavior analysis have much in common, and together form the basis of an instructional theory.

In contrast, Holmberg (1986) argues that a cognitive orientation, with course designs that enhance deeper-level processing of content, and which accommodate individual learning styles, best fits the DE context. The focus of his orientation is on approaches conducive to problem-solving (i.e., approaches that direct student's attention to the subsumability of new concepts under broader ones already known, and which also engage students in internalized conversations and interaction with their study materials).

These are no doubt useful, but they represent only general approaches to the instructional process, and do not offer specific guidelines on the application of particular instructional strategies within the constraints of teaching at a distance. This may account for the fact that strategies most commonly applied in DE are only manipulations of textual variables such as the inclusion of behavioral objectives, inserted questions, exercises, and graphical design features (Marland, Patching, Putt, & Putt, 1990; Melton, 1990; Parer, 1988). The primary function of these strategies is to enhance verbal processing, and beyond that they have limited

potential for facilitating the active learning involvement suggested by Coldeway and Holmberg.

The orientation of this research is that behavior-analytic, cognitive and systems approaches are all useful for conceptualizing the conditions of active learning. Bloom (1980) has suggested that in fact, instructional strategies, irrespective of their theoretical orientation may be combined to enhance one another and approach the superior performance and effectiveness possible through one-to-one, face-to-face tutorial instruction.

Table 1, adapted from a similar conceptualization by Bloom (1984) and Walberg (1984), lists several instructional strategies that have the potential for serving the purposes suggested by Rigney described above. The listed strategies were selected for their suitability for application in print-based DE environments. They are arranged according to a four-part framework for conceptualizing the teaching and learning process in DE settings developed by Bernard, Naidu and Amundsen (1991) and appear in the table as follows:

1. *Content presentation strategies*. These include advance and graphic organizers, objectives and instructional illustrations and they comprise the most commonly adopted strategies in DE settings. Their primary function is to help the presentation and organization of the subject matter. Their influence on learning achievement, as shown by their effect sizes reported alongside, is rather small.

Table 1

Effect Sizes[a] for Instructional Strategies of Relevance to DE

Category • Strategies (primary nature of sample[b])	Effect Size	Percentile Rank
Content presentation		
• Advance and graphic organizers (HE)	.20	58
• Specification of objectives (ML)	.20	
• Instructional illustrations (ML)	.30	62
Activation		
• Student participation (ML)	up to 1.00	84
• Reading+study skills training (E/S)	up to 1.00	
• In-text (inserted) questions (HE)	.30-.50	62-69
• Homework (ungraded) (E/S)	.36	64
Socialization		
• Cooperative Learning (ML)	.80	79
• Peer group influence (E/S)	.20	
Feedback and correction		
• Feedback (overall) (ML)	up to 1.42	92
• One-to-one tutorial instruction (ML)	.60-2.0	73-98
• Feedback (corrective) (ML)	.50-.65	69-74
• Homework (graded) (ES)	.80	64-79

Note. [a]Effect Size: ES = $\mu_{Treatment} - \mu_{Control} / \sigma_{Control}$.
[b]Key to nature of sample: E = Elementary; S = Secondary;
E/S = Elementary and Secondary; HE = Higher Education;
ML = Mixed Levels.

2. *Activation strategies.* These include student participation, reading and study skills training, in-text questioning and ungraded homework. These are strategies and arrangements that are provided by the designer or the instructor and are intended to help initiate and sustain learning activity. They are less commonly applied in DE settings and with varying degrees of intensity. The effect sizes for some of them are reportedly quite high.

3. *Socialization strategies.* These include cooperative learning and peer group influence (institutionalized attempts only). Normally these are difficult and expensive to arrange, and their effect sizes have been varied.

4. *Feedback and correction strategies.* These include graded homework, generalized forms of feedback, corrective feedback in the context of mastery learning strategies, and one-to-one tutoring. These strategies are concerned with assessing and evaluating learner performance. Although these have been seen to influence achievement substantially they are the least commonly applied instructional strategies in DE settings.

Strategies in the Current Study

Table 2 presents the instructional strategies implicated in this study. The nature of their application in the current study along with brief commentary on each of the strategies is presented in the following sections of this chapter.

Table 2

Instructional Strategies Implicated in This Study

Content presentation strategies

- Advance and graphic organizers
- Specification of objectives
- Instructional illustrations

Activation of learning strategies

- In-text questions (factual and higher-order)
- Homework (ungraded)

Feedback in designer-imposed strategies

- One-to-one tutorial instruction
- Feedback (group-based mastery learning and PSI)
- Homework (graded)

Feedback on learner-generated strategies

- Study skills development (e.g., via concept mapping, cognitive mapping and elaboration techniques etc.)

Content presentation. For the purposes of the current study, literature on the following instructional strategies is reviewed in the next chapter: (a) advance organizers; (b) objectives; and (c) instructional illustrations. These strategies are most commonly incorporated in print-based DE materials and their primary function is to support and enhance the presentation of the course content. As such they perform the functions of embedded instructional strategies, for they are directly focussed on the instructional materials. Each of these are briefly described in the following paragraphs.

Advance organizers, as originally described by Ausubel, (1960) are materials that are presented in advance of an instruction. They are to be presented at a higher level of abstraction, generality and inclusiveness than the actual instructional materials. Ideally, they provide a meaningful subsuming context for all impending learning activities by either anchoring detailed content in more inclusive superordinate concepts (i.e., expository organizers) or by relating new information to conceptual structures already possessed by the learner (i.e., comparative organizers). Advance organizers may be presented in verbal or non-verbal forms. In the latter instance they are called graphic organizers (Moore & Readance, 1984).

Whether written in a more general format or in precise behavioral terms (Mager, 1962), objectives are statements that are intended to indicate to the learner the information

in the text that will be the focus of the study and the assessment. They provide students with a clear goal for organizing their learning activities, studying more efficiently and assessing their progress prior to evaluation. As pointed out by Hartley and Davies (1976), this assumes that students possess both the motivation and skill to use objectives in the manner in which they are intended.

Illustrations, according to Duchastel (1980), are included in instructional materials for three primary purposes: (a) to perform an explicative role (i.e., explaining concepts that are difficult to present verbally); (b) to perform a retentional role (i.e., aid memory for verbal content); and (c) to perform an attentional and motivational function (i.e., facilitate greater enjoyment and interest).

Activation of learning. Strategies that perform this function in printed instructional materials and included in this discussion are (a) in-text (inserted) questions, and (b) ungraded homework. These strategies are also commonly found in print-based DE materials where their primary function is to activate the learning process. As such they perform the functions of embedded instructional strategies since they are directly focussed on the instructional materials they accompany. These are briefly described in the following paragraphs.

In-text or inserted questions stem from a theoretical orientation which focuses on what students do to transform an

instructional stimulus into an internal representation. In-text questions are one means of activating, what Rothkopf (1970) called mathemagenic behaviors, in the context of print-based instructional materials. They are intended to promote active as opposed to passive learning by directing learners to perform some activity or task which is related to a predetermined set of learning objectives. Behavior related directly to answering in-text questions is referred to as "intentional learning", while behavior directed toward content not specified in such questions is called "incidental learning".

As distance study is essentially homework, instructional activities that are suggested in DE study materials without feedback on them are considered here as "ungraded" homework. Literature on this subject is reviewed in the following chapter.

Feedback in designer-imposed strategies. The strategies cited in this category have been selected for their feedback component. These include: (a) graded homework; (b) one-to-one tutoring; (c) group-based mastery learning and Personalized System of Instruction. These are examples of designer-imposed strategies and seldom applied in DE settings. Moreover, in being content specific, they serve the functions of embedded instructional strategies. In the following sections of this chapter, the conditions of feedback in general terms, and within the context of each of these strategies is discussed.

Both behavioral and cognitive instructional paradigms
incorporate some form of feedback as an essential element of
their instructional processes. Indeed, any instructional
system, that views learning as a process of mutual influence
between learners and their instructional resources, must
involve some feedback, implicitly or explicitly, for without
feedback, any mutual influence is by definition, impossible.
From a review of research on effects of feedback in written
instruction, Kulhavy (1977) described four conditions of
feedback: (a) that feedback corrects errors; (b) that the
error-correcting action of feedback is more effective when it
follows a response about which the student felt relatively
certain; (c) that the effectiveness of feedback is enhanced
if it is delivered after the learner has made a response; and
(d) if feedback is to be effective, its availability in
advance of learner response must be controlled. Kulik and
Kulik (1988) found that feedback delivered following learner
response is beneficial only under controlled and somewhat
artificial conditions. They recommended immediate feedback
for conventional educational settings. Schimmel (1983) found
that the amount of information in feedback was unrelated to
its effects, while from a review of forty studies, Bangert-
Drowns, Kulik, Kulik, and Morgan (1991) showed that feedback
does not always increase achievement and, in fact, is
sometimes associated with decreased achievement.

From these general assessments of the effects of
feedback, several conclusions can be drawn about conditions

of feedback. Foremost, among these, is that feedback is not a unitary phenomenon and that it may differ in several ways. First, feedback may differ according to its *intentionality*. This refers to whether feedback was designed to inform learners about the quality and accuracy of their responses, or it happened to be an *incidental* consequence of the instructional environment. Intentional feedback is typically found in direct and expository instructional settings, although informal feedback in such contexts has an important function in instructional events such as peer group interactions and unassisted group simulations.

Intentional feedback can be further differentiated according to the manner in which it is delivered. It may be delivered via direct interpersonal communication between instructor and learners or between learners. Alternatively, intentional feedback may be delivered in mediated forms such as telephonic and computer-based communication systems. In any event, intentional feedback is highly specific and directly related to the performance of the task.

Feedback can also be distinguished according to its *target*. Some feedback is primarily designed to influence affective learning capacities such as support for intrinsic motivation. Otherwise, feedback may be intended to support self-regulated learning activity by cueing self-monitoring processes of the learner. Most commonly, though, feedback is targeted at indicating whether learners have performed the

specified tasks or applied the learned concepts and procedures correctly.

Feedback is also distinguishable according to its *content,* which is identifiable by: (a) *load* (i.e., the amount of information given in the feedback from yes-no statements to fuller explanations); (b) *form* (i.e., the structural similarity between information in the feedback compared to that in the instructional presentation); and (c) *type of information* (i.e., whether the feedback restated information from the original task, referred to information given elsewhere in the instruction, or actually provided new information).

Following from the above, and the work of their predecessors with feedback, Bangert-Drowns et al. (1991) developed a five-point model for conceptualizing the effects of feedback. According to this model, learners come into an instructional context in some state which is manifested by their interests, goals, degree of self-efficacy, and relevant prior knowledge. Upon commencing instruction, search and retrieval strategies are activated during or following the process in numerous ways. Learners respond to these activities and evaluate their responses on the basis of subsequent feedback. After this response evaluation, learners are in a position to make adjustments to their knowledge, level of motivation, and assessment of self-efficacy.

Feedback is provided to learners in a variety of ways. Some of those are briefly considered in the following. Most

commonly, feedback is associated with "homework". From a review of research on the effects of homework on learning, Paschal, Weinstein and Walberg (1984) concluded that the largest effects of homework on achievement were found when feedback or teacher comments were provided. The mean effect size for homework overall, was .36 σ, and for homework with feedback from the instructor was .80 σ.

One-to-one tutorial instruction comprises individualized attention, frequent formative assessment and corrective-feedback. Given these, its effects on learning achievement have been reported to be as high as 2 σ above the mean of conventional group-based methods (Bloom, 1984). But it is also a very expensive instructional arrangement and therefore rarely available in public institutions by itself, except in special cases of private tuition or in the context of a personalized system of instruction.

Feedback comprises a very critical element in mastery learning, the defining characteristic of which is the establishment of a criterion level of performance held to represent mastery of a specified skill, regular assessment of student progress toward this criterion, and the provision of corrective instruction to enable students who do not initially meet the mastery criterion to do so on later parallel assessments (Slavin, 1987). There are two primary forms that have grown out of this basic notion: (a) *group-based* mastery learning, and (b) *Personalized System of Instruction* (Keller Plan). Learning concepts that underlie

both methods of instruction have been stated as follows (Stice, 1979).

1. If aptitude is normally distributed, but the amount and quality of instruction, and amount of study time are varied to match the skills and needs of each student, then most students should be capable of achieving mastery of the subject.

2. Learners are less apprehensive and more willing to take risks when they know what they are supposed to learn and what sorts of responses are desired.

3. Students use individual strategies to acquire knowledge. Differing needs of students require a variety of instructional strategies.

4. Learning occurs best when the material to be learned is divided into small increments. Breaking the course down into smaller units or modules encourages students to engage in more regular study.

5. Learning proceeds by a sequence of more or less logical steps. Several small unit tests instead of a few major examinations provide students with more information about how they are doing. The more immediate the feedback, the more efficient the learning.

6. Students need varying amounts of time to learn things owing to their aptitude for the material, their learning style etc.

In group-based mastery learning an instructor determines the objectives for a course in terms of the skills students

are expected to acquire. The material is broken down into a sequence of smaller learning units, each unit typically covering the course objectives contained in about two weeks of instruction. Brief ungraded student-scored diagnostic mastery tests for all learning units are constructed and a set of alternative learning materials of instructional correctives keyed to these tests are also prepared.

The instructor teaches the course using group-based instructional methods and after completion of the first unit gives the formative test designed for that unit. The unit tests are called formative tests because the students are in the formative phase of their study of the subject at hand. On the basis of preset mastery criterion, the instructor may grade these tests as having reached "mastery" or designate them as "more work needed", or pass out the answers and let the students score their own tests. Learners are directed to alternative sources, or learning correctives which they can use to help understand those points on the formative tests that they failed to master.

Students proceed through the course unit by unit. A final examination is administered, and the students' grades in the course depend entirely upon their grades on the final examination. This is called a summative examination because it sums the student's achievement of the course objectives. Students who meet or exceed the mastery criterion (typically 85%) specified at the beginning of the course, obtain an "A"

grade. Those who do not meet the mastery criterion obtain correspondingly lower grades.

PSI (Keller Plan), on the other hand, is an individualized form of mastery learning. This also requires the teacher to make a careful analysis of what students are to learn in a course, up-front. Having established the terminal and intermediate objectives, the instructor divides the course material into units, each containing a reading assignment, study questions, collateral references, study problems and any necessary introductory or explanatory material. A unit typically takes about one week to complete. The student studies the units sequentially at the preferred rate, time and place. When the student feels he or she has completely mastered the material for a given unit, a proctor gives a "readiness test" to determine if the student can proceed to the next unit. The proctor is a student who has been chosen for already achieving mastery of course material. On the readiness test the student must make a grade of 100%. If the students do not complete the work successfully, they are told to restudy the unit more thoroughly and return later for another test. A student receives a different test each time he or she comes to be tested. No matter how many times a student is required to retake a readiness test, he or she is never penalized. The method requires that ultimately the student demonstrates proficiency. A student's final grade is determined by the number of units completed in the course and his or her score on the final examination.

The lecture is greatly de-emphasized as a medium for delivering essential information. Lectures may be given at stated times during the course, but only those students who have completed a specified number of units may attend them. However, students who qualify for lectures are not *required* to attend them, and the material discussed in the lecture is not covered on any examination. Lectures are used as rewards for those who have gained mastery of the material. Keller (1968) has listed the following essential features of the PSI method.

1. The *go-at-your-own pace* feature which permits students to move through the course at a speed commensurate with their ability and other demands upon their time.

2. The *unit-perfection* requirement for advancement, which lets students go ahead to new material only after demonstrating mastery of that which preceded it.

3. The use of *lectures as vehicles for motivation*, rather than as sources of critical information.

4. The related *stress upon the written word* in teacher student communication.

5. The *use of proctors*, which enables repeated testing, immediate scoring and almost unavoidable one-to-one tutoring, and a marked enhancement of the personal/social aspect of the educational process.

Feedback on learner-generated strategies. The only strategy included in this category is called concept mapping

which is a studying strategy that has not been commonly incorporated in print-based DE study materials. As mentioned earlier in this chapter, concept mapping can be either designer- or instructor-imposed or learner-generated. In any event, it is an example of a detached instructional strategy that has the potential for enhancing learning capability irrespective of content. The characteristics of the strategy are briefly described in the following section.

Concept mapping is the process of representing "valid and meaningful relationships between and among concepts in the form of propositions", which are "two or more concept labels linked by words in a semantic unit" (Novak & Gowin, 1984, p. 15). Concept mapping skills, once acquired, can be useful in a variety of contexts, such as in: (a) reading comprehension; (b) planning an assignment or report; (c) organizing content for a presentation, and (d) preparing for examinations. Concept maps are developed by identifying key concepts in a body of content material and arranging them around a focal concept with connecting lines to show valid and meaningful relationships between and among them.

Each concept map represents a personal expression of meaning in a selected piece of course content and therefore concept mapping is an idiosyncratic learning and working strategy which serves to satisfy a mapper's particular approach to understanding the selected material. Typically a concept map comprises a number of selected key concepts, one of which is identified as the focal concept on a map. The

selected concepts are linked by lines with arrows and labelled to stipulate meaningful relationships among them.

A focal concept is a concept that is of special interest to a mapper and is the focus of the particular map. On a page the focal concept can be placed at its center, on the sides, at the top or the bottom. Usually, a focal concept is chosen from the most general concepts in the selected material. However, the choice of a focal concept is a personal one and mappers of the same material are quite likely to differ on choice of focal concepts. One's focal concept may not be his or another person's focal concept in another map of the same material. Lines connecting selected concepts on a map and labelled with valid and meaningful propositions reveal relationships between concepts. Lines from one part of a map to another represent "cross links" and reveal relationships between concepts in different parts of the map.

The literature on concept mapping is small but growing and there are no reported applications of the strategy in DE contexts. Results from conventional educational practice suggest a positive effect for achieving improved learning outcomes (Novak, 1990). One of its greatest advantages for DE applications is that training in concept mapping can be accomplished in a print-based self-instructional format. Concept maps are useful for assessing learning and providing students with feedback. In this instance, they are best applied as a qualitative measure.

Summary

The separation of the teacher and learner, and the teaching acts from the learning acts in distance education, defines the differential roles of the distance learner and the distance teaching institution in that context. Distance learners, by and large, study independently. Their concept of "schooling" is limited to the instructional materials they have been provided, their own study space, mail box and/or their telephones. Distance teaching institutions, because of the constraints imposed on them by this mode of instruction, are required to play a different and more active role than their conventional counterparts in the delivery of instruction to their clientele. For instance, resources that are often taken for granted in conventional institutions such as library services, bookstores, classroom processes, tutorials and peer group contact have to be made accessible to the distance learner through other means. This is usually done, or its lack compensated for by the provision of carefully designed instructional materials.

High quality instructional materials can possess equivalent qualities to those typically associated with instruction and student support in conventional settings. For this reason, and also because research on the application of instructional strategies in the design of DE study materials is sorely lacking, it is an area of concern for distance learners and distance teaching institutions alike. This study

investigated the effects of chosen instructional strategies on cognitive performance and learning outcomes in a distance education context. The selected strategies were drawn from conventional educational practice with known effects in that context. The current research, therefore, makes an original and valuable contribution to literature concerning the design of course materials for distance education.

Research Questions

The independent variable in this study was the type of instructional strategy (concept mapping and post-questioning with feedback). Post-questioning without feedback, comprised the control condition in the overall design. Concept mapping, post-questioning with feedback, along with post-questioning without feedback and text-based design strategies, were also presented in a combined condition. The dependent measures were cognitive achievement scores of subjects on multiple-choice test items and essay-type questions on the midterm and final examinations in the course within which the study was conducted. The following broad research questions guided the investigation in this study.

Question 1. Would the presence of feedback produce higher cognitive achievement while textual design strategies were held constant?

Question 2. Would concept mapping exercises yield higher cognitive achievement than post-questions when feedback was provided on both, and while textual design strategies were held constant?

Question 3. Would there be a large attrition rate with concept mapping and if so, would there be a difference between performance in the low and high mapping conditions?

Question 4. Would concept mapping produce an initial (in the midterm) decrement on recognition type knowledge and comprehension test items?

Question 5. Would a combination of concept mapping and post-questioning with feedback provided on both, produce higher cognitive achievement than produced by the two conditions separately?

CHAPTER TWO

Literature Review

Scope of Review

This review includes studies on instructional strategies
that were implicated in this research, either as experimental
variables or as standard elements of instructional design in
the experimental materials. The strategies and the functions
they serve in the instructional process are presented in
Table 2. Studies from both conventional educational practice
and DE are cited in this review. Instructional strategies
that were not treated as experimental variables in the study
appear first in the review. They are followed by those that
were examined as experimental variables.

Enhancing Content Presentation

The strategies considered in this section include (a)
advance organizers, (b) objectives, and (c) instructional
illustrations. These are the most commonly used instructional
strategies in DE study materials. Their primary function is
to help the presentation of course content and in that regard
they serve a useful pedagogical role in orienting learners to
the instruction. These strategies were, however, not treated
as experimental variables in the current research. They were
included as "standard" features of instructional design in
the experimental materials to which all subjects in the study

were exposed. They are therefore only briefly discussed in this review with reference to their uses as aids to the presentation of course content.

Advance organizers. These are instructional materials or learning activities that are presented in advance of the actual instruction. Advance organizers provide a meaningful context for content that follows, by anchoring details into more inclusive structures and relating new information to conceptual structures already possessed by learners. They are constructed at a higher level of generality and inclusiveness than the instruction that follows, and are usually presented in verbal form.

A majority of studies that have been conducted to test the effectiveness of advance organizers for producing greater learning outcomes have reported positive results. Luiten, Ames and Ackerson (1980) reviewed 135 studies and concluded that advance organizers facilitated both learning and retention. They estimated an effect size of .20 σ for advance organizers, while Kozlow (1978) examined 99 studies and also found that advance organizers facilitated learning and retention. From an analysis of 29 studies largely drawn from the period 1970-1980, Stone (1983) derived a median effect size of .48 σ for advance organizers. Several studies have also failed to support the facilitative effects of advance organizers (e.g., Barnes & Clawson, 1975; Barron, 1980; Bauman, Glass, & Harrington, 1969).

In DE contexts, advance and graphic organizers have been included with discussions of a variety of textual design variables, such as overviews, pretests, objectives, graphical and typographical devices, and inserted questions (Marland & Store, 1982; MacDonald-Ross & Waller, 1976). Practice has shown that advance organizers are most effective as orienting devices if used with content that can be differentiated into smaller units which becomes progressively more specific, more concrete, and less inclusive. An advance organizer is also most useful when students must have a conceptual framework for subsequent use in clarifying their tasks, and when the learning material possesses a structure which can readily be integrated with student's existing knowledge. Use of advance organizers is also appropriate when the subject matter is unfamiliar and learners either lack past experiences or are unaware of ideas they have in their cognitive structure.

Specification of objectives. Objectives are statements that are intended to indicate to learners the information in the text that will be the focus of instruction and evaluation (Mager, 1962). As such, they are designed to help learners organize their learning activities, study more efficiently and assess their progress prior to formal evaluation.

There is no consistent evidence that specifically stated objectives are any more effective than more generally stated ones. However, specifically stated objectives have been known to enhance intentional learning while impeding incidental learning (Duchastel, 1979). When distributed within sections

of the text, as opposed to being located at one point, they have produced positive outcomes for learning (Faw & Waller, 1976). Hartley and Davies (1976) reported that specifically stated objectives may in fact have a deleterious effect on the acquisition of problem-solving skills. On the other hand, Melton (1978) found that specifically stated objectives have produced positive results for students whose past experiences with objectives have been rewarding, and who have previously used objectives to search for relevant material. There is evidence that, on the whole, objectives are more useful with higher-level learning tasks such as analysis, synthesis and evaluation, and less effective with lower-level tasks, such as knowledge acquisition and comprehension (Duchastel, 1979).

Although there have been no studies on the usefulness of incorporating either form of objectives within DE materials, few distance education course developers have neglected their use. Evidence from some surveys at the United Kingdom Open University suggests that students do not use objectives for the purposes they are intended (i.e., as attention-directors or as goal statements for problem solving) but as a means for assisting them to find their way in the instructional text (MacDonald-Ross, 1979). This led the researchers to conclude that for most students objectives are "access devices" that allow learners to chart their ways through the study materials.

In the face of these results, Marland and Store (1982) offer the following guidelines for practice in DE contexts.

They argue that, for maximum benefit as facilitative tools, objectives are most effective when used in conjunction with other instructional devices, and especially if the learning tasks are complex and difficult. Since the actual use of objectives by students is likely to differ from the intended use, dispersing objectives throughout the text in small sets and in company with the relevant material would be wise. Furthermore, it would help to advice students of the purposes of objectives and how they might be used.

Instructional illustrations. In instructional materials, these refer to a variety of elements such as photographs, schematic drawings, diagrams, maps, charts, tables and cartoons. A functional view of illustrations considers them as serving an attentional, explicative or retentional roles. Illustrations are included to interest and motivate readers, help explain a point that is being made, or to enhance long-term recall (Duchastel, 1978).

Levie and Lentz (1982) reported that in studies where illustrations were included in text for their retentional value, a .30 σ difference was observed between groups that did, and those that did not receive illustrations. When processing instructions are added to inform learners of ways in which information from illustrations may be more effectively derived, learning achievement has been seen to increase dramatically (Bernard, 1990; Weidenmann, 1989).

In distance education contexts where the instructional materials are largely print-based and self-instruction is the

norm, use of illustrations makes intuitive sense. While most
DE course developers appreciate the value of illustrations in
the course materials and use them as much as possible, little
systematic study of their effectiveness has been carried out
within the context of distance education.

Marland et al. (1990) from their study of distance
learners' interactions with their study materials reported
that students generally ignored illustrations in their study
materials (i.e., the "non-verbal devices"). They believed
that a possible explanation for this was that their students
saw the content of illustrations as serving restricted and
noncritical functions, namely as supplementing, illustrating
or highlighting points in prose and perhaps simply relieving
the monotony of prose. From a similar study Parer (1988)
reported findings to the contrary. His subjects asserted that
diagrams, graphs, tables and illustrations "were significant
and useful for stimulation and adding to meaning" (p. 82).

Reports of the value or otherwise of illustrations,
however, must be considered in view of the likelihood of
disparities between actual use students make of such devices
and their claims about how they use them. These disparities
may be manifested in several ways. Firstly, learners'
assertions about what they may have found useful could be
generalizations that do not apply to other situations.
Secondly, their perceptions about how they study may diverge
from their actual practices. Thirdly, the content of
illustrations could have been seen as only supplementary or

peripheral to the content of the text, and not as fully integrated features of the whole.

Inducing Student Learning Activity

After consideration of aspects of the presentation of instructional materials, it is logical to consider strategies that serve to activate student learning. Commonly known strategies that perform the functions of activating student learning in print-based instructional materials include in-text questions and homework with or without feedback. Neither of these strategies were treated as experimental variables in the current study. They are included in this review for their potential as tools for activating learning at the disposal of the designer.

In-text (inserted) questions. The practice of inserting questions in instructional text is quite widespread. Often they are referred to as adjunct questions and self-assessment activities or exercises. Their function is the same, which is to activate learning by coercing learners to interact with their instructional materials. The need to do so was best illustrated by Rothkopf (1970) when he compared the situation of a student and his study materials to that of the horse and water. As he put it, "you can lead a horse to water but the only water that gets into his stomach is what he drinks" (p. 400). The analogy is appropriate, for in most instructional situations, what is learned depends mostly on the activities

of the student. Rothkopf argued that while the content of the instructional materials and its organization are important in determining what is learned, what students do with the instructional materials is more important.

Much of the earliest work on inserted question was initiated by Rothkopf (1965) and stems from a theoretical orientation that places emphasis on what students do to transform an instructional task or stimuli into an internal representation. Rothkopf described this phenomenon as "mathemagenic activity" which are behaviors that give birth to learning and more specifically, student activities that are relevant to the achievement of specified instructional objectives in particular situations (1970, p. 401-402). According to Rothkopf, mathemagenic behaviors include a wide range of activities from overt physical reactions to covert mental processes. Inserted (in-text) questions are one means of stimulating mathemagenic behaviors in the context of print-based instructional materials. They are intended to promote active rather than passive learning by directing learners to perform tasks that are related to a predetermined set of learning objectives. Behavior related directly to answering inserted questions is referred to as intentional learning, while behavior directed toward content not specified in the questions is called incidental learning.

Research on inserted questions has addressed the following issues of importance to the instructional designer (Hamaker, 1986). These are (a) the cognitive level of in-text

questions (i.e., factual or higher-order), (b) the relation between questions and the criterion test questions (repeated items or related items), and (c) the position of questions in the text (pre-question or post-questions).

It is not surprising that the effects of factual and higher-order questions differ. Factual questions used with related but not identical criterion test items have produced an effect size of about .50 σ, whereas higher-order inserted questions when used with related test items have resulted in an increase of approximately .30 σ. With repeated criterion measures these effect sizes have been considerably higher. On related criterion test items, the effects of factual pre-questions have been slightly larger than for post-questions. Prequestions induced a forward search strategy since they identified content to be learned in advance, while post-questions encouraged both general and specific backward processing.

A review by Faw and Waller (1976) concluded that higher-order inserted questions have been of most benefit for total learning. Entwistle and Ramsden (1983) reported that students vary their approaches to studying in response to perceived demands (i.e., type of questions posed) from instructional text. In a study of this phenomenon, Säljö (1975) carried out an experiment in which detailed factual questioning appeared to induce a surface approach to learning, but which was less successful in inducing a deeper approach. These findings lend support to Rothkopf's view that in fact, the most interesting

result of all is that "mathemagenic activities are adaptive, and that they can be altered by instructional stimuli such as adjunct questions" (Rothkopf, 1970, p. 408).

Anderson and Biddle (1975) reviewed 40 studies that had compared a reading only group with an experimental group which had been exposed to post-questioning. In 37 out of 40 cases the questioned group performed better on repeated test items than the non-questioned group. Sixteen out of the 17 experiments in this survey which had compared differences between pre- and post-questions reported that post-questions were more facilitative than pre-questions. Other studies by Roderick and Anderson (1968), and Anderson and Myrow (1971) compared the use of short-answer inserted questions with multiple-choice type questions to find that groups receiving short-answer questions outperformed both the multiple-choice type and the control groups.

Several studies have investigated effects of the frequency of inserted questions. Frase (1968a, 1968b), Frase, Patrick and Schumer (1970), and Boyd (1973) found that groups exposed to more frequent questioning close to the relevant materials outperformed those with several questions grouped together at the end of a section. Lockwood (1978) suggested that the frequency of questions should be determined by the nature of the content since some materials call for student responses every few minutes while others need a response every few hours. Eischens, Gaite and Kumar (1972) found that

the beneficial effect of questions declined sharply with the number of pages between the information and the question.

In-text questions comprise the most commonly used inducer of mathemagenic behavior in DE materials. These questions encourage the learner to search for key concepts and provide tentative answers to questions for verification. Generally, learners are not provided any systematic feedback on their answers. When presented at the end of units, these questions serve as self-assessment exercises, and may be regarded as ungraded homework. The effect size for ungraded homework from conventional educational settings is .36 σ (Paschal et al., 1984). Since there has been little research undertaken within the context of DE on the use of in-text questions, caution must be exercised on assuming that the findings about the facilitative effects of such questions would necessarily produce the same results in DE settings. There is some evidence to show that DE students use the study materials they are provided, including its features, in very idiosyncratic ways (Clyde, Crowther, Patching, Putt, & Store, 1983; Marland, Patching, Putt, & Store, 1984; Marland et al., 1990; Morgan, Gibbs, & Taylor, 1980).

Duchastel and Whitehead (1980) surveyed students' use of inserted questions at the United Kingdom Open University and reported that many students attach some importance to inserted questions even though they could at times be highly critical of irrelevant or unhelpful questions. Students in their survey who had objected to inserted questions felt that

these questions had disrupted their study habits, routines and lines of thought, while others had felt antipathetic and uninterested when they encountered too many questions. Their own research confirmed the common anticipation that distance students would probably not use inserted questions for what they were intended. Lockwood (1978) has suggested that space left for students to write in their answers to questions is advisable. Winderlich and Parer (1983) reported that their students found writing out answers to inserted questions helpful in their study and a useful aid at revision time for examinations.

Clyde et al. (1983) observed how 12 DE students used self-assessment (inserted) questions in their study materials to report that at the minimum students read these questions. They also found that some of the questions were answered more carefully than others were, depending on whether the students perceived questions to be important and related to assessable activities or relevant to their needs. From a similar study, Marland et al. (1990) reported that students were satisficers and avoided inserted questions and activities whenever it was possible. They believed the reasons for this rather casual dismissal of inserted questions by students were diverse and complex, and were derived from time constraints, volume of set reading, assessment loads, lack of study skills, and a "surface" approach to study. The structure of the materials and the nature of assessment tasks were contributory factors as well, so they argued that if content was compartmentalized

and presented in a way that did not emphasize interdependence and coherence in the materials, students would not be pressed to relate competence in one specific segment of content to competence in other segments. Consequently, students could afford to become selective with respect to content to be studied, without jeopardizing their prospects of coping with assessment tasks or subsequent material.

Given the findings of their study, Marland and his colleagues suggested several possibilities as solutions. They thought it would be helpful if DE course developers were to: (a) reduce the coverage of content to allow for more in-depth study; (b) be more explicit about their expectations as to study strategies to be employed, quality of student response, and types of cognitive processes to be used when completing in-text activities; (c) structure text in ways that projected a cumulative and an interactive view of learning and not as the acquisition of isolated pieces of information; (d) design assessment activities which required some re-interpretation of content; and (e) use outcomes of in-text activities as prerequisite knowledge for further study, and also make completion of some in-text activities compulsory.

From a review of research on the use of inserted questions largely from conventional educational contexts Kember (1985) culled the following additional guidelines for distance education practice: questions should be positioned as closely as possible to the relevant content; essay-type questions are preferable instead of multiple-choice type and

they should be formulated at a higher cognitive level; they should demand a response and feedback on at least some of them must be provided. Marland and Store (1982) suggested also that questions ought be clearly related to the course objectives.

Combining instructional strategies. An innovative approach for combining instructional strategies that has potential for activating student learning and thus inducing enhanced learning outcomes has been proposed by Bloom (1984).

There is a small body of research on combining instructional strategies to achieve learning outcomes that are possible through one-to-one tutorial instruction. In one such study, Nordin (1979) examined the effects of combining enhanced cues, student classroom participation and feedback-correction on a group of sixth grade students. He found that the average student achievement in the combined condition was 1.5 σ above that of the average found in the conventional instruction condition. In a similar study, Tenenbaum (1986) combined enhanced cues, participation, reinforcement and corrective-feedback with sixth and ninth graders and found overwhelming support for combining strategies. The final achievement scores of subjects in the combined condition was 1.7 σ above that of subjects in the control condition. Leyton (1983) combined enhanced initial cognitive prerequisites with mastery learning in a maximal condition to produce an effect size that was 1.6 σ above that of the control group.

Combining instructional strategies has been shown to have beneficial effects on affective outcomes as well. Tenenbaum (1986) found that on an average, students exposed to the combined condition became 22% more positive towards themselves as learners, the subject matter they studied, their teacher and the school, than students in the control condition. Bloom (1984) and Leyton (1983) have also reported similar positive affective outcomes of combining strategies on enhanced self-concept, greater interest in the subject matter and a greater desire to learn.

There have been studies with combining strategies that have not produced enhanced cognitive outcomes. For example, Mevarech and Werner (1985) combined cooperative learning with mastery learning to find students in their combined group outperformed by those exposed to the strategies separately. Amato, Bernard, D'Amico and DeBellefeuille (1989) combined cooperative learning, enhanced classroom participation and advance organizers and found no significant difference between the combined condition and their control group.

On the whole, combining instructional strategies in order to achieve higher learning outcomes has produced more successes than failures. However, despite positive results of combining strategies on cognitive and affective learning, the guidelines for combining strategies is somewhat unclear and certainly in need of further continued research effort.

Bloom (1984) has suggested two criteria for selecting strategies for combining so that the effects of the chosen

strategies are additive rather than disruptive to each other. These are to select strategies that affect different objects of change in the instructional process, and which occur at different times in the process. There could be a problem with this though. While the latter criteria can be applied with some accuracy, the former may not be as easy to ascertain. It is neither feasible nor appropriate to always identify strategies that contribute to the instructional process as affecting one agent of change only. For instance, improved reading and study skills may not only directly affect changes in the learner (cf. Bloom), but have implications for the instructional materials that are provided, as well as the role of the instructor. Researchers therefore run the risk of combining strategies that may not complement each other, in which case, the outcomes of the study may be suspect. This may have been the case with Mevarech and Werner's study.

Existing work with combining strategies has employed strategies that have shown effect sizes larger than .5 σ. It is not clear whether strategies with lower effect sizes could be combined as effectively and meaningfully. Studies carried out so far, have all employed mastery learning as one of the combined strategies and mastery learning is known to produce larger effect sizes in most conditions anyway. If mastery learning were removed from this combining equation, similar positive outcomes of pitching strategies together in order to induce enhanced learning may not be achievable.

Providing Feedback and Reinforcement

The importance of feedback and reinforcement on student learning activity cannot be overstated. In most educational settings, feedback and reinforcement is provided to learners in a wide variety of contexts. Commonly known practices from conventional educational practices are (a) assigned homework (b) tutorial instruction; and (c) group-based mastery learning and Personalized System of Instruction (PSI). These contexts for the delivery of feedback are briefly discussed in this section. Practice and research with the delivery of feedback in DE is discussed first, and the suitability of conventional methods of providing feedback for DE settings is considered.

The importance of providing feedback and reinforcement to distance learners is especially critical in view of the separation of learners from sources of institutional support. Consequently, DE literature is replete with studies and reports of various formats for providing feedback, the pros and cons of various media for communicating feedback, kinds of feedback, and need for individualizing feedback (Bellamy, 1978; Sewart, 1975; Sharples, 1982; Northedge, 1975; Watkins, 1975).

On the subject of designing feedback in DE contexts, Howard (1987), has warned DE course developers against basing their decisions regarding delivery of feedback to learners on particular media. She contends, the instructional function of

feedback has to be the most important design consideration, and that instructional designers must not lose sight of this in the face of technological opportunities. For effective outcomes, she proposes a decision model for the planning of learner feedback on the basis of (a) the content of feedback, (b) degree to which feedback is individualized, (c) timing or immediacy of feedback, and (d) the source and delivery methods used.

On a much larger note, it may be argued that any instructional theory which depicts learning as a process of mutual influence between the learner and the instructional environment, must involve some form of feedback, for without it, such mutual influence is not possible. The notion of feedback is grounded in the principle that the consequences of learning acts have enduring effects on future performance of learners and both behaviorist and cognitive learning paradigms concur on this point.

Several attempts have been made at synthesizing the corpus of research on the effects of feedback on learning outcomes in a variety of educational contexts. Kulhavy (1977) has reviewed research on the effects of feedback in written instruction to identify conditions in which feedback could be used with greatest instructional effectiveness. He discovered that the most important instructional effect of feedback was error correction, and not so much as strengthening of correct responses. Furthermore, he argued that the effectiveness of this error correction function of feedback depended very much

on student expectations. When students discovered that an answer they were certain about was actually incorrect, they were more likely to take heed of feedback that was provided.

Of particular relevance to the current research is Kulhavy's conceptualization of the function of availability of feedback prior to students' response. He coined the term *presearch availability* to describe uncontrolled availability of feedback. He explained that in studies where availability of feedback was uncontrolled, students simply copied feedback answers and therefore, did not study the material at all. He found that subjects in such uncontrolled feedback conditions showed lower post-treatment achievement, lower error rates during instruction, and naturally took less time to complete the instruction than subjects in the no-feedback conditions. However, when feedback was controlled, subjects receiving some form of feedback demonstrated much higher achievement than those who did not receive any feedback.

In a review of research on the effects of feedback in programmed and computer-based instruction, Schimmel (1983) extracted 15 studies in which the experimental and control groups studied the same material, but where the experimental groups received feedback when responding to the questions. Schimmel was looking for differences in performance due to the amount of information contained in the feedback. He found no significant relationship between amount of information and the effects of feedback.

Kulik and Kulik (1988) carried out a meta-analysis of studies focussed on the timing of feedback. They found that delayed feedback was effective only in special cases, such as where subjects were to acquire tested content with feedback that would repeat the stimulus word. These situations tended to emphasize memorization. In tasks that required greater cognitive demands, such as in conceptual learning, immediate feedback was found to be superior.

Bangert-Drowns et al. (1991) examined the effects of "intentional" feedback in four instructional settings: (a) programmed instruction; (b) computer-assisted instruction; (c) texts with adjunct questions; and (d) conventional instruction. Their search extracted 40 studies mainly from the college level. On an average they found that feedback made a positive, although small contribution to achievement. Effect sizes ranged from a very low -.83 σ to a very high 1.42 σ. The presence of negative effects of feedback and the variation in effect sizes in their review led the researchers to look for factors that might explain these patterns of outcomes.

They found that uncontrolled availability of feedback was strongly related to effect size. In studies where prior viewing of answers was not possible (controlled), feedback made an important contribution to achievement, but when feedback availability was uncontrolled, effect sizes dropped. Type of instruction was also related to effect sizes. They found that feedback in programmed instruction produced the

lowest effects, and feedback in conventional test performance and text comprehension produced the largest effects. Type of feedback was related to effect sizes as well. When learners were only told if their answers were right or wrong, feedback had no effect. However, when they were guided to the correct answer, the average effect size of feedback was higher.

In distance education settings, feedback is often logistically difficult to provide. Consequently, feedback is either not provided, except in the form of final grades on assessable items, or provided within the instructional materials in an uncontrolled form as Kulhavy describes it. Neither of these represents satisfactory practices by most standards. Thus, an objective of the current research was to explore different ways of providing useful feedback in a typical DE environment without necessitating extra time costs and/or resources on the part of the educational institution.

Common practices from conventional educational settings for providing feedback to learners are briefly discussed in the following sections. Their effects on learning achievement and persistence in courses is noted and their suitability for DE settings is also considered.

One-to-one tutoring. This instructional strategy is in fact, most conducive to providing high quality feedback and ensuring correction. Glass, Cohen, Smith and Filby (1982) estimated an effect size for adult one-to-one tutoring as being .60 σ above that of the control groups. Anania (1983) reported an effect size of 2 σ for one-to-one tutoring when

enhanced with the conditions of mastery learning. However, by definition, one-to-one tutoring requires the teacher and the learner to be together in a particular location during the instructional process. As such, in DE settings the strategy is almost impossible to arrange for any length of time, or for any substantive part of a course.

There have been attempts at providing some tutoring in DE settings, in supplement to the instructional materials, or in search of solutions to specific problems of distance study through a variety of means such as telephones and computers. However, these efforts cannot be considered as equivalent to one-to-one tutoring. Therefore, the strategy remains largely inappropriate for adoption in most forms of DE applications.

Group-based mastery learning. This is another instructional strategy in which the provision of feedback to learners is a key element. The defining characteristic of mastery learning is the establishment of a criterion level of performance which is held to represent "mastery" of a given skill or body of knowledge, frequent assessment of student progress towards this mastery criterion, and the provision of corrective-feedback and instruction to enable students who do not initially meet the mastery criterion, to be able to do so on later assessments (Slavin, 1987). The strategy is based on the principle of holding the achievement level constant and allowing the time for studying to vary rather than keeping instructional time constant and allowing achievement to vary as is common in most conventional instructional systems.

As an instructional technique, mastery learning has been extensively applied in conventional classrooms at all levels. A great deal of research has been undertaken on its practice and effectiveness. These have been synthesized in the reviews of Block and Burns 1976), Lysakowski & Walberg (1982), Slavin (1987), and Guskey and Pigott (1988). All reported positive outcomes for mastery learning against conventional methods of instruction. The strengths of mastery learning are several and include:

- The availability of frequent feedback on student learning activity.
- The possibility of high achievement for students of all ability levels.
- The cultivation of cooperative individualism in learners rather than inter-personal competition.
- Explicitly stated learning objectives that provide clear directions to both teachers and learners.

However, mastery learning, as an instructional strategy includes more than the possibility of receiving feedback. The strategy requires frequent contact between the students and the instructors, among student peers and also students and the educational institution, for the purposes of assessment. A major criticism of its implementation is the increased time costs for remedial work that slower students must have, and as some have claimed, "wasted" time for the faster learners (Arlin & Webster, 1983). For these reasons, mastery learning is also very difficult to implement in most DE settings where

learners are neither in contact with their instructors and peers, nor with their educational institutions as much as the implementation of the strategy would necessitate.

Personalized System of Instruction. A form of mastery learning that does have greater potential for DE settings is Personalized System of Instruction (PSI). Reviews of research on the effects of PSI, from conventional instruction reported an effect size of .50 σ (Kulik, Kulik, & Cohen, 1979). As an individualized form of mastery learning, PSI has received greater attention in DE literature, as opposed to group-based mastery learning strategies, because many of its features make it amenable to adaptation in DE settings.

Coldeway and Spencer (1982) have argued that PSI and most forms of DE activity have many common features. For instance, both shared the need to deliver individualized instruction, and that both relied heavily upon instructional materials (primarily print-based) that could be used by an individual learner. Also, the additional tutoring provided in DE institutions served a function very similar to that of proctoring in PSI. Both DE and PSI often adopted a modular presentation of their subject matter by breaking down course content into small units with clear objectives for each.

In order to demonstrate this compatibility of PSI with the practices of distance education, these authors undertook a study to determine, among other things, how feedback could be made available as prescribed in the PSI model within the context of DE. Students enrolled in a DE course were assigned

to one of five treatment conditions. The conditions were: (a) baseline; (b) PSI — phone; (c) PSI — mail; (d) choice between conditions a and b; (e) choice between conditions a and c.

The results of their investigation benefited completion rates, but not achievement. A substantially larger percentage of students in the PSI-phone condition than in any one of the other groups passed the first examination. These researchers were able to conclude that differences in completion rates between the PSI-phone and the other experimental conditions were the consequence of immediate feedback. They reported also, that not only had PSI provided them with a management system for an efficient delivery of feedback, but that PSI using the telephone could be successfully implemented in DE settings.

However, as in the case of group-based mastery learning, there is more to PSI than the possibility of feedback on learning activity, which makes it difficult to implement in the majority of DE settings. Coldeway and Spencer have identified the following difficulties of PSI in DE settings.

- PSI requires a fair amount of pacing flexibility. This allows slower learners to take more time and faster learners are not held back. However, DE systems in which a reasonable amount of pacing flexibility is not possible will not be able to reap the full benefits of the model.

- The basic components of PSI may be difficult to implement in content areas that are more subjective than

others. PSI may require creative assessment techniques when multiple-choice or short-answer questions will not work for some learners. In face-to-face contexts, a proctor can easily improvise to serve the special needs of slower learners. In DE settings with the separation of the student and tutors, this may not be as practicable.

• PSI requires regular and continuous tutor training and support system, where tutors comprise an important resource and a source of special assistance for more needy students. Many DE systems do not have such a facility and will find PSI difficult to implement.

• Finally, the success of PSI depends a great deal on the quality and availability of multiple forms of unit tests and on providing feedback. Inadequate attention to these will not likely produce any additional benefits for the system.

Homework. When feedback is available in DE, it is usually provided on student assignments. These are equivalent to "assigned homework" in conventional educational settings. Paschal et al. (1984) reported an effect size of .80 σ above the control groups for homework on which instructor feedback is provided.

One of the problems that has plagued most DE systems with regards to providing feedback to learners on, both, assessable and non-assessable activities, is the amount of time elapsing between students' submission of their work and

receipt of the resulting feedback. In most contexts, average turn-around times on student work in DE institutions that use the postal services for this purpose is two weeks (Haggmann, 1970; Saxe, Graff, & Ostyngen, 1966; Sloan, 1965). Longer (2 to 4 months) turn-around times have been also reported (Harter, 1969).

At the NKI-skolen in Norway, Rekkedal (1983) investigated the relationship between turn-around time on students' assigned homework and persistence in their course. He defined turn-around time as "the time from the moment the students mailed in their assignment for a study unit until it was received by the students with the tutor's correction and comments" (p. 232). It was hypothesized that a longer turn-around time would lead to slower study pace and/or decreased motivation. The study examined the effects of two mailing schedules on students' pace, grades and completion or non-completion of the course. One of the groups was exposed to a quicker turn-around time (median = 5.6 days), while the other group received delayed feedback (median = 8.3 days).

Results of this study showed that quicker responses on students' homework assignment led to higher completion rates. From the group with the quicker turn-around time, 91% of the students completed the course, while only 69% of the students with delayed (i.e., normal) response completed their course. Students who had been exposed to a quicker turn-around time, also completed a greater number of study units within a three month period after their registration in the course.

From a somewhat similar study Bååth (1971) reported reducing turn-around time on DE students' assigned homework from 10 days to a median of 4.4 days by the use of optical readers. Data obtained from a questionnaire revealed that students were "pleased" with reduced turn-around times for feedback. Students who had received feedback within 5 to 7 days thought that they had received their assignments quickly enough and were very satisfied. Those who had received their assignments any later than 7 days said that it took too long to receive feedback and as such were dissatisfied with the turn-around time.

Roberts (1987) investigated turn-around time and submission density of assignments for 57 distance education courses at the University of the South Pacific. Of these 57 courses, 21 courses had a mean turn-around time of less than 12 days (which was considered satisfactory). Twenty-nine of these courses had experienced turn-around times in excess of twelve days (and that was considered unsatisfactory).

While providing feedback on student learning activities in this format may be most feasible for DE contexts, these reports and studies show that unless feedback is delivered to learners within a reasonable time frame, it is not likely to be of any benefit, and in fact may have detrimental effects on motivation, persistence and students' pace of learning. Along with the timing and frequency of feedback, the amount, type and quality of feedback are also critical considerations

in ensuring effective outcomes of student activities and instruction.

Feedback that is provided on instructor or designer-imposed strategies such as one-to-one tutoring, mastery learning methods and assigned homework are clearly viable formats for some instructional settings including some forms of distance education. According to Rigney (1978) these comprise "embedded" instructional strategies because they are content specific.

Learners are also capable of generating their own learning or instructional strategies such as concept mapping, cognitive mapping, note-taking, various mnemonic devices, and elaboration techniques. Some of these reconstructive learning skills can in fact be systematically taught without reference to any particular content. Once acquired and applied feedback can be provided on these strategies. Rigney has referred to these as "detached" instructional or learning strategies because of their independence from content. Their strength is in their potential for enhancing the information processing capability of learners irrespective of the course content. In this manner, they serve to complement the contributions of embedded instructional strategies and feedback that is contingent upon them.

For optimum outcomes of learning and instruction, it makes intuitive sense to focus on both designer-imposed and learner-generated strategies and the provision of feedback in both contexts. While examples of designer-imposed strategies

is more commonly considered in DE settings, the development of learning strategies and study skills have been given scant attention. The remainder of this review addresses this issue. Literature on concept mapping as one concrete example of a learner-generated strategy is examined and its potential for application in DE settings is explored.

Developing Learning and Study Skills

There is some evidence to support that training students in a variety of learning and studying skills improves the quality of learning from their educational experiences and decreases the time needed to achieve the instructional goals (Muth, 1987). Study skills refer to a wide range of behaviors that are applied by the learner relating to the physical accompaniments of studying, for example, organizing one's study space as well as studying techniques. Learning strategies have been referred to behaviors and thoughts that learners engage in during studying and which are intended to influence their encoding process (Nisbet & Shucksmith, 1986).

Learning and Study Skills Training in DE

Much has been said about the unique characteristics of distance learners and also ways and means of supporting their unique circumstances in a variety of ways. However, very little has been done on the development of learning and study skills in the context of DE. Holmberg (1986) argues that much

of the existing advice to distance learners on learning and studying skills is improperly conceived because these do not seem to take into account individual learner characteristics. He refers to the importance of the work of Marton (1979), Marton and Säljö (1976), and Entwistle and Hounsell (1975) on learning styles and approaches to studying. In particular, he draws attention to Marton and Säljö's distinction between surface level learning and deep level learning approaches, and to Pask's (1976) similar description of learners and learning styles as holists, serialists and versatile types.

Holmberg has argued that it would be deleterious to teach, for instance, serialists in a holist manner, and holists in a serialist manner. Pask and Scott (1972) concur with Holmberg on this and say that the holist, serialist and versatile learning strategies are manifestations of important underlying differences in the ways students generally think about and approach problems. Students will very likely adopt a holist or serialist approach, and by extension surface level or deep level approach, if and when they are given the opportunity to do so. The onus is on the instructor or the designer of instruction to attempt to present learning tasks and assessment procedures that demand deep level processing, assuming of course, that deep level learning is the desired goal in the learning context in question. Holmberg suggests a number of ways in which this can be achieved.

Instruction and assessment of achievement can be designed to foster deep level processing by asking questions

and setting tasks that require demonstration of understanding
and analysis, rather than requiring recall of information.
Attempts can also be made to direct students' attention to
the subsumability of new knowledge under what is already
known and to the inter-relationships between concepts. Also
recommended are the use of a problem oriented approach and
presentation of instruction in a thought-provoking way that
is cognizant of individual learner needs.

Kember and Harper (1987) examined the predominant
learning styles of distance learners and output variables
such as academic success and persistence in their programs.
They found that a positive attitude to study, organized study
methods and a strategic approach were the best predictors of
high academic performance. They found that the variable that
most strongly discriminated between the persisters (passers)
and non-persisters (failures), was a surface approach to
studying. Having discovered this, they explored a number of
input variables such as curriculum and instructional design
and the nature of assessment that could influence desirable
approaches to studying. They argued that since a surface
approach to studying most strongly discriminated between
persistence and non-persistence, it is reasonable to suggest
that withdrawal rates might be reduced if distance educators
were to orientate their students away from a surface approach
to studying. This argument seemed appealing because it is
arguing for abandoning the habitual rote learning behavior in
favor of a more meaningful learning style.

However, they cautioned that if a study skills program to teach students the skills needed for a deep approach and to teach them to employ it was instituted, it had to be very carefully formulated. Like Holmberg and Pask and Scott, they too believed that students who are capable of applying a deep approach to a task would employ a surface approach if a deep approach was not demanded, not rewarded, or difficult to perform. There is evidence in the literature that students can be induced to adapt their approaches to suit the content and the context of the learning tasks. For instance, Marton and Säljö (1976) asked two groups of students to read three articles that were taken from their academic subjects. After each reading, one group was asked questions on the underlying meaning of the article and the other group was asked about factual detail only. Students in the latter group who habitually employed a deep approach tended to adopt a surface approach in the face of persistent factual questioning. On the other hand, the surface learners who were asked meaning-oriented questions did not adopt a deep approach but tried to remember summaries of the author's arguments without actively examining them. The conclusion drawn by these investigators was that desirable approaches to studying could be developed, although trying to persuade surface learners into adopting a deep approach was not an easy task.

DE study materials often incorporate in-text review questions and exercises in a variety of ways. If these are presented in a manner in which they consistently asked for

nothing more than recall of factual information presented in the study materials, students would likely assume that the course demanded memorization of details and therefore resort to rote learning. However, if higher order skills development such as application, analysis, synthesis and evaluation are really the objectives, then questions and exercises in the materials should be presented in a manner that they demand students to demonstrate those same skills.

The amount of workload also can have an influence on the learning style of students (Dahlgren, 1978). When faced with larger quantities of information to be learned, Dahlgren found that students tended to abandon the search for meaning in favor of memorization in order to pass their examinations. However, a case is not being made for reducing the workloads in courses, instead, placing less emphasis on the acquiring of information and increasing the emphasis on the skills for acquiring them, so that students develop into independent learners able to look for information on their own.

The above recommendations are useful in that they can be readily incorporated in the existing instructional materials design process in DE. Howard (1985) suggests the development of a comprehensive reading and study skills program, with appropriate content, flexible format and a structure that is adaptable to individual learner needs. The skills learned in such programs and time spent on learning them will have to be seen by the learners as cost-effective, that is, the benefits

to learning course content must be seen as outweighing the time and effort spent on acquiring these study skills.

Concept Mapping

One study skill that has attracted much attention in recent years as both a learning and an instructional aid is concept mapping. In the following paragraphs, the term is defined and its treatment in this study is mentioned briefly.

Studies on concept mapping span the literature on reading comprehension, writing and science education. Due to its widespread appeal the strategy has been referred to with various terms. In the literature of reading and writing, the notion of mapping has been referred to as cognitive mapping, idea mapping, patterned note-taking, webbing, construct procedure, graphic overview, flow charting, networking and semantic mapping. In the educational literature synonyms for concept mapping have been structural mapping, pattern notes, semantic analysis, networking, cognitive mapping and also entailment meshes or structures.

A considerable amount of work on concept mapping has been carried out by Joseph Novak and his colleagues at Cornell University who have defined concept mapping as a technique for representing meaningful relationships between concepts in the form of propositions (Novak & Gowin, 1984). In elaboration, they described a concept as a perceived regularity in events that is designated by an arbitrary label (e.g., rain is the label used for water dropping from the

clouds). Propositions, in their definition, refer to linking words between concepts in a semantic unit that illustrate a specific regularity, for example, force (equals) mass (times) acceleration. Two other features of concept maps are labelled connecting lines for making propositions between concepts explicit and a hierarchical structure in maps.

Hierarchical structuring means that maps should be organized with the most general, most inclusive idea at the top or apex of a map, with successively less general and less inclusive concepts in appropriate subordinate positions. Hierarchical ordering of concepts would depend upon the unit of knowledge that is being mapped and the focus of a mapper. Therefore, the same concept could appear at various levels in maps of different units of knowledge. A concept map thus, may be conceived of as a fishing net wherein one can lift up any node on the sheet and create a new hierarchical relationship between the linked concepts. In so doing the propositional linkages between concepts would be altered as alternative hierarchical structures are revealed.

In the research that is reported in this document, hierarchical ordering of concepts was not seen as an integral feature of concept maps. Concept mapping, in this case, was seen as the process of identifying key concepts in a body of subject matter and arranging them around a focal concept. The process also involved linking the selected concepts by lines and labelling them to show meaningful relationships between the concepts.

Concept mapping as reading aids. A number of studies in the literature of reading comprehension have reported many positive outccmes of concept mapping for students from middle school through to adult levels (Armbruster & Anderson, 1982; Dansereau, Holley, Collins, Brook!, & Larsen, 1980; Geva, 1981; Gillis, 1985; Holley, Dansereau, McDonald, Garland, & Collins, 1978; Holley, Dansereau, McDonald, Garland, & Collins, 1979; Long & Aldersley, 1982; Mayer, 1984; Slater, Graves, & Piché, 1985; Singer & Bean, 1984).

In the study by Singer and Bean (1984), subjects who created a concept map, recalled more information than those who used a simple outlining technique. Slater et al. (1985) found that subjects who were provided with an outline grid of the author's plan of organization recalled more information than those who just took notes. Dansereau et al. (1980) discovered that students recalled more information from their maps when mapping and imagery techniques were used.

Holley et al. (1978, 1979) investigated the potential of concept mapping in helping subjects acquire key ideas and related details. While subjects in experimental conditions were able to acquire more key ideas than those in the control conditions, they could not surpass those in the control condition on the recall of details. The efficacy of mapping strategies on the recall of different kinds of information was also investigated by Miccinati (1988). She taught a group of students how to develop a concept map of material from an academic source they had read and observed quite different

results. The experimental subjects outperformed the control subjects on a 10 item multiple-choice test and on recall of details. No differences were found between the two groups on the recall of key ideas.

The difference between outcomes of teacher and student developed maps was investigated by Berkowitz (1986) who found that, while both teacher-generated and student-developed maps were useful, maps generated by students were more effective. Berkowitz reported that students who generated their own maps had an advantage on immediate recall over all the other groups of students. On short essay-type questions in the immediate post-test, those who constructed their own maps had an advantage over the students who studied maps or reread the text. On the delayed performance measures, the groups did not differ.

In summary, a common finding of all these studies was that, subjects in the experimental groups, who were taught to use concept mapping for the purposes of recalling information outperformed those in the control groups. There was evidence that getting students to actually draw concept maps was more effective than giving them an instructor prepared map to study from. However, subjects' performance on the recall of key ideas and details was somewhat equivocal.

Concept mapping as writing aids. A few studies have investigated the usefulness of mapping as a planning aid in academic writing. In a project on learning from text, Ruddell and Boyle (1984) studied the effects of mapping on reading

comprehension and written protocols. The purpose of the study was to discover if, and how mapping assisted college students in gathering information from long prose passages and also in organizing that information for subsequent writing.

The researchers hypothesized that mapping would help improve students' writing fluency and cohesion, as well as assist them in identifying main ideas and supporting details in the articles. Students who developed maps for their essays were expected to score higher on evaluations of the written protocols. In addition, mapping was predicted to also assist students in identifying key ideas and supporting details in the articles. The subjects were 51 undergraduates who had volunteered to take a course on learning from text.

Subjects were tested before and after introduction to, and practice with mapping techniques, to assess their ability to analyze and synthesize test passages and to write about them. The post-test passages comprised three organizational patterns: (a) informational, (b) thesis-proof, and (c) problem-solution. Subjects in two of the treatment groups were given ten minutes to map the passages before writing essays, while those in the third treatment group prepared for the essays using an organizational strategy of their choice.

Subjects in the mapping groups scored higher on all the three post-test essays than those in the nonmapping groups. Moreover, when pre and post-test scores were compared for subjects in the mapping groups, significant differences in gain scores on the thesis-proof and problem-solution patterns

were observed. Subjects in the mapping groups used a greater number of conjunctions, wrote longer essays, and used more supportive details in comparison with those in the nonmapping groups. There was no difference among the groups on the identification of key ideas.

Miccinati (1988) reported that subjects who were asked to write summaries and papers from concept maps, were reluctant initially, but very positively disposed towards the use of mapping for the purposes of writing later on. On an attitude measure she found 92% agreed that mapping could be used throughout college. Fifty-eight percent of the subjects claimed mapping had helped them organize their writing more efficiently and were planning to use mapping in other classes.

Of interest to this present study are the anonymous written comments received from Miccinati's students at the end of the term. Some of them were as follows: "You are right, mapping forces me to think". "When we were learning it, I hated it. Now that I know what I am doing, my reading comprehension has improved greatly. I am able to write with ease and know how to write because I understand all of the information that I have placed on my concept map. It is time consuming, but it is time well spent". "I wish I could have learned to map from the beginning. I can organize my thoughts more easily because I do not worry myself with details. I simply make another branch" (p. 546).

In summary, concept mapping was found to be useful for organizing ideas, facts and details for the purposes of writing. Its benefits were found to be especially evident with more conceptual and difficult prose patterns. Subjects with mapping skills were able to generate more ties in their prose passages, and include a larger number of supportive details than those without such skills.

Concept mapping as aids to science education. The largest number of studies on the application of concept mapping in general educational literature is in the area of science education. The most prominent among these studies, is Cornell University's "Learning How to Learn" project (Novak, 1981). The studies that were carried out as part of this project, were centered around the questions: Can junior high school science students acquire skill in, and use concept mapping to facilitate meaningful learning? Also, will their acquisition of science knowledge and performance on problem solving tasks change as a result of concept mapping, and will there be a shift toward a more positive student attitude about science?

The studies were conducted with 7th and 8th grade science students in the Ithaca region of New York (Novak, Gowin, & Johansen, 1983). Data showed that both high and low ability 7th and 8th graders (as measured by standardized achievement tests) can acquire adequate skill in the use of concept mapping in conjunction with ordinary junior high school programs. While students in both grades were found to

be relatively successful in drawing hierarchical maps, most were very weak in showing links across concepts on their maps.

Arnaudin, Mintzes, Dunn and Shafer (1984) introduced concept mapping to biology majors at university level and found that those who had chosen to develop concept maps achieved significantly higher course grades than those who did not.

Sherris and Kahle (1984) compared the cognitive achievement of students within a high school biology class with and without concept mapping. On a 25-item multiple-choice test and five short-answer questions that required application of concepts and principles, the researchers found no significant differences between the treatment groups on post-test scores. However, they observed a difference in favour of subjects with an external locus of control. On the 6-week delayed post-test, they found an interaction between treatment and locus of control (i.e., subjects with an external locus of control benefiting more from concept mapping strategies). Their study showed that with longer periods of experimentation with mapping strategies, changes can occur perhaps also in the affective dimensions.

Lehman, Carter and Kahle (1985) used concept mapping with inner city black students in an 8-week biology unit. No significant differences were found between the control and experimental groups on the achievement scores in this study, although mean scores of the experimental group were greater

than those of the control group on achievement post-test, delayed post-test and the relation test.

Pankratius and Keith (1987) compared the effects of concept mapping and text outlining with ninth grade general science students to find no significant difference among treatment groups on the achievement measures. With twelfth grade physics students, they reported significant results in favor of subjects who had prepared concept maps prior to, and after a unit of study, compared with those who had prepared maps only after they had studied their unit. Both the groups had been given practice in concept mapping prior to the study. The researchers found that concept mapping succeeded in getting students more involved in learning how to learn and the teachers more involved in how their students learned.

In summary, the most pervasive outcome of most of these studies was that subjects in the experimental groups who were taught concept mapping techniques outperformed those in the control groups. But most importantly, it was evident that the strategy can be acquired by younger and older students alike, and that it can be implemented within the existing school and college science curriculums as a superior learning strategy.

Issues in the Applications of Concept Mapping

Effects of reading and cognitive ability. There is some evidence that concept mapping has benefits for learners with lower reading ability, and that it is in fact disruptive to higher ability readers. A recent study by Schmid and Telaro

(1990) investigated the effects of concept mapping in a high school biology class over a four-week period. Subjects were exposed to either a traditional teacher-based lecture or a lecture with concept mapping. Three levels of verbal-reading ability were created with the Stanford Diagnostic Reading Test. The dependent measures consisted of multiple-choice test items. Based on affective data, Schmid and Telaro reported that the concept mapping procedure, while useful for lower ability readers, was initially disruptive for high ability readers, although members of this group rated concept mapping as being significantly superior to the alternative approaches and continued to spend extra time working with it.

Schmid and Telaro found that on higher level skill items (application skills), concept mapping clearly benefited the performance of subjects with lower reading ability, to the extent that they not only outperformed lower ability readers in the non-mapping group, but performed as well as the higher ability readers in both the conditions. This result has been lent support by Driscoll and Tessmer (1985), who also found that students with lower reading ability benefited to a greater extent than students with higher reading ability from a concept mapping strategy over a straightforward text presentation format.

Cognitive ability on the other hand, has not been found to consistently interact with the outcomes of concept mapping. In their work with concept mapping with 7th and 8th grade science students, Novak et al. (1983) used student's

verbal and quantitative scores from their school files to
categorize them into four ability groups and mean concept
mapping scores were computed for students in each ability
group. They found that although higher ability students
tended to do better on mapping in the 7th grade sample,
students in all ability levels scored "good" scores on their
maps. The researchers concluded that students of any ability
level could be successful in acquiring skill in concept
mapping. The correlation between cognitive ability and
concept mapping scores was .34.

Immediate versus delayed effects of mapping. The effects
of concept mapping may not be revealed for the majority in
the short term, however, there is evidence that practice and
persistence with it leads to significant positive outcomes.
Moreira (1977) used concept mapping and traditional subject
matter organization with university students in his physics
classes. Subjects were administered three tests during the
term. Each of the three tests included items requiring
identification of general, intermediate, and most specific
concepts. No differences were observed between groups on the
first test, but on the second and third tests subjects in the
experimental group outperformed those in the control group on
the identification of all three categories of concepts.

Novak (1990) observed a similar pattern of results in
his work. When working with concept mapping, Novak observed
that for two to four weeks there was an average decline in
performance for the experimental subjects on standard course

examinations. The averages started moving up only later on in the course and for subjects using concept mapping strategies, scores usually ended up finishing significantly higher than those of the others. Students' attitudes also tended to shift from a generally negative to a positive one, and sometimes highly positive attitudes towards concept mapping and also towards the subject matter they studied. Miccinati (1988) in a study cited earlier had also reported a similar trend. When introduced to concept mapping subjects were initially reluctant, but very positively disposed towards the use of mapping later, as well as towards its usefulness in other areas of their school curriculum. Cliburn (1987) reported that on a delayed post-test, but not on the immediate post-test, students who used concept mapping during a three-week unit, significantly outperformed those who had not used mapping.

Novak explained that these patterns in achievement were not surprising. He argued that these outcomes were reflective of the commonly observed significantly lower performance for the experimental subjects exposed to a new strategy, such as concept mapping for only two to four weeks, but significant differences in their achievement scores over 10 or 12 weeks, when compared with the scores of students in the control or conventional instructional formats.

Effects of disposition towards mapping. Novak and his colleagues report that one of their major obstacles to successful implementation of concept mapping strategy has

been the difficulty of drawing teachers and students away
from rote learning practices. In addressing this problem,
Edmondson (1985) tried instructing a group of Cornell
University freshmen in learning how to learn strategies.
Twenty-one students attended an orientation session, and only
one remained in the program. Most said they did not have the
time for such a program while others said the proposed
strategies were inconsistent with the way they normally
studied, and were also incompatible with what they believed
was required to pass their examinations. Edmondson found that
only 20% of those he interviewed were committed to learning
for meaning. Lehman et al. (1985) found teachers and students
were unfamiliar with concept mapping strategies and unwilling
to attempt to use them, and also cited this disposition of
participants as a major limitation.

A similar negative disposition to the use of concept
mapping strategy was encountered by Feldsine (1987), when he
attempted to get college chemistry students to draw concept
maps of material they had read. However, Feldsine found that
this reluctance on the part of his subjects was short lived,
and as the course progressed, the reluctant mappers began to
see the usefulness of concept mapping in the understanding of
conceptually difficult topics, and also in identifying the
misconceptions in their subject matter. Arnaudin et al.
(1984) surveyed the range of attitudes of college students
toward concept mapping and observed a mixture of positive and
negative attitudes. They reported, many of their students

agreed that concept mapping was a good way to study biology but very few thought they might use it in other courses. The majority felt that concept mapping was not difficult to learn and that it provided a good picture of how they learned, but few wished to discuss their maps with an instructor.

Based on the above observations, these researchers surmised that college students have developed idiosyncratic study habits over a period of years and are reluctant to substitute new studying techniques for those that they have found successful. They noted that developing a good concept map often takes time and effort, and students often tend to prefer more expedient methods. Moreover, concept maps can expose fundamental misconceptions which students would prefer to conceal from their instructors.

Importance of type of testing. Research on the effects of concept mapping as a learning strategy shows that it has greater potential for conceptual than factual or procedural learning tasks. Schmid and Telaro (1990) found that mapping appeared to influence higher levels of learning positively, and especially for less capable learners. Since concept mapping did not facilitate learner performance on the recall of information at the knowledge and comprehension levels, they argued that unless application and analysis of knowledge were taught and tested, the positive effects of concept mapping would be neither seen nor valued.

Novak (1990) also argued, that studies which used learning strategies such as concept mapping were likely to

show no significant advantages over conventional methods if the measurement instruments did not require demonstration of meaningful learning and transfer of knowledge, and in which rote learning could suffice to achieve high scores. Cliburn (1990) found that subjects who had been exposed to mapping gave fewer verbatim textbook answers to essay questions than students who were instructed without concept mapping. Pankratius and Keith (1987) also noticed that test items requiring higher-order thinking were better discriminators of performance between subjects who had prepared concept maps prior to and after a unit of study, and those who had prepared maps only after they had studied their unit.

Instructor versus student developed maps. Concept mapping is a process oriented learning strategy that is not likely to produce benefits unless mapping is actually attempted, and for some time. Cardemone (1975) and Bogden (1977) found that while concept mapping had helped them plan their instruction, only a minority of the students found the instructor's maps of any value. Berkowitz (1986) cited earlier on in this review also investigated differences in the effectiveness of teacher and student developed maps in reading comprehension and reported that maps that were generated by students themselves were more effective.

Concept maps as evaluation tools. Concept mapping has been seen as having potential as an evaluation tool in the assessment of student learning. Schmid and Telaro (1990) have called for extending concept mapping into the evaluative

domain. Moreira (1985) has described concept mapping as a useful non-traditional evaluation tool with potential as a qualitative measure. From his use of concept mapping as an evaluation tool in the teaching of science and literature, Moreira has claimed that concept maps have provided him with far superior evidence of his students' understanding of course content than that supplied by other evaluation instruments.

Arnaudin, et al. (1984) taught concept mapping to a group of non-science majors in an introductory biology class. Subjects were asked to map the contents of a topic they had not been lectured on and after mapping they were offered lectures on the mapped content. A week later subjects were asked to map the same content as part of their midterm examination. In comparing the two sets of mapping exercises, the researchers found that the post-instruction maps were considerably more complex than their earlier maps, and contained a greater number of concepts, branches, and cross-links. They concluded that concept maps were indeed sensitive to changes in students' structure of knowledge and as such were helpful tools for measuring student learning.

Lay-Dopyera and Beyerbach (1983) investigated the potential of concept mapping as a measure of understanding with teacher trainees. In one study the researchers attempted to determine whether changes in students' knowledge and understanding of a topic were reflected in concept mapping before and after the study of that topic. Subjects' maps were

analyzed qualitatively. The researchers found that the final concept maps of subjects were markedly clearer than their pre-test maps, and especially with regard to revealing a hierarchical structure and showing inter-relationships. From this observation these researchers surmised that concept maps go beyond assessing students' knowledge at the recognition level, because they demanded recall and the placement of the recalled information within a more meaningful and graphical representation. Concept maps showed potential as a diagnostic instrument as well as a measure of understanding after delivery of instruction. They claimed that concept mapping is a viable means for determining what information individuals had readily available in their memory without much prompting.

Cohen (1987) used concept mapping for diagnostic purposes and reported that the strategy helped give the teachers a better idea of where their students were on a subject. It was non-threatening and more informative and illuminating than the conventional diagnostic pre-test. He suggested that mapping could be used at various stages of instruction in this manner as a better formative evaluation tool. From his experience with the application of concept mapping in the study of Earth Science, Ault (1985) expressed faith in similar uses of the technique.

Effects of cognitive style. Since concept mapping is fundamentally concerned with the identification of underlying principles and showing relationships among concepts, it has been suggested that subjects with such learning tendencies

should perform better on measures of meaningful learning. From this perspective, Okebukola and Jegede (1988) examined the effects of cognitive preferences of subjects exposed to concept mapping on its outcomes. Cognitive preference was defined as a person's usual way of perceiving, remembering, thinking and problem-solving. Four cognitive preference styles were defined as follows: (a) *recall*: acceptance of information for its own sake; (b) *principles*: interest in identifying relationships between variables; (c) *questioning*: preference for critically analyzing and commenting on the validity of information; and (d) *application*: preference for using scientific information to solve problems.

Results of their study showed that cognitive preference was found to significantly influence meaningful learning through concept mapping. Moreover, those subjects who worked cooperatively on concept mapping tasks attained meaningful learning better than subjects who worked individually on the concept mapping tasks.

Conclusions

The following conclusions can be drawn from the
foregoing review of literature on concept mapping.

1. It is likely that reading and cognitive ability
levels will interact with the outcomes of concept
mapping strategy.

2. The effects of concept mapping may not be revealed
for the majority in the short term, however, practice
and persistence with it will likely lead to significant
positive outcomes.

3. On being exposed to the strategy, there is likely to
be much opposition and reluctance to participating
initially, but this will diminish with greater exposure
and practice. The strategy is initially daunting and
considerably time consuming and will initially seem to
upset idiosyncratic learning strategies whether they
have proven successful or not. Concept maps can be very
revealing and as such many adults may not want to share
them with their peers or instructors.

4. Concept mapping involves identifying concepts, events and objects and showing relations between and among them. As such, the strategy is likely to have greater potential for complex and more conceptual rather than factual or procedural learning tasks. Mapping skills once acquired should help one remember more connections, ties and supportive details than is possible through other learning strategies.

5. Concept mapping is a process oriented learning strategy that is not likely to produce benefits unless one is willing to actually attempt to map, and to do so for some time. Like any other learning strategy, it will take time and practice for it to become part of one's repertoire of cognitive processing strategies.

6. Concept mapping can be usefully applied as a diagnostic and an evaluation tool in the assessment of student learning. In this manner it will probably be most useful and illuminating if it were applied as a qualitative measure.

7. Since concept mapping is fundamentally concerned with identifying underlying principles and showing relationships among concepts, it is likely that those with such tendencies or preference for them should benefit most from concept mapping.

Summary

Literature on selected instructional strategies has been reviewed in this chapter. The selected strategies were considered according to their function in the instructional process as follows. Those applied for the purposes of enhancing content presentation and inducing student learning were considered first. However, neither of the strategies from these categories were considered experimentally in the current research. They were applied as standard features of the experimental materials in the research. Strategies for providing feedback and reinforcement (i.e., variables treated experimentally in the current study) were considered next. The active ingredient of most relevance to the current research from the strategies cited under this category was feedback.

According to Rigney (1978), commonly known strategies for providing feedback in conventional instructional settings such as one-to-one tutoring, mastery learning and assigned homework comprise "embedded" instructional strategies because they are closely related to their context and content. However, learners are also capable of generating their own learning strategies and some of these learning and study skills can be systematically taught without any reference to particular context or content. Rigney has referred to these as "detached" instructional or learning strategies because of their independence from content.

In order to address both sides of the educational equation, that is, teaching and learning it makes intuitive sense to focus on both, designer-imposed (embedded) instructional strategies as well as learner-generated (detached) instructional strategies, and to provide feedback in both contexts. The current research was conceptualized to address this issue. The provision of feedback was the independent variable in the overall design and offered in different contexts. Post-questions with feedback in the experimental materials was considered as an example of an "embedded" instructional format, and concept mapping with feedback on student developed maps was seen as an example of a "detached" instructional format.

Research Hypotheses

In light of this review, the theoretical orientation of the study and the broad questions posed in the introductory chapter, the following research hypotheses were generated for investigation in this research.

Hypothesis 1. The three experimental conditions with feedback (concept mapping, post-questioning and the combined condition) would outperform the control condition (post-questions without feedback) while textual design strategies were held constant.

Hypothesis 2. Concept mapping exercises with feedback would yield higher cognitive achievement than post-questions with feedback while textual design strategies were held constant.

Hypothesis 3. There would be a large attrition rate with concept mapping exercises, with those who would have completed more than two-thirds of the suggested mapping exercises outperforming those who would not have done as many mapping exercises.

Hypothesis 4. The high persistence mappers would produce lower results than the other conditions on the midterm multiple-choice test items.

Hypothesis 5. A combination of concept mapping exercises and post-questioning with feedback provided on both, and textual design strategies held constant would produce higher cognitive achievement than produced by either of the two conditions separately.

CHAPTER THREE

Method

In this chapter the research carried out is described. The context of the research is discussed first. Comment is made on the generalizability of the research context and the research itself to the practices of distance education. The design of the research is discussed next and finally, the development of materials used, and the research procedure adopted are described.

Context of Research

Research Site

The research described here was carried out at Saint Francis Xavier University in Antigonish, Nova Scotia. Saint Francis Xavier (henceforth — St.F.X.) is a conventional university, meaning that among other things, most teaching and learning activity at the university is carried out in an on-campus mode. An exception to this is an extremely resourceful non-formal continuing education program at the university which offers a wide range of courses to members of the local community. Indeed, continuing education activity at the university dates back to the *Antigonish Movement* of the 1920s which was a program of adult education initiated by the university to cope with poverty and social unrest in Atlantic Canada during the 1920s and 1930s. Through the Coady Institute, each year St.F.X. offers a program in development

studies to adult educators and social workers from the
underdeveloped and developing countries around the world. To
add to this already strong tradition of continuing education
the university has been showing interest lately in distance
education.

The B.Sc. (Nursing)

In 1982 the Canadian Nurses Association adopted a
resolution that the minimum educational requirement for entry
into the nursing profession by the year 2001 will be a
baccalaureate in nursing. This resolution was later adopted
by the provincial nurses associations and also endorsed by
the Canadian Association of University Schools of Nursing.
Yet in 1988, only 12% of the registered nurses in Canada had
baccalaureate degrees.

In a direct response to this call of the nursing
profession, in the Spring of 1989, the nursing department at
St.F.X. began to offer its on-campus Bachelor of Science in
Nursing program in the distance education mode. The program
is available to all registered nurses in the provinces of
Nova Scotia and Prince Edward Island. Essential criteria for
entry is current nursing certification and a minimum of one
year's relevant work experience.

The complete B.Sc. is a 96 credit program of which 42
credits are devoted to core nursing courses, 24 credits to
humanities, 18 to science courses and 12 to electives from
sociology and psychology. Nursing courses in the program are

existing courses in the department that have been converted for offer in the distance education format. These are compulsory for all students and must be taken from St.F.X. Of the humanities and science course requirements, students are to take a minimum of 18 credits from St.F.X. They may take a maximum of 36 credits of equivalent course work from other institutions and apply for transfer of those credits to their program at St.F.X.

Unlike most other DE programs, this one is not self-paced. All courses in the program are offered in a rigid lock-step fashion and not available all the time. Failing or missing a course, especially one of the required nursing courses which must be taken from St.F.X. greatly jeopardizes one's chances of completing the program within the suggested time span. Students must take the compulsory courses when they are offered. However, there is more flexibility with the humanities and science courses which may be taken from St.F.X. or any other convenient institution. In this manner it is possible to complete all the requirements of the degree in five years.

Course development. The distance education courses in the program are designed for the purposes of studying independently at a distance from the services provided by the university for on-campus studies. They are developed by professors who offer those courses on campus, and have to be equivalent in content covered, assessment and evaluation of student performance to the on-campus version. The bulk of the

study materials are presented in printed format, but there has been some use of video tapes in some of the courses. Typically, a DE course package includes a student Study Guide (with objectives and suggested activities), commercially produced textbooks and readings around which courses are usually built.

In the course development process, the professors are essentially on their own, although some advice on instructional design and materials production is available from the Extension Department. For the professors without exception, course development activity for DE is an entirely new experience. This model of course development places an immense amount of strain on the faculty and is the source of much of their disenchantment with DE. The model, known as the "intuition model" of course development, has been denounced by distance educators as unacceptable by most standards (Smith, 1980, p. 67). Text-processing of the course materials is done on Ventura™ which is a desktop publishing software. Final copies are laser printed, photocopied and bound in ring-binders.

Student support. Students in the program are assigned to a local educational consultant who is usually a colleague at work and who has a baccalaureate or a higher qualification in nursing. Each educational consultant is responsible for up to ten students. Their overall function is to help the students in any way possible. More specifically the consultants are hired to: (a) help students with the subject matter, mark

some of the assignments, and supervise the examinations; (b) distribute the study materials to the students and manage the services of the study center. Students have access to a toll-free telephone line to their professor and also to the program office. There is a quarterly newsletter from the program office for the students and one for the consultants.

The student body. The students in the program are all women and at the time of entry into the program (Spring, 1989) their modal age was 33 years. Fifteen percent were 40 years or older while 32 percent were under 30 years. Nearly half of them (49%) had more than 10 years of work experience. Seventy three percent, in 1989 were in staff nurse positions and 18% in administrative positions. For 46% of them the main reason for seeking entry to the program was to learn more, so that they will be better able to perform in the jobs they held. For 33%, the main reason was to obtain a qualification necessary for the job they desired. Some 20% of them were seeking a B.Sc. in nursing for personal satisfaction. A little more than half of them (55%) had previous university credits.

Twenty-nine percent of the students in 1989 were the sole income earner in their families. Over a half of the students (54.6%) were spending 41-50 hours per week on work or related activities and 20% were working 31-40 hours per week. Most of them said that family care and home maintenance took up much of their time. Twenty-five percent were spending over 20 hours a week on family care, while 47% said they were

devoting over 15 hours per week to household chores. Thirty percent of them spent 10-12 hours per week on leisure while 46% spent over 12 hours a week on leisure. Fifty-five percent of the students estimated they were spending 2 hours per week on community activities and 16% thought they were spending 3-5 hours per week.

All students were aware that time for studying at a distance for them would compete with time for the upkeep of their households, children and leisure. Like most other distance learners most of them were concerned about learning in the distance mode and their ability to cope with its demands. A few were concerned about their ability to manage their academic workload along with their family and work commitments. However most believed that in this regard, they had the support of their families, supervisors and colleagues at work.

External Validity

According to Campbell and Stanley (1963), external validity asks to what populations, contexts, treatment and measurement variables can the effects from an experimental context be generalized. In DE, generalizability is perhaps best determined with reference to consistencies in student characteristics and program structures between the research context and like institutions.

Student characteristics. The students of the nursing DE program at St.F.X. are typical of DE students in several

ways. Like most DE students they are employed, have household and family commitments and are older than their counterparts in conventional universities (Coldeway, 1986; McInnis-Rankin & Brindley, 1986; Tekin & Demiray, 1989). Their learning experience is also quite different (Clennel, 1988; Moore, 1987). For the majority, as is the case in this study, their learning experience is unlikely to be one of major concern (Bryne, 1989; Field, 1982). Often it would take place in the midst of a variety of activities and obligations that crowd the daily routine of household maintenance and work.

Program structure. Generalizability can also be established by examining consistencies in program structures. Keegan and Rumble have attempted to classify various forms of DE according to their most pervading elements (Keegan, 1990; Keegan & Rumble, 1982). Keegan's classification is used here to describe the institutions to which outcomes of this study may be generalized (see Figure 1).

The St.F.X. context best resembles Keegan's Group 5 — the Australian integrated model which is a variation of the "mixed-mode" category of institutions. The outcomes of this study are foremost, generalizable to institutions that fall in that category. This model is also called the *New England Model* because it was popularized by the University of New England in Australia. It has since been widely adopted within Australia, New Zealand, South Pacific, th Caribbean, Papua New Guinea, Hong Kong, India, Sri Lanka. Pakistan, Malaysia and Canada.

Figure 1. Keegan's typology of distance teaching institutions.
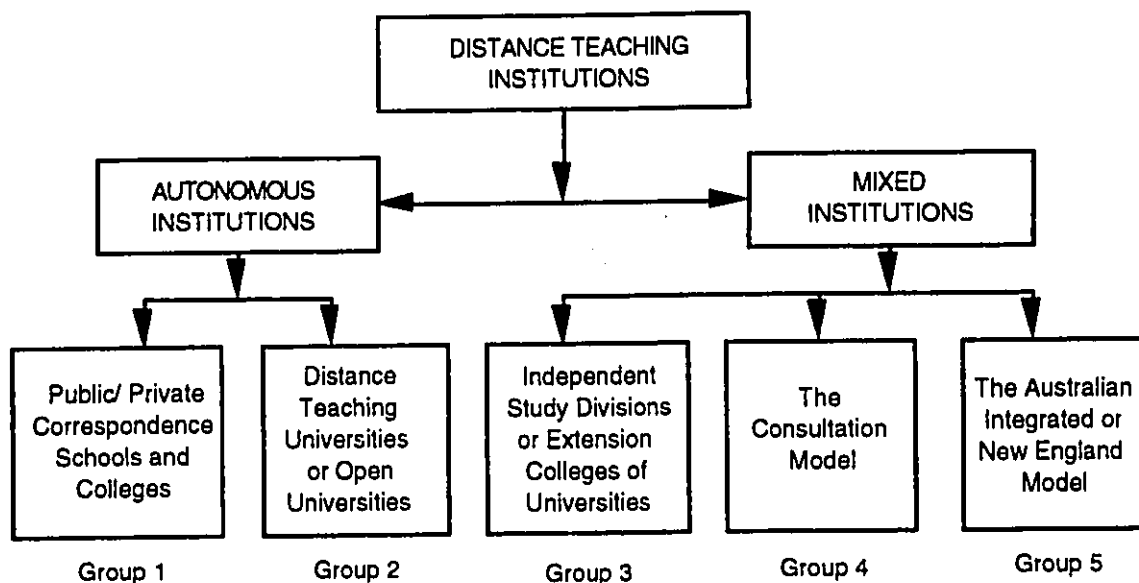
In this model the academic staff are assigned responsibility for on-campus (conventional) and off-campus (DE) students, hence the term "mixed-mode". It includes developing all the course materials, teaching and evaluating the work of both groups of students. They are not responsible for any administrative work. The administration of DE activity is the responsibility of a separate department which has no teaching function. Its primary functions are the production and distribution of all course materials, registering students, providing student support services, arranging residential sessions, and facilitating the work of the teaching staff (Keegan, 1990).

There are similarities, also between the St.F.X. site and Keegan's Group 3 — independent study divisions of conventional educational institutions. Keegan has labelled this model of DE as essentially a "North American phenomenon" (p. 132), although there are several examples of this model in Europe (Willén, 1983), Asia (Carr, 1983), and South America (Escotet, 1983). In this model, administration of DE is the responsibility of a Continuing Education or Extension department such as at St.F.X. Course materials for DE are developed by the university faculty who are paid additionally which is also true at the St.F.X. site. Subject matter experts from outside may be hired for course development work, but this is not a feature of the practice at St.F.X.

Experimental Design

Subjects

The first student cohort in the nursing distance education program at St.F.X. comprised the subjects in this study. There were 141 students in the sample at the beginning of the study and by the end there was one dropout for reasons not related to the study. For the duration of the study all subjects were registered in the same course — *Nursing 200: Community Mental Health*, and were reportedly progressing at the same pace. At the time of the study all of them had satisfactorily completed all the courses that had been offered in the program. Since the subjects comprised all

students registered in the program at the time of the study, they were a valid sample.

Design of Study

The study described is a non-equivalent control group design with multiple independent and dependent variables and a covariate. The design comprised four treatment groups which were drawn from naturally occurring groups based on the geographical distribution of subjects in the context. Subjects could not be randomly assigned to the treatment conditions for the following reasons. Firstly, because subjects working together often consulted each other, and assigning them different instructional activities would have caused a confounded design. Secondly, mailing of different materials to each subject and ensuring that correct packages were received by them would have been extremely difficult. In order to avoid the possibility of such faux pas, groups of subjects in proximity were assigned to the different treatment conditions. The procedure adopted is described in greater detail later in the chapter.

The experimental and the control groups in the design were however "equivalent" in several respects including prior achievement on four other courses subjects had taken in the nursing DE program prior to the current study. Using Campbell and Stanley's (1963) notations, the design may be represented as follows (X = Treatment; O = Observation).

$$X_1 \quad O_1 \quad X_1 \quad O_2$$

$$X_2 \quad O_1 \quad X_2 \quad O_2$$

$$X_3 \quad O_1 \quad X_3 \quad O_2$$

$$X_4 \quad O_1 \quad X_4 \quad O_2$$

Time 1   Time 2

Independent variables. The independent variable in the study was feedback on three instructional treatments — concept mapping, post-questioning and a combined condition.

Post-questioning without feedback comprised the control for the overall design, while post-questioning and concept mapping (with post-questioning without feedback and textual design variables held constant) was the combined condition in the experiment.

Dependent variables. The dependent variables in the study were: (a) achievement scores of subjects on the midterm and final examinations in *N200 — Community Mental Health*; (b) responses to attitudinal items on methods of studying; and (c) responses to questionnaire items related to the different treatment conditions.

Subjects' scores on the two examinations, midterm and final, were broken down according to type and focus of questions. Scores on multiple-choice type items were separated from those on essay type questions. The essay questions were distinguished by those that were cued to content with concept mapping exercises and content without concept mapping exercises. Furthermore, scores on all essay

type questions were separated by "key" and "related" idea units. Key idea units represented those that were essential to an answer and related idea units were regarded as complementary to it. Therefore, for each of the two exams there were five dependent measures contributing scores to the subsequent data analysis.

Achievement scores on the midterm examination were entered under the following categories.

1. Multiple-choice items.

2. Key idea units on essay questions (Mapping).

3. Related idea units on essay questions (Mapping).

4. Key idea units on essay questions (Nonmapping).

5. Related idea units on essay questions (Nonmapping).

Achievement scores on the final (end-of-course) examination were entered similarly as follows.

6. Multiple-choice items.

7. Key idea units on essay questions (Mapping).

8. Related idea units on essay questions (Mapping).

9. Key idea units on essay questions (Nonmapping).

10. Related idea units on essay questions (Nonmapping).

Subjects' scores on the attitudinal measure were derived from fifteen statements related to methods of studying in a questionnaire that was administered at the end of the study. Subjects indicated the strength of their feelings toward each of the fifteen statements on a five point Likert-type scale ranging from strongly disagree to strongly agree.

The final set of scores were derived from questions in the rest of the questionnaire. These included questions on subjects' compliance with the instructional treatment, the level of difficulty, and the usefulness of the instructional activities they were exposed to as part of the study.

Materials

The Course Package

The complete instructional package for the course within which this study was carried out included two commercially produced textbooks and a self-instructional Study Guide which was developed in-house. The textbooks were:

1. Stuart, G. W., & Sundeen, S. J. (1987). *Principles and Practice of Psychiatric Nursing* (3rd ed.). Toronto: The C. V. Mosby Company.

2. Barry, P. D. (1989). *Psycho-Social Nursing – Assessment and Intervention: Care·of the Physically Ill Person* (2nd ed.). London: J.B. Lippincourt Company.

3. *Mental Health For Canadians*. Health and Welfare Canada.

The Study Guide developed by the course instructor was:
4. *Nursing 200: Mental Health Nursing.*

Design and Development

The textbooks were selected by the instructor on the basis of their coverage of course content and suitability for this level of study. The Study Guide was "wrapped-around" material selected from these two textbooks as well as readings selected from other sources on the content of the course. The bulk of the materials development work was carried out by the course instructor with the help of this researcher in the areas of instructional design.

The materials development process was, on the whole, guided by procedures outlined in the systems approach to instructional design proposed by Dick and Carey (1990), although not necessarily limited by it. The following is a description of the procedures followed in the design and development of the self-instructional Study Guide.

Identification of instructional goal. The first step in this process was to determine what the students were required to be able to do or know after they had completed study of the course. This was fairly simple since the DE course had to be modelled on the existing on-campus course. *Nursing 200* was a six credit course that would run for 20 consecutive weeks. The content to be covered within this time frame was determined from the prescriptions of the existing course.

Instructional analysis. At this stage, the type of learning required by the student was determined. The nature of subject to be covered required emphasis on the development of communication and interpersonal skills. The content was

predominantly conceptual in nature and students were required to apply the concepts learned to real life situations in mental health practice.

Development of key concepts. In order to further define the coverage of course content for each of the 20 weeks in the term, a set of key concepts to be covered in each week was produced. Reading for each week was identified to balance the distribution of workload in the 20 weeks. Page references from textbooks and readings from other sources were identified for each week's work. Assessment requirements were also considered in light of the suggested weekly learning activities.

Determination of objectives. Based on the instructional analysis and the identification of the key concepts to be covered in the course, more specific statements were developed for each week's work. These statements helped determine the skills students were required to perform, and the criteria for successful performance.

Development of criterion-referenced tests. From the key concepts and the objectives identified, lesson assessment items were developed for each of the lessons. These items were to measure the student's ability to perform the tasks outlined in the lesson objectives.

Development of instructional sequence. From the above procedures a sequence for the presentation of lesson material for each week's work was developed. The sequence adopted was as follows: (a) an introduction to lesson material; (b) a

list of key concepts covered; (c) a statement of objectives;
(d) required readings; (e) suggested readings; (f) discussion
of lesson content; and (g) lesson test or exercise. The 20
lessons in the Study Guide were organized into four modules,
each comprising five lessons (see Table 3).

Developing instruction. A draft for each of the 20
lessons was then produced according to the sequence outlined
in the previous step. Each lesson was one week's work and
required 12 to 15 hours of study by the students. Appendix A
is an example of one lesson from the Study Guide. Lesson
discussion began with a brief introduction on the content
that was to be covered in that week, and followed with a list
of the key concepts. The objective of this was to orientate
the student for the oncoming discussion in the lesson.
Following this, there was a a list of performance objectives
for the lesson. These were the activities students were to be
able to carry out after completing that week's work.
The discussion of the subject matter of the lesson followed.
This adopted an interactive and a conversational style. There
were references to textbook materials, additional readings,
other sources and also personal experiences of the instructor
as well as the students. Throughout the discussion of the
lesson material the student was presented with questions and
exercises to reflect upon and answer. Some of these in-text
questions required recall of factual information while others
needed more elaborate answers and a higher level of cognitive
processing. Students were advised to make a response to all

Table 3

Nursing 200: Mental Health Nursing Course Outline

Module One: Conceptual Models of Mental Health Nursing	
Week:lesson	**Lesson Content**
1:1	The mental – illness continuum
2:2	Conceptual models in mental health
3:3	The therapeutic nurse-patient relationship
4:4	Communication skills in nursing
5:5	Psychiatric evaluation (history)
Module Two: Intervention Modes	
Week:lesson	**Lesson Content**
6:6	Crisis intervention
7:7	Group therapy
8:8	Family therapy
9:9	Stress management
10:10	Forms of treatment
Module Three: Nursing Interventions I	
Week:lesson	**Lesson Content**
11:11	Disturbances in mood
12:12	Self-destructive behavior
13:13	Alterations in self-concept
14:14	Anxiety
15:15	Psycho-physiological illness
Module Four: Nursing Interventions II	
Week:lesson	**Lesson Content**
16:16	Problems with expression of anger
17:17	Disruptions in relationships
18:18	Impaired cognition
19:19	Variations in sexual response
20:20	Substance abuse

these questions before continuing. Depending on the nature of the subject matter in the lessons, illustrations with processing instructions were also included for enhancing the discussion. At the end of each lesson there was a test or a concept mapping exercise which the student was urged to take before moving on to the next lesson in the module.

Formative evaluation. This was carried out to the extent that the lesson drafts were thoroughly reviewed by me and read by two other practicing nurses who were also educational consultants in the program. Comments received on the lesson drafts comprised useful feedback for revisions.

Production. The Study Guide material was typed on WordPerfect™ and formatted using Ventura™. Final laser printed copies were duplicated and collated at the St.F.X. University printing services.

Experimental Materials

For the purposes of this research students in *Nursing 200* were assigned to one of four treatment conditions. All of them received the same instructional package, irrespective of the treatment group they were assigned to. Only one feature of their Study Guide varied from group to group. This was the instructional activity at end of certain lessons in the Study Guide. Characteristics of these for each of the groups are now discussed.

Self-assessed tests. At the end of each of the 20 lessons in their Study Guide, subjects in the *control*

condition were presented with a self-assessed test. These were printed on white paper. Each lesson test comprised four or five questions and required brief responses only. The questions were mostly testing knowledge and comprehension of content covered in the lesson. After completing their study of the lesson material, subjects were urged to respond to all the questions in the self-assessed test before moving on to the next lesson. After responding to the questions, they were asked to check their answers against the material in their textbooks. The onus was on the students to do the self-assessed tests in the manner suggested as they were not graded, not compulsory and not checked by the instructor. No feedback was provided on these tests. Subjects did not have to do them if they did not wish to, although the value of doing the tests to their understanding of lesson material and in their performance on the examinations was pointed out to them.

Consultant-assessed tests. On selected lesson tests from among the 20 lessons, subjects in a different treatment condition were given feedback on their responses to questions in the lesson tests. These tests had exactly the same questions as in the self-assessed tests for the control group. They were called "consultant-assessed tests" only because the educational consultants provided subjects with feedback on their answers. These tests were printed on pink paper. After completing their study of each lesson, subjects in this treatment group were asked to respond to the

questions in the lesson tests and submit them to their educational consultant in order to receive feedback on them.

Lessons which incorporated consultant-assessed tests did not include self-assessed tests. The questions in the tests required brief answers which were mainly testing knowledge and comprehension skills. They were open-book tests and students were to do them in their own time, but preferably immediately after completing study of the lesson material. Like the self-assessed tests, the consultant-assessed tests were not compulsory and were not graded.

Training consultants on providing feedback. Procedures for giving feedback to subjects in this treatment condition was detailed in a guide book (see Appendix B). This book also included procedures for keeping records of tests completed by the students and feedback that was provided to them.

Concept mapping exercises. On a selected number of lessons from the 20 lessons, subjects in another treatment condition were given concept mapping exercises. These were printed on yellow paper and lessons which incorporated concept mapping exercises did not include any other form of end-of-lesson activity. After completing study of the lesson content, subjects were asked to do the mapping exercises at the end of the lessons and send in their completed exercises to their local educational consultant in order to receive feedback on them. Feedback on the mapping exercises was in the form of concept maps developed by the instructor. The concept mapping exercises, like the lesson tests, were

optional and not graded. If subjects completed these exercises, then they received feedback on them. If they did not do the exercises, no feedback was provided.

Training subjects in concept mapping. Training in concept mapping skill to subjects was provided through a self-instructional workbook. This workbook was developed with reference to the content of this course and made available to all the students who were asked to develop concept maps as well as to the respective consultants. It introduced subjects to the idea of concept mapping, explained its usefulness in understanding particular kinds of content, and provided them with a step-by-step approach for developing a concept map (see Appendix C).

Training consultants on providing feedback. A guide was developed for consultants outlining procedures students would follow in doing the mapping exercises. It offered guidelines for evaluating concept maps developed by the students, and also included sheets for keeping records of exercises completed and submitted by them (see Appendix D).

Self-assessed tests, consultant-assessed tests plus concept mapping exercises. In one of the four treatment conditions in this study, subjects were exposed to all three forms of instructional activities described above. For each lesson, however, there was only one form of activity at the end of the lesson, that is, either there was a self-assessed test, consultant-assessed test or a concept mapping exercise to do. In order to keep the amount of workload for subjects

in the four treatment conditions about equal subjects in this group were offered half the number of consultant-assessed tests and concept mapping exercises that were offered to subjects in the other two groups, with self-assessed tests in the non-experimental lessons.

Coverage and distribution of lesson activities. In this study, self-assessed tests, consultant-assessed tests and concept mapping exercises were applied as alternative forms of instructional activities. The activities covered the same lesson content except in different forms. For example, Lesson 2 (Week 2) of Module One in this course for subjects in the control condition incorporated a self-assessed test with four essay type questions. For subjects in another treatment the same four questions were offered as consultant-assessed test and if they answered the questions in the test, they received feedback on their answers. In another group, subjects were given concept mapping exercises on the same content covered by questions in the lesson tests for the other two groups. If subjects completed these mapping exercises, they too received feedback. Finally, in one of the four groups these exercises were alternated. The distribution of the self-assessed and consultant-assessed tests, and concept mapping exercises in the four treatment conditions is presented in Figure 2.

Development of Experimental Materials

Instructional analysis. Before any one of the lesson tests or concept mapping exercises could be developed, a

Figure 2. Distribution of SATs, CATs, MAPs in N200

DISTRIBUTION OF SELF-ASSESSED TESTS (SATs), CONCEPT MAPS (MAPs) AND CONSULTANT-ASSESSED TESTS (CATs) AMONG 20 LESSONS IN N200

	Module 1	Module 2	Module 3	Module 4
SATs (CONTROL)	SAT SAT SAT SAT SAT	SAT SAT SAT SAT SAT	SAT SAT SAT SAT SAT	SAT SAT SAT SAT SAT
MAPs	SAT MAP MAP SAT MAP	MAP SAT MAP MAP SAT	MAP SAT MAP MAP SAT	MAP MAP SAT SAT MAP
CATs	SAT CAT CAT SAT CAT	SAT CAT CAT CAT SAT	CAT SAT CAT CAT SAT	CAT CAT SAT SAT CAT
CATs/MAPs	SAT CAT MAP SAT CAT	SAT MAP CAT SAT MAP	CAT SAT MAP CAT SAT	MAP CAT SAT SAT MAP

FIRST DEPENDENT MEASURE (after Module 2)

Midterm Examination

SECOND DEPENDENT MEASURE (after Module 4)

Final Exam plus Attitude Questionnaire

decision had to be taken on which lessons would be appropriate for which kind of instructional activity. An instructional analysis was carried out for each of the 20 lessons in the course in order to determine the instructional goals that were required of the student. Instructional analysis is a set of procedures that helps identify relevant steps for performing an instructional goal and subordinate skills required for a student to achieve the goal. A subordinate skill is one that helps learning of some higher or superordinate skill (Dick & Carey, 1990).

The instructional objectives of each of the lessons were examined along with the required reading material for the lessons in order to determine the nature of the reading material and the skill required of the student. Lessons in which the performance objectives stressed lower order skills of recall and comprehension and in which the reading material was of more factual and procedural nature were considered appropriate for self-assessed and consultant-assessed tests. Conversely, lessons in which the objectives emphasized higher order skills and in which reading material was of a more conceptual nature, were considered appropriate for concept mapping exercises.

Lesson activities. Once it was determined which lesson would incorporate which form of instructional activity, lesson tests and concept mapping exercises were developed concurrently with the lesson material for the Study Guide. In developing the questions for the lesson tests and the concept

mapping exercises, particular care was taken to ensure that the objectives of the lessons were being adequately evaluated in these tests and exercises. The list of key concepts that had been produced for each of the lessons also helped to ensure congruency in lesson objectives, key concepts and the lesson tests.

Formative evaluation. The lesson tests and mapping exercises were reviewed by the course instructor and two research assistants. These two research assistants were graduating students from the on-campus B.Sc. (Nursing) program and their services were available at various stages throughout this study. Feedback from the instructor and the two research assistants was incorporated in the improvement of questions in the lesson tests and the concept mapping exercises.

Development of answers for feedback. Once a final version of questions for the lesson tests and concept mapping exercises was determined, complete answers to the questions and exercises were developed by the two research assistants. Both students had recently taken this course as part of their on-campus nursing program and so were qualified to perform this task. However, they had to learn how to develop concept maps before they could do the mapping exercises suggested. They learnt how to develop concept maps from the self-instructional workbook on concept mapping that was developed for the students. Answers developed by them were checked for accuracy and completeness by the instructor and myself.

Several benefits were derived from this exercise. Firstly, it helped determine that the questions in the lesson tests could in fact be answered from the material in the textbooks without too much difficulty. Secondly, that the concept mapping exercises could also be developed in the manner they were suggested. Thirdly, that it was possible to develop concept maps satisfactorily, with the help of the self-instructional workbook.

This exercise revealed a number of difficulties also and some very useful suggestions. It was found that some of the questions in the lesson tests were too ambiguous and some were inordinately time consuming to answer. Some of the concept mapping exercises covered too much content for it to be clearly and meaningfully represented on one concept map. There were some serious discrepancies in the amount of time needed to do a concept mapping exercise in comparison with that required to do the corresponding lesson test. Also, there were some differences in the amount of material covered by a concept mapping exercise in comparison with that covered by the corresponding lesson test.

All of these suggestions comprised extremely valuable feedback and were incorporated in the development of better questions for the lesson tests and concept mapping exercises. The answers that were developed by the research assistants comprised the feedback that subjects in the study received if they did the tests and exercises themselves first.

Concept mapping workbook. Concept mapping is the identification and representation of key concepts in a body of course content, and the relationships among them, in some meaningful way. As a method of learning it has been found to be useful in the comprehension of conceptual material. In order to help subjects in this study develop useful concept maps of their course content, a self-instructional workbook was developed (see Appendix C). This workbook included: (a) a definition of concept mapping; (b) reasons for mapping; (c) examples of concept maps; and (d) a four-step procedure for developing concept maps. This workbook was developed from existing literature on concept mapping and practice exercises in it were drawn from the subject matter of *Nursing 200*. In the questionnaire that was administered at the end of the study, subjects were asked to indicate how helpful they found the workbook. Most of them said they found the workbook "quite helpful".

Formative evaluation of workbook. The mapping workbook was formatively evaluated with three students from St.F.X. and six from the educational technology program at Concordia University. The three student evaluators from St.F.X. were senior students from the on-campus B.Sc. nursing program who were not familiar with concept mapping. Of the six evaluators from Concordia University, two were not very familiar with concept mapping, two were a little more familiar than the previous two, and the remaining two were considered subject matter experts on concept mapping. These latter two had done

research with concept mapping, and were therefore familiar with the literature on concept mapping.

Evaluators in both contexts were given copies of the workbook plus a list of topics on which they were to comment. These were as follows: (a) language and readability; (b) structure and layout; (c) clarity of instructions; (d) sequence and progression of discussion; (e) effectiveness of discussion; (f) use of diagrams, illustrations and charts; (g) use of practice exercises; and (h) overall effectiveness of the workbook.

The evaluators were met under two circumstances: first on a one-to-one basis and second, in a dyad format. The evaluators at St.F.X. were met with individually on a one-to-one basis. The two novice evaluators from Concordia were met with individually. The other four evaluators from Concordia University were met as dyads. The two experts on concept mapping made up one dyad, and the other two who were somewhat familiar with concept mapping made up the other dyad. Their concerns were discussed, and appropriately incorporated in a revised version of the workbook.

Generally speaking the evaluators found the workbook readable, clear, concise and effective for the purposes it was designed. Their negative criticisms were directed at unclear instructions in certain parts, unclear discussion in certain places which was sometimes confusing, and a style of presentation that was considered too academic.

Consultants' guide (concept mapping). Educational consultants whose students would be doing concept mapping exercises were also sent a copy of the concept mapping workbook. In addition, they were sent a guide booklet which outlined the procedures subjects would follow and the manner in which their maps could be evaluated. The evaluation procedures that were recommended in this guide booklet were largely extracted from Novak and Gowin (1984). The record sheets included in the guide booklet were designed to note the dates on which the mapping exercises were received from the students and the dates on which feedback was sent to them. The purpose of recording the dates of this transaction was to ensure that the turn-around time was kept to the minimum. An additional ruled sheet was included in the guide for any other comments that the consultants might wish to record.

Consultants' guide (consultant-assessed tests). A guide booklet was developed to help educational consultants whose students would be doing the consultant-assessed tests. Essentially, the guide booklet outlined the procedures students would follow in doing the tests, and the manner in which the consultants were to provide feedback. The record sheets for the consultant-assessed tests were like those that were developed for keeping records of mapping exercises. Both were designed to serve essentially the same function. There was an additional ruled sheet in this guide booklet also for any other comments that consultants might want to make.

Formative evaluation of consultants' guides. Both guide booklets for the consultants were reviewed by the instructor and the nursing DE program coordinator. Their suggestions were incorporated in the final versions.

Production of experimental materials. All experimental materials for this study were duplicated and collated at the St.F.X. University printing services. Master copies of all materials were developed by this researcher in Montréal.

Materials Development Schedule

All materials for the study were developed in the Spring and Summer months of 1990. The schedule followed is presented in Table 4. The dates indicated are about when the specified projects were completed and all items were ready to go for printing.

Negotiations for carrying out this study were initiated in January, 1990. A site visit by this researcher was made to St.F.X. University during the week of March 12-18, 1990 for the purpose of presenting the research proposal. In a series of meetings with the professor offering the course within which the study was to be carried out, the coordinator of the Post—RN DE program, the chair of nursing department and the coordinator of continuing education programs of the Extension Department, the research proposal for the study was discussed in great detail and agreement reached on most aspects of its conduct.

Table 4

Materials Development Schedule

Project/Items	Development Period
March (Preliminary) Site Visit	
• Preliminary discussions with program staff about the research design and feasibility of its implementation	March 12-18, 1990
Training Booklets Development	
• Consultants' guide (feedback)	April, 1990
• Consultants' guide (concept mapping)	April, 1990
• Student workbook (concept mapping)	April, 1990
• Formative evaluation of workbook+guides	July, 1990
• Documents produced and printed	July, 1990
Study Guide Development	
• Key concepts for 20 lessons	May 4, 1990
• Lesson objectives+content identified	May 18, 1990
• Draft lessons of the Study Guide	May 21, 1990
• First full draft of Study Guide	June 30, 1990
• Development of all experimental instructional activities (SATs/CATs/MAPs)	June 30, 1990

Table 4 Continued

Materials Development Schedule

Project/Items	Development Period

July Site Visit

- Editing Study Guide — July 1-15, 1990
- Incorporating instructional activities — July 1-15, 1990
- Developing answers to tests and maps — July 1-15, 1990
- Self-assessed tests, consultant-assessed tests, and answers — July/Aug, 1990
- Concept mapping exercises and answers — July/Aug, 1990
- All materials sent for printing — August 1, 1990

August Site Visit (Mailing)

- Preparation of Study Guides and all experimental materials — August 26-5 Sept., 1990
- Mailing of all materials — September 17, 1990

December Site Visit

- Formative evaluation of questionnaire — December 8-15, 1990
- Development of second cognitive measure

January Site Visit

- Administration of questionnaire — January 13-20, 1991

Instruments

The following instruments were used for gathering data in this study.

1. *Cognitive achievement measures.* There were two cognitive achievement measures in this study. These were the midterm and the final examinations.

2. *Attitude measure.* This was measured via selected items in the questionnaire administered to subjects at the end of study.

3. *Post-Experimental Questionnaire.* Comprised questions on the three different forms of instructional activities.

Other data. These comprised the following:

1. *Demographic data.* This was extracted from existing records at the university. Since the subjects in this study comprised a very homogeneous group (all women, registered nurses, and employed), demographics was not considered to be an important discriminating variable. Therefore no systematic attempts were made to collect such information from the subjects during or prior to the study.

2. *Prior cognitive achievement.* This was derived from subjects' final examination scores on four nursing courses they had recently completed in the program. The mean of these scores for each subject served as the covariate in the analysis of data.

3. *Other records.* These were maintained by the educational consultants in their guide booklets on subjects' compliance and progress with the treatment conditions.

Development of Instruments

First cognitive measure. The midterm examination was the first cognitive measure. It was administered after the first ten weeks of study in the course. The examination was a two-hour paper and pencil test and comprised 60 multiple choice-type questions and 6 essay type questions. The questions were selected from a test bank which was developed by the authors of the main reference text for *Nursing 200* to accompany their textbook. The questions in the test bank were available on disk as well as in printed form, and accessible only to instructors. Students could not purchase a copy of this product. Use of questions from the test bank was considered advisable since it assured a greater degree of external validity for the measure.

Of the 60 multiple-choice type questions selected, there were six on each of the ten lessons covered in the examination. Questions for each of the lessons were selected to test knowledge, comprehension and application skills (Bloom, 1956). Questions testing higher order skills than those could not be found in the test bank. With the help of the classification developed by Bloom and his partners three raters rated the selected questions according to the skills each question was testing. The most popular vote was used to achieve about equal distribution of questions that tested knowledge, comprehension and application skills. The same procedure was adopted for the selection of questions in the final examination. The raters chosen were students of

educational technology who were familiar with test development procedures. Care was also taken to ensure an even representation of questions from both, lesson content on which concept mapping exercises were set as well as content on which there were no mapping exercises.

The essay type questions were also obtained from the test bank. However, they were reworded slightly to suit the expectations in this examination. Three of the six questions were based on lesson content on which concept mapping exercises had been set, and the remaining three were based on content in which there were no mapping exercises.

Second cognitive measure. The final examination was the second cognitive measure and it was administered at the end of the course, after twenty weeks of study. The examination however, was based on content covered since the midterm exam (i.e., lessons 11-20). It was a three-hour paper and pencil exam of a 100 multiple-choice type and 10 essay type questions. All the questions in this examination were also drawn from the same test bank from which the midterm test was developed.

Of the 100 multiple-choice type questions, ten questions were selected for each one of the ten lessons covered in the examination. The selection procedure was the same as adopted for the preparation of the first cognitive measure. Once again, care was also taken to ensure an even representation of questions from both, lesson content on which concept

mapping exercises had been set as well as content on which there were no mapping exercises.

The essay type questions for the final exam were also obtained from the test bank. They were reworded to suit the requirements in this examination. Six of the ten questions were based on content in which concept mapping exercises had been set, and the remaining four were based on content in which there were no mapping exercises.

Reliability of cognitive measures. The multiple-choice items selected were tested for reliability with Kuder-Richardson's formula (rK-R21). The reliability coefficient for the 60 multiple-choice items in the midterm examination (first cognitive measure), was .06. For the 100 items in the final exam (second cognitive measure), the reliability coefficient was .32.

These reliability coefficients were far below that which is considered adequate (.80), for tests that seek to differentiate between group means. Clearly, a number of questions in the exams did not discriminate well enough across the treatment groups. But, the questions could not be pretested on a comparable sample to improve their reliability without risking confidentiality. At least, the questions selected were considered to be high in both internal and external validity. Moreover, the subjects in the study comprised an extremely homogeneous sample by way of prior academic achievement and current performance, vocation, and

demographics. Less variable sample characteristics are also a source of lower reliability in performance.

Attitude measure. The last section of the questionnaire which was administered to subjects at the end of the study included fifteen items on various methods of studying. Subjects were asked to indicate the strength of their agreement or disagreement with each of the items using the following categories: 1=strongly disagree; 2=disagree; 3=unsure; 4=agree; and 5=strongly agree. The items were developed from a review of the literature on designing attitudinal items, as well as the literature of instructional strategies.

Questionnaire data. The rest of the questionnaire addressed the different instructional treatments in this study. Section one which was common to all, focussed on the self-assessed tests. There were nine questions in this section, three of which were open-ended and the rest required selection of the best response. Section two addressed the concept mapping treatment. There were twelve questions in this section, three were open-ended and the rest required selection of the best option. Section three was focussed on consultant-assessed tests and it included ten questions. Three of these were open-ended and the rest needed selection of the best choice.

The questions were presented basically in the same format and they sought the same kind of information for each of the different treatment conditions (see Appendix E). These

were: (a) number of exercises completed; (b) difficulty in the beginning and later on; (c) feedback received or not; (d) usefulness of feedback received; (e) time required to do the activities; and (f) usefulness of the suggested strategies.

Formative evaluation. The questionnaire items were formatively evaluated with the two research assistants at St.F.X. during a site visit to Antigonish in December 8-15, 1990. Comments from the nursing program staff at St.F.X. were also solicited. Reviewers from Concordia University were also used for this purpose. Comments from all the reviewers were elicited on a one-on-one as well as dyad formats.

<center>*Procedures*</center>

Assignment of Subjects to Treatments

Random assignment. A random assignment procedure, although desirable, was inappropriate in this study. Random assignment refers to a process of distributing subjects to treatments which guarantees that each member of the sample has an equally likely chance of being included in any given treatment. A random assignment procedure could not be used in this study to assign subjects to different treatment conditions for two reasons in particular. Even though the subjects in this study were distance learners, they worked together and often studied in small groups. With random assignment, subjects would have had an equal chance of being assigned to different treatments and as such, would have been

exposed to different instructional activities. In that event the design would have been confounded from the effects of subjects sharing their learning experiences with one another.

A second reason why a random assignment procedure could not be used in this study was because distribution of study materials would have become extremely difficult. Study materials in this program are distributed to students through their local educational consultants. Materials are delivered to the consultants via the courier services. Sending Study Guides with different instructional activities in them for different students and ensuring that the correct materials were received by each student would have been extremely complex to manage by mail. It would have required much greater involvement on the part of educational consultants who were, as it was, participating in the study only out of goodwill. The costs of this route would have been a deterrent, especially since they were being subsumed by the normal mailing budget of the program. During the study, consultants would have had to deal with keeping track of different forms of exercises from different students in their groups and also different forms of feedback. This would have increased the workload of the consultants in many ways and undermined their goodwill somewhat. That goodwill was better not jeopardized.

In any case, the instructional activities for subjects in the different treatment conditions were optional and no one had to do them if they did not wish to. After receiving

their course materials subjects were free to either do the lesson exercises suggested, and by doing so participating in the study, or opt out and not do any of the suggested lesson exercises with impunity.

Alternative procedure. A cluster assignment procedure was adopted instead, to assign groups of subjects living in proximity, to the different treatment conditions. The procedure was as follows. Foremost, the geographical dispersion of students across the two provinces of Nova Scotia and Prince Edward Island was examined. The objective was to identify four large clusters of students without overlapping boundaries which could be assigned to the four different treatment conditions in the study. This would ensure that subjects were not influenced by instructional activities other than those that were incorporated within their Study Guides.

Four clusters of subjects according to geographical dispersion were finally determined. All the students from Prince Edward Island in the north west of Nova Scotia were assigned to the control condition. There were 20 of them in this group – the smallest number among the four groups. All 20 stayed in the course until the end. A second cluster of students was located around the cities of Halifax and Yarmouth in the southern tip of Nova Scotia. Subjects in this area were assigned to the group receiving consultant-assessed tests. There were 38 students in this group. A third cluster was found in the central region of Nova Scotia around the

cities of Antigonish, New Glasgow and Truro. Students in this area were assigned to the combined condition in which they were given a balance of consultant-assessed tests and concept mapping exercises. There were 33 students in this group. The fourth cluster, the largest of all was found in the Cape Breton area in the north east of Nova Scotia. There were 50 in this group and they were assigned the concept mapping condition.

As expected, group sizes could not be kept equal. There were several advantages in adopting this procedure. Nova Scotia is not a very densely populated region. Its population is concentrated in and around the urban centers and nurses mostly work and live in central locations, usually in urban centers where the medical facilities are located. Both these factors helped in the identification of clusters of subjects.

Consent from consultants. On May 14, 1990 all the educational consultants were sent a letter which sought their participation in this study. This letter explained the nature and purpose of the study, its implications on them and also on the students under their tutelage. They were given the option of not participating if they did not want to. Those consultants who did not wish to participate in the study, or had questions regarding it, were asked to contact the course professor on the toll-free phone line by May 31. They were told that if they had not called by that date, it would be assumed that they had agreed to participate in the study. By May 31 none of the consultants had called in to decline

participation. As soon as this information was in hand, the four treatment conditions were confirmed.

Experimental Procedure

Preparation of course package. The core course components included prescribed textbooks and the Study Guide. The experimental materials included the concept mapping workbook, consultants' guide on concept mapping, answers to the mapping exercises, consultants' guide on consultant-assessed tests and answers to the consultant-assessed tests. Experimental materials were collated separately and placed inside the cover of the Study Guide folder. Care had to be taken in preparing the Study Guides with the appropriate instructional activities included for subjects in the different treatment conditions.

The experimental instructional activities at the end of the lessons were printed on separate sheets, and for easy identification the self-assessed tests were printed on white paper, the consultant-assessed tests on pink paper, and the concept mapping exercises on yellow paper. In preparing the Study Guides for different treatment conditions, appropriate exercises were retained at the end of lessons in which the exercises were varied. For instance, for lesson 2 in module 1, lesson exercises were varied. Subjects in the control condition were to do a self-assessed test, so the pink and the yellow sheets were removed for that lesson from their Study Guides. Subjects in the mapping condition were to do a

mapping exercise, so the white and the pink sheets were removed from their Study Guides. Subjects in the third condition were to do a consultant-assessed test, so the white and the yellow sheets were removed from their Study Guides. Similarly, depending on the activity subjects in the fourth condition were to complete for that lesson, the two alternative versions of lesson activity for that lesson were removed. For a distribution of the instructional activities for this group as well as for the others, review Figure 2.

Mailing of materials. Following this exercise, course packages with appropriate experimental materials were prepared for subjects in the different treatment conditions. The materials were delivered to the educational consultants by courier service. A covering letter explained that the answers to the mapping exercises and consultant-assessed tests were to be retained by them and given out to students as feedback only after they had completed the lesson activities. The consultants' guides explained the procedures students were to follow in the study. These are described in the following section.

Self-assessed tests. Subjects were to do these tests and verify their answers with the course materials by themselves. They were not required to submit their answers to their local consultants or their instructor and therefore, no feedback was provided on their answers. The self-assessed tests were a standard feature of all the lessons for subjects in the control condition.

Consultant-assessed tests. These tests appeared at the
end of selected lessons in the student's Study Guides for two
of the four treatment conditions in this study. These were
open-book tests and students took them in their own time.
Answers to consultant-assessed tests were to be sent in to
the educational consultant. Subjects who sent in their
answers were entitled to receive feedback and the procedures
for doing so were as follows:

- When subjects sent in their answers to the
consultants, the date on which the test answers were
received was recorded on sheets provided at the end of
the consultants' guide booklet.
- Consultants assessed student answers as soon as they
were received with the help of the answers they had been
sent. They were not required to give subjects a mark or
grade for their answers on these tests. However, they
could give them generalized feedback and indicate their
correct and incorrect responses.
- Consultants returned the answer sheets to the students
along with a copy of the appropriate set of answers they
had been sent. They were to note their own mailing date
on the record sheets at the end of their guide booklet.
- Subjects moved on to the study of the next lesson or
module without waiting to receive feedback on completed
tests.
- Consultants were to make a photocopy of the student
answer sheets before returning them to the students and

send these in to the instructor as the students completed each test.

• Consultants were urged to keep complete records on individual student progress with the tests on the forms provided for this purpose. They were to send in these forms to the course professor at midterm and at the end of the course.

Concept mapping exercises. For 2 of the 4 treatments, subjects in this study were given concept mapping exercises. These exercises were specified at the end of selected lessons in their Study Guides. Subjects were to do the exercises and send in their concept maps to their local consultant. Those who sent in their maps were entitled to receive feedback. The procedures for doing so were as follows:

• When subjects sent in their concept mapping exercises, the consultants noted the date on which the exercises were received on the sheets provided at the end of their guide booklet.

• Consultants evaluated the submitted maps, according to guidelines provided in their guide booklet. They were not required to give students a mark or grade on their mapping exercises. They were to give them only generalized feedback on the adequacies, strengths, weaknesses and completeness of their maps.

• Consultants returned subjects their mapping exercises along with a copy of the map they were sent as feedback for that exercise.

• They noted their own mailing date on the record sheets at the end of their guide booklet.

• Meanwhile, subjects moved on to the study of the next lesson or module without waiting for feedback on their completed mapping exercises.

• Consultants were urged to make a photocopy of all student developed maps with their comments on them and to send these in to the professor regularly.

• Consultants were urged to maintain complete records of individual student progress with the mapping exercises on the forms provided at the end of their guide booklet and send these in to the course professor at midterm and at the end of the course.

Data Collection

Cognitive measures. The two cognitive measures, midterm and final examinations, were administered as examinations are normally given in the program. On both occasions the examinations were held at the local resource centers, and were invigilated by the educational consultants.

The two measures covered different sections of the course content and both comprised multiple-choice and essay type questions. The midterm examination incorporated 60 multiple-choice and 6 essay type questions. The final examination included a 100 multiple-choice and 10 essay type questions. Multiple-choice items which required the selection

of the best response were answered on computer cards, and so were marked electronically and then verified manually by me.

The essay type questions on the other hand, elicited a more comprehensive response, and responses to these were graded on the basis of specific scoring rules. The scoring of subject's responses (recall protocols), were done by comparing each of them with a list of pre-established "idea units". An idea unit in this instance was defined as a single complete idea or piece of information that was regarded as a relevant and correct response to the question that was asked (Dean & Kulhavy, 1981, p. 58). Scoring recall protocols on the basis of whether or not the substance of an idea was present, rather than requiring verbatim recall was considered an appropriate method of scoring to use in this context. The procedure has been previously applied to the study of prose (Cofer, 1941; Meyer, 1975).

Procedure for establishing list of idea units. This was as follows:

- A list of correct idea units for each of the essay type questions in the two examinations was established from the course content.

- Key and related idea units for each of the questions on the lists were identified.

- Key idea unit in this instance referred to a single correct, content specific word, phrase, clause or sentence.

• Related idea unit in this instance referred to any correct and meaningful elaboration or explanation of a key idea unit.

Procedure for scoring idea units. This was as follows:

• All recall protocols were scored by two scorers (myself and a research assistant). Each of us scored a half of all the cases from the four treatment conditions. Both of us were familiar with the subject matter in order to be able to correctly identify relevant idea units.

• Each correct idea unit (whether key or related) was worth one point. Errors in spelling and grammar were disregarded.

• No points were awarded for incorrect responses or repetition of idea units in any form (i.e., verbatim of paraphrased).

• Each recall protocol was scored by marking each key idea unit identified, with a number (1, 2, 3, etc.), and each related idea unit with a letter (a, b, c, etc.).

• The total number of key and related idea units for each recall protocol was recorded separately. A subject's score on each recall protocol was the total number of correctly identified key and related idea units for that question. The sum of these for all the essay type questions comprised a subject's total score on the examination for essay type questions.

Inter-rater reliability. Scoring of all the recall protocols were equally shared between the two scorers. There were a 140 cases in each of the two examinations. Twenty-eight cases were randomly selected from all cases scored by the research assistant for each of the two examinations and rescored by this researcher. The twenty-eight cases comprised 7 cases from each of the four treatment conditions.

For the midterm examination, on the two sets of scores in this sample, the inter-rater reliability estimate for all treatments was .997. For the final examination the inter-rater reliability estimate for all treatments was .999.

Questionnaire. The post-experimental questionnaire (incorporating the attitude measure), was mailed out to subjects directly to their work addresses, two weeks before the end of the course. These were mailed out from Antigonish post office, during a site visit to St.F.X. in January 1991. A covering letter explained the purpose of the questionnaire and urged subjects to complete it and return it directly to the DE nursing program office at St.F.X. A postage-paid return addressed envelope was enclosed for their use.

The support of the educational consultants in reminding students to complete the questionnaires was sought. All returned questionnaires were received by the nursing distance education program secretary who kep. a record of the dates on which each questionnaire was received. Of 138 questionnaires that were mailed out, 124 completed and usable questionnaires were returned. This amounted to a 90% return rate.

Data Analysis

The design in this study was tested using multivariate analysis of covariance (MANCOVA) on the cognitive measures. Stepdown analysis and univariate procedures were carried out to investigate sources of significant differences from the original MANCOVA. Factor Analysis was used with attitudinal data from the questionnaire to identify like groups of items. The factor scores that were generated from the principal components analysis were used as multiple DVs in the MANOVA design. The rest of the questionnaire data was analyzed using means tables and ANOVAs.

CHAPTER FOUR

Results

In this chapter results of the analyses of data collected in this study are presented. Results of the analysis of achievement data are presented first. This is followed by results of attitudinal data and the rest of the questionnaire data. In each case the source of data and plan of analysis are described. Statistical procedures employed are then discussed and outcomes of the various analyses are reported. All procedures were carried out with Version 4.0 of the Statistical Package for the Social Sciences (SPSS).

Achievement Data

Source of Data

The data that are analyzed in this section were derived from the midterm and final examinations in the course within which this study was carried out. The midterm exam was taken by subjects after ten weeks of study in the course and the final examination was held at the end of the course. Both the examinations were closed-book and subjects took them at their local study center under the supervision of their educational consultant. The examinations comprised multiple choice and essay type questions.

Variables in the Design

The independent variables in this study were levels of instructional strategy. Subjects were exposed to either one of four treatment conditions in the course within which the study was carried out. These were: (a) post-questioning only without feedback; (b) concept mapping only with feedback; (c) post-questioning only with feedback; and (d) concept mapping and post-questioning with feedback. Feedback was provided only after subjects had done the instructional activities themselves first, and had submitted their responses to their educational consultants. In each case the instructional activities were optional, and not graded.

The covariate was the mean score (percentage correct) constructed from the final examination marks of four courses which subjects had taken prior to this study. All of these courses were taken by subjects in the year preceding the course within which this study was carried out. As an aid to interpretation, raw scores for all variables, including that of the covariate, were transformed into z scores. This was done prior to calculating group means. While the grand mean for each variable was 0 with a standard deviation of 1.0, the individual treatment group means were in standardized units above and below 0.

The dependent variables in the design were derived from the performance of subjects in the midterm and final exams in the course within which this study was carried out. Both the exams comprised multiple-choice and essay type questions. The

essay type questions included items either cued to content with concept mapping exercises or without mapping exercises. Furthermore, scores on all essay type questions were separated by key and related idea units. Therefore, for each of the two exams, midterm and final, there were five separate dependent variables entered into the analyses yielding ten variables in the design. The chronological ordering of the variables in the analysis also allowed for an assessment of the treatments over time without having to compare midterm and final examination measures directly.

The Fifth Treatment Group

Rationale and procedure. In one of the four treatment conditions in this study, subjects were asked to do concept mapping exercises. As indicated, these mapping exercises were optional and not graded, although feedback was provided on them if subjects completed the exercises and submitted the responses to their educational consultant. At the end of the study, out of the fifty subjects who had been exposed to the concept mapping only with feedback condition, about half had completed most of the suggested mapping exercises, while the others had completed considerably fewer number of exercises. According to reports in the literature on the applications of concept mapping, this was not surprising. Table 5 presents a frequency distribution of number of mapping exercises done by each of the fifty subjects in this treatment condition, and their separation into low and high persistence mappers.

Table 5

Frequency Distribution of Exercises Completed by Subjects in the Mapping Only Group

Number of exercises completed	Frequency	Percentage
Low persistence mappers[a]		
1	2	7
2	6	21
3	10	36
4	1	4
5	3	11
6	6	21
7	0	0
High persistence mappers[b]		
8	4	18
9	0	0
10	0	0
11	5	23
12	13	59

[a]$N = 28$

[b]$N = 22$

Instead of eliminating those who did not do the mapping exercises (i.e., "low persistence" mappers) from subsequent analyses, for not fully participating in the treatment, and thereby losing a potential source of data, they were retained as a separate (fifth) group in the analyses. Eight mapping exercises were determined as the appropriate cut-off point for this separation between low and high persistence mappers. Those who would have completed eight mapping exercises would have very likely done all six offered before the midterm exam and at least two of the six exercises offered after midterm. This would permit legitimate inferences to be made on the implications of mapping for these subjects in the final exam. In addition, there appeared to be a watershed in the number of mapping exercises that were completed around eight. Most of the low persistence mappers evidently stopped doing the mapping exercises after the midterm exam. This division of mappers resulted in 22 "high persistence" concept mappers and 28 "low persistence" mappers. The average number of concept maps completed by the high persistence mappers was 11 out of 12 exercises and for the low mappers it was 3.

Limitations. The classification of subjects based upon a characteristic of the experimental design is potentially problematic from an inferential point of view. In a design already lacking in random assignment of subjects to the treatment conditions, the decision to subdivide a condition, further reduces the ability of the researcher to establish causal inferences concerning the effects in question.

However, to ignore half of a treatment group, or even worse, not discriminate between low and high mappers in the concept mapping only condition, runs the greater risk of failing to establish important distinctions that could guide further research using more refined experimental procedures. Since there was no apparent reason for discarding a large number of subjects with low persistence characteristics, the analyses of data proceeded with the inclusion of a "fifth" group in the overall design.

Statistical Procedures Used

Both multivariate as well as univariate procedures were employed in the analyses of data that were collected in this research. The multivariate procedures — Multivariate Analysis of Covariance (henceforth — MANCOVA), and univariate procedures — Analysis of Covariance (henceforth — ANCOVA) are parallel procedures but differ in their uses. MANCOVA is a test of mean differences among groups on a combination of dependent variables (DVs), whereas ANCOVA is a test of mean differences on a single dependent variable.

Bray and Maxwell (1982) have discussed several benefits of using the MANCOVA procedure in the analysis of data with multiple DVs. For instance, a researcher may be interested in the effects of treatments on several DVs individually, or in the relationships among them, or both. The MANCOVA procedure is also appropriate if a researcher wishes to reduce several DVs to a smaller set of dimensions, or is interested in the

set of measures as they represent some underlying constructs or dimensions. The current study investigated the effects of experimenter controlled treatment variables on several (ten) dependent measures. The interest was in both the individual effects of different treatment conditions on the DVs and the relationships among the DVs.

Assumptions of MANCOVA

Research designs that employ the MANCOVA procedure in the analyses of data make several assumptions about the data set. Some of these, of relevance to the current study, are discussed in the following sections.

Unequal sample size. While cell sample size in the data set should be equal, Harris (1975) states that in no event should the ratio of the largest to smallest cell sample size be greater than 4:1. In this design, cell sizes for the five treatment conditions were as follows: Control Condition — 22; Low Persistence Concept Mapping — 28; High Persistence Concept Mapping — 22; Post-Questioning — 36; and Combined Condition — 32. When cell sample sizes are unequal, the sum of squares for effect plus error no longer equals the total sum of squares (i.e., the design is non-orthogonal). Overall and Spiegal (1969) suggest a number of ways for adjusting such overlap in sum of squares due to unequal cell size. The method that is most appropriate for experimental research such as this is the regression approach to MANCOVA.

Tabachnick and Fidell (1989) consider this approach to be the most conservative approach for adjusting unequal cell sizes.

Missing data. The achievement data in this study came from the midterm and final examinations. No data were missing from either of the two examination scores. The covariate in this data set was an average of final examination scores from four nursing related courses which the subjects had completed in their program prior to the current study. However, there were two cases in which subjects from the control condition were missing their covariate scores. They were allocated the group mean — a procedure that is recommended by Tabachnick and Fidell.

Outliers. The presence of outliers in a data set can lead to interpretations that may result in a Type I or Type II error. One of the ways in which Tabachnick and Fidell suggest that outliers may be detected in a data set is by inspecting standardized scores wherein cases with ± 3.00 standard deviations from the mean are regarded as potential outliers. With a large N however, they say a few cases in excess of ± 3.0 standard deviations are acceptable. All the scores in this study were transformed into standardized z scores for all analyses because of differences in parameters across the different variables. No outliers were found that required transformation or elimination from the data set.

Homogeneity of regression. The assumption of homogeneity of regression implies that slopes of regression lines (coefficients) of the DVs on the covariate(s) are the

same for all cells in the design. Violation of this
assumption means that there is an interaction between the
independent variables (IVs) and the covariate(s). Such an
interaction, if present, would mean that the relationship
between the covariate and the DVs is different at the various
levels of the IV(s), requiring a differential adjustment for
various cells in the design. Homogeneity of regression was
tested across all DVs in the design and no violation was
observed in this data set.

Approach to Analysis

A Multivariate Analysis of Covariance was performed on
the ten measures of cognitive performance from the midterm
and final examinations across the five treatment conditions
with levels of instructional strategy as the independent
variables. Prior academic performance averaged across four
nursing related courses was used as a covariate to adjust for
unexplained variability due to the academic background of
subjects. The overall MANCOVA was followed up with univariate
tests and a stepdown procedure on the complete set of ten DVs
in the analyses. The Roy-Bargmann stepdown analysis is a
multivariate procedure in which the *F*-Ratio is adjusted by
the previously entered variable. Group differences were
investigated across each of the variates in the design that
reached significance levels in the univariate analyses.

A direct comparison of subjects' performance on the
midterm and final exams was not carried out because the two

examinations covered different parts of the course content. Moreover, while both examinations comprised multiple-choice and essay type questions, the number of questions in each case differed in the two exams. The midterm examination comprised sixty multiple-choice and six essay type questions, while the final examination comprised a hundred multiple-choice and ten essay type questions. The number of essay questions that were cued to course content on which mapping exercises had, and also content on which mapping exercises had not been set, also varied in the two examinations. In the midterm exam three of the six essay type questions were cued to content on which concept mapping exercises had been set. In the final exam, six of the ten essay questions were cued to content on which mapping exercises had been set.

Descriptive Statistics

The means and standard deviations for the ten dependent variables by treatment groups are presented in Tables 6 and 7. All means and standard deviations in Table 6 are reported in z scores. The raw score means and standard deviations are presented in Table 7. Variation within all dependent measures is fairly consistent across the treatment groups, with two exceptions — related idea units for questions in the final exam cued to content with and without concept mapping. This discrepancy was not judged as a particularly serious problem. Possible reasons for this variability will be discussed in the final chapter in this document.

Table 6

Standardized Means and Standard Deviations on Achievement Data

	Treatment levels				
DVs	Control	Low CM	High CM	Post Quest	Combined
MT Multi-Choice					
Mean	.02	.14	-.61	.05	.23
SD	1.02	.93	1.01	1.03	.89
Idea Units (Key-Map)					
Mean	.13	-.06	.14	-.23	.13
SD	.94	.88	1.10	.86	1.19
Idea Units (Rel-Map)					
Mean	.06	-.04	.03	-.29	.30
SD	1.01	.92	1.05	.85	1.14
Idea Units (Key-Nmap)					
Mean	-.06	.12	.50	-.12	-.27
SD	.89	1.09	.80	1.02	1.01
Idea Units (Rel-Nmap)					
Mean	-.27	.17	.40	-.13	-.09
SD	.88	.94	.99	.87	1.21

Note. Cell Sizes: Control=22; Low Concept Mapping=28; High Concept Mapping=22; Post-Questioning=36; Combined=32.

Table 6 Continued

Standardized Means and Standard Deviations on Achievement

Data

DVs	Control	Low CM	High CM	Post Quest	Combined
FN Multi-Choice					
Mean	.20	-.08	-.38	-.01	.21
SD	.99	1.02	.10	1.11	.83
Idea Units (Key-Map)					
Mean	-.66	.16	.61	-.07	-.04
SD	.62	1.22	1.15	.82	.81
Idea Units (Rel-Map)					
Mean	-.24	.12	.62	-.17	-.18
SD	.27	1.18	1.62	.69	.73
Idea Units (Key-Nmap)					
Mean	-.18	.37	.58	-.26	-.31
SD	.85	1.08	1.15	.85	.83
Idea Units (Rel-Nmap)					
Mean	-.02	.35	.63	-.25	-.44
SD	.83	1.03	1.41	.64	.78

The top of the table is headed **Treatment levels**.

Note. Cell Sizes: Control=22; Low Concept Mapping=28; High Concept Mapping=22; Post-Questioning=36; Combined=32.

Table 7

Raw Score Means and Standard Deviations on Achievement Data

DVs	Control	Low CM	High CM	Post Quest	Combined
MT Multi-Choice					
Mean	39.77	40.25	37.41	39.89	40.56
SD	3.87	3.51	3.80	3.90	3.38
Idea Units (Key-Map)					
Mean	15.68	14.75	15.73	13.86	15.72
SD	4.93	4.44	5.58	4.38	6.01
Idea Units (Rel-Map)					
Mean	12.86	12.25	12.68	10.53	14.50
SD	6.87	6.20	7.08	5.75	7.72
Idea Units (Key-Nmap)					
Mean	12.00	12.64	13.95	11.77	11.28
SD	3.13	3.81	2.82	3.59	3.54
Idea Units (Rel-Nmap)					
Mean	8.68	11.64	13.27	9.64	9.88
SD	5.99	6.41	6.73	5.94	8.28

Note. Cell Sizes: Control=22; Low Concept Mapping=28; High Concept Mapping=22; Post-Questioning=36; Combined=32.

Table 7 Continued

Raw Score Means and Standard Deviations on Achievement Data

DVs	Control	Low CM	High CM	Post Quest	Combined
FN Multi-Choice					
Mean	70.36	68.79	67.09	69.16	70.38
SD	5.53	5.69	5.56	6.19	4.62
Idea Units (Key-Map)					
Mean	5.59	10.61	13.36	9.22	9.41
SD	3.81	7.47	7.05	5.04	4.96
Idea Units (Rel-Map)					
Mean	9.77	14.07	20.14	10.72	10.56
SD	3.21	14.17	19.42	8.26	8.75
Idea Units (Key-Nmap)					
Mean	7.05	8.89	9.59	6.75	6.59
SD	2.87	3.65	3.87	2.88	2.82
Idea Units (Rel-Nmap)					
Mean	6.68	8.79	10.41	5.42	4.31
SD	4.70	5.81	7.98	3.62	4.43

Note. Cell Sizes: Control=22; Low Concept Mapping=28; High Concept Mapping=22; Post-Questioning=36; Combined=32.

Analysis of the Covariate

The initial MANCOVA examined the question: Is the covariate a significant predictor of performance on the DVs? This test demonstrated that the covariate was significantly related to the DVs. Hotellings trace was F (10,125) = 6.60, p <.001. A multivariate effect size of .35 revealed a fairly strong association between the covariate and the DVs.

An Analysis of Variance on group means for the covariate found no significant differences across the treatment groups F (4,135) = .89, p = .47, thereby establishing treatment group equivalence, prior to the experiment. Treatment group means and standard deviations for the covariate are reported in Table 8.

Table 8

Standardized Means and Standard Deviations for the Covariate

	Treatment levels				
Prior Achievement	Control	Low CM	High CM	Post Quest	Combined
Mean	.20	.20	-.03	-.20	.07
SD	.75	1.05	1.16	1.06	.90

Note. Cell Sizes: Control=22; Low Concept Mapping=28; High Concept Mapping=22; Post-Questioning=36; Combined=32.

In order to investigate more specifically the power of the covariate, for adjusting differences in the set of DVs, univariate F tests were requested for each of the DVs in turn. Complete results of this analysis are reported in Table 9. All dependent variables retained their significance levels indicating that the covariate was uniform in providing adjustment for each one of the DVs.

Analysis of Group Differences

Following adjustment by the covariate, the complete set of DVs in the design was tested for multivariate treatment effects across the five conditions. The omnibus MANCOVA produced a significant main effect for the IV on the set of DVs, Hotellings F (40, 494) = 2.13, p <.001. The multivariate effect size for Hotellings trace was .15. Canonical correlation for the first root was .55 with an eigenvalue of .43 representing 62 percent of the total variance in this effect. Canonical correlation for the second root was .38 with an eigenvalue of .16 representing almost 24 percent of the total variance. The remaining 14 percent of the total variance was explained by the last two roots.

A dimension reduction analysis produced one significant vector, only the first, F (40, 475.84) = 2.05, p <.001. This analysis suggested that the set of DVs in the design is multivariate (i.e., they are correlated). One approach to investigating this type of an outcome is to perform pairwise analysis using, either discriminant functions analysis (where

Table 9

Univariate F-Tests With (1,134) DF for the Covariate

DVs	R^2	R	R^2(Adj)	Mean Squares Hyp.	Error	F	P
MT-MC	.11	.33	.10	14.31	.85	16.80	< .01
IUKM	.05	.22	.04	6.31	.97	6.52	< .01
IURM	.06	.25	.06	8.24	.93	8.86	< .01
IUKN	.15	.39	.14	19.52	.83	23.63	< .01
IURN	.13	.35	.12	16.60	.86	19.23	< .01
FN-MC	.10	.32	.10	13.63	.89	15.25	< .01
IUKM	.09	.30	.08	11.04	.82	13.53	< .01
IURM	.04	.21	.04	5.70	.90	6.30	< .01
IUKN	.16	.40	.15	19.15	.76	25.12	< .01
IURN	.07	.27	.07	8.51	.82	10.41	< .01

Key. MT-MC=**Midterm** multiple-choice; IUKM=Key idea units (mapping); IURM=Related idea units (mapping);IUKN=Key idea units (non-mapping); IURN=Related idea units (non-mapping); FN-MC=**Final** multiple-choice; IUKM=Key idea units (mapping); IURM=Related idea units (mapping); IUKN=Key idea units (non-mapping); IURN=Related idea units (non-mapping).

the multivariate set of DVs is entered into the discriminant equation as a block using each pair as the discriminating member), or to use Hotellings T^2 in an essentially similar manner. In this study it was desirable to examine the DVs separately since their administration sequence and individual meaning was of concern to the overall purpose of the design. Therefore, two approaches were pursued simultaneously, one which took into account the inter-correlations among the DVs in a stepdown procedure and one which assessed the DVs as if they were independent entities. Issues surrounding each approach and their different outcomes are presented in the following section.

Related issues. Tabachnick and Fidell point out two problems with reporting univariate *Fs* when the DVs are correlated. First, the correlated dependent variables measure overlapping aspects of the same behavior. Saying that several DVs in a correlated set are significant, erroneously suggests that the IVs affect two different behaviors separately. The second problem with reporting univariate *Fs* for correlated DVs is the inflation of Type I error rate. With correlated DVs, the univariate *Fs* are not independent, and therefore, no straight-forward adjustment of the error rate is possible.

The problem with reporting univariate *F* tests on correlated DVs is resolved by stepdown analysis (Bock, 1966; Bock & Haggard, 1968). The Roy-Bargmann stepdown procedure is analogous to testing the importance of IVs by hierarchical analysis in multiple regression or discriminant functions

analysis procedures. Dependent variables in stepdown analysis are ordered on the basis of some theoretical or practical consideration, or on the basis of some statistical criteria, such as the results of the univariate F tests. The DV with the highest priority in the design is tested in an ANOVA model. The rest of the DVs are tested in a series of ANCOVAs, where each successive DV is tested with higher-priority DVs as covariates to see what it adds to the combination of DVs already tested. Roy and Bargmann (1958) demonstrated that while each of the successive F tests (ANCOVAs) are statistically independent under the null hypothesis, the successive steps are not equivalent. The second step is the effect on the second criterion, with the effects of the first criterion covaried out. The third step has the effects of the first two variates removed, etc.

The choice between the use of univariate or stepdown analysis is not always simple and often one may want to use both. When there is very little correlation among the DVs, univariate analysis, with adjustment for Type I error is acceptable. However, when the dependent variables are correlated, the stepdown procedure is preferable on the grounds of "statistical purity", provided the DVs are prioritized in some meaningful way (Tabachnick & Fidell, 1989, p. 402). When the dependent variables are correlated and there is some sort of order in the set, stepdown analysis should be used, with univariate Fs and pooled within-cell correlations reported alongside. Furthermore, adjustment for

inflated Type I error due to multiple testing should be provided in the stepdown analysis.

Follow-Up Analyses

Since the omnibus MANCOVA produced a significant main effect, it was desirable to further examine the nature of the relationships between the independent variable (IVs) and the DVs. A three-step procedure was adopted in the follow-up analyses which included (a) univariate *F* tests on all the DVs, (b) stepdown analysis, and (c) univariate contrasts.

Univariate analyses. Table 10 presents the complete results of the univariate *F* tests on the ten dependent variables in the design. Six of the ten DVs in the set were significant with α set at the .05 level. The pooled within-cell correlations among the set of DVs are reported alongside in Table 11.

From the midterm exam, significant differences across the treatment groups were observed for performances on multiple-choice test items and recall of key idea units in essay type questions that were cued to course content on which concept mapping exercises were not set. Group mean differences are reported with the results of the *Post hoc* analysis, later in this chapter. According to the direction of the means (see Table 6), on multiple-choice test items, subjects in group 3 (high persistence mappers) performed poorly against all the other treatment groups. On the recall of key idea units in essay type questions on non-mapping

Table 10

Univariate F-Tests With (4,134) DF for Each DV

DVs	Hyp.	Error	F	P
	Mean Squares			
Midterm multi-choice	2.47	.85	2.90	.024*
Key idea units (mapping)	.65	.97	.67	.613
Related idea units (mapping)	1.20	.93	1.28	.280
Key idea units (non-mapping)	2.23	.83	2.70	.034*
Related idea units (non-mapping)	1.77	.86	2.05	.091
Final multi-choice	1.31	.89	1.46	.217
Key idea units (mapping)	5.01	.82	6.14	.001*
Related idea units (mapping)	3.06	.90	3.38	.011*
Key idea units (non-mapping)	4.06	.76	5.33	.001*
Related idea units (non-mapping)	4.95	.82	6.05	.001*

* Significance levels reached at α = .05.

Table 11

Pooled Within-Cell Correlations Among the DVs

	ZDV1	ZIUKM	ZIURM	ZIUKN	ZIURN	ZDV2	ZIUKM	ZIURM	ZIUKN	ZIURN
	Within Cells Correlations With SDs on the Diagonal									
ZDV1	.92									
ZIUKM	.03	.98								
ZIURM	.08	.55	.96							
ZIUKN	.00	.25	.25	.91						
ZIURN	.02	.28	.28	.39	.93					
ZDV2	.30	-.03	-.08	.09	-.06	.95				
ZIUKM	-.08	.17	.20	.27	.33	.01	.90			
ZIURM	.10	.08	.22	.20	.30	.02	.58	.95		
ZIUKN	.10	.08	.14	.15	.21	.02	.52	.42	.87	
ZIURN	.07	.07	.17	.30	.27	.05	.34	.64	.30	.90

Key. ZDV1=**Midterm** multiple-choice; IUKM=Key idea units (mapping); IURM=Related idea units (mapping); IUKN=Key idea units (non- mapping); IURN=Related idea units (non-mapping); ZDV2=**Final** multiple-choice; IUKM=Key idea units (mapping); IURM=Related idea units (Mapping); IUKN=Key idea units (non-mapping); IURN=Related idea units (non-mapping).

content, the performance of the high persistence mappers (subjects in Group 3) was however, better. According to the direction of the means, the weakest results on the latter DV were from the control, post-questioning with feedback and the combined conditions. Possible reasons for these outcomes are discussed in the next chapter.

On the final examination, significant differences across treatment groups were observed in performance on the recall of key and related idea units on essay questions that were cued to content on which mapping exercises had been set, as well as questions cued to content on which mapping exercises were not set. The direction of the means show that the performance of the persistence mappers (Group 3) was much improved and higher than all the other groups on each of these four DVs. Likely reasons for this outcome, and its consistency in favor of the high persistence mappers, against all the other treatment groups is discused in the next chapter.

Stepdown analysis. To investigate the impact of each main effect from the univariate analysis on the individual DVs, stepdown analysis was performed on the complete set of DVs. Results of this analysis are presented in Table 12. Pooled within-cell correlations among the DVs are reported in Table 11. In the stepdown analysis, each DV was analyzed in turn, with higher-order DVs treated as covariates, and with the highest-ordered DV tested in a univariate ANOVA. The DVs in the analysis were ordered according to the sequence of

Table 12

Roy-Bargmann Stepdown F-Tests

DVs	Mean Squares			DF		
	Hyp.	Error	Stepdown F	Hyp	Error	P
MT-MC	2.47	.85	2.90	4	134	.024*
IUKM	.68	.97	.70	4	133	.595
IURM	.53	.65	.80	4	132	.526
IUKN	2.20	.78	2.82	4	131	.028*
IURN	.84	.71	1.18	4	130	.324
FN-MC	.75	.81	.93	4	129	.449
IUKM	**2.88**	**.73**	**3.97**	**4**	**128**	**.005**★★
IURM	1.01	.59	1.70	4	127	.153
IUKN	1.67	.56	2.98	4	126	.022*
IURN	1.08	.49	2.22	4	125	.071

* α = .05

★★ Significance level reached with both α = .05, and with redistributed α (.05/10 DVs) = .005.

Key. MT-MC=**Midterm** multiple choice; IUKM=Key idea units (mapping); IURM=Related idea units (mapping);IUKN=Key idea units (non-mapping); IURN=Related idea units (non-mapping); FN-MC=**Final** multiple choice; IUKM=Key idea units (mapping); IURM=Related idea units (mapping); IUKN=Key idea units (non-mapping); IURN=Related idea units (non-mapping).

their presentation in the study, that is, variables which subjects were exposed to first in the study, were entered before the others, in the following manner.

The midterm examination scores were analyzed first, with scores on the multiple-choice type questions followed by scores on the essay type questions. Scores on the essay type questions which were focussed on course content with concept mapping exercises were analyzed before scores on questions which were focussed on content without concept mapping exercises. Furthermore, scores on essay type questions were separated by key and related idea units. Scores for key idea units were examined before those for the related idea units.

Protection against inflated Type I error, due to multiple testing, was provided through the redistribution of α among the ten dependent variables in the complete set.

Bray and Maxwell (1982) suggested that the appropriate technique for interpreting the stepdown analysis is to begin with all the variates in the model. The last variate entered in the model is tested with the effects of all the foregoing variates covaried out. If this test is not significant, the next higher level variate is examined in the same backward selection manner until a significant F is encountered and the null hypothesis of group differences is rejected. As shown in Table 12, only one DV in the set reached significance (at $\alpha = .005$) level in the stepdown analysis. This was key idea units in essay questions in the final examination that were cued to content in which concept mapping exercises were set.

The results of the univariate and stepdown analyses are summarized in Table 13. The univariate analysis represents the most liberal interpretation of the effects of the IVs, while the stepdown analysis with α set at .005 is the most conservative interpretation. Four of the six DVs in the design that produced significant univariate *Fs* remained significant in the stepdown analysis when α was kept at the .05 level. However, when this α was redistributed among the ten DVs in the design to adjust for familywise error, only one of the four significant results in the stepdown analysis remained significant.

Performance on multiple-choice items in the midterm examination was significantly different across the treatment groups on both univariate and the stepdown analyses when α was retained at .05, univariate and stepdown *Fs* (4,134) = 2.90, *p* = .024. On both sets of analyses, significant group differences were also observed on the recall of key idea units in essay type questions in the midterm examination that were cued to content on which concept mapping exercises were not set, stepdown *F* (4,131) = 2.82, *p* = .028; and univariate *F* (4,134) = 2.70, *p* = .034. Two other DVs which produced significant group differences in both sets of analyses were key idea units in essay questions in the final examination that were cued to content with mapping exercises and key idea units in questions that were cued to content without mapping.

Table 13

Summary of Univariate and Stepdown F-Tests

DVs	Univariate			Stepdown		
	F	P	df	F	P	df
MT-MC	2.90	.024*	4/134	2.90	.024*	4/134
IUKM	.67	.613	4/134	.70	.595	4/133
IURM	1.28	.280	4/134	.80	.526	4/132
IUKN	2.70	.034*	4/134	2.82	.028*	4/131
IURN	2.05	.091	4/134	1.18	.324	4/130
FN-MC	1.46	.217	4/134	.93	.449	4/129
IUKM	**6.14**	**.000***	**4/134**	**3.97**	**.005****	**4/128**
IURM	3.38	.011*	4/134	1.70	.153	4/127
IUKN	5.33	.001*	4/134	2.98	.022*	4/126
IURN	6.05	.000*	4/134	2.22	.071	4/125

* Significance reached in stepdown contexts when α = .05.
** Significance reached with redistributed α (.05/10 DVs) = .005.

Key. MT-MC=**Midterm** multiple choice; IUKM=Key idea units (mapping); IURM=Related idea units (mapping);IUKN=Key idea units (non-mapping); IURN=Related idea units (non-mapping); FN-MC=**Final** multiple choice; IUKM=Key idea units (mapping); IURM=Related idea units (mapping); IUKN=Key idea units (non-mapping); IURN=Related idea units (non-mapping).

Significant group differences which were reported in the univariate analysis for the recall of *related idea units* on essay type questions in the final examination that were cued to both content with and content without concept mapping were subsumed by higher-order DVs (i.e., key idea units) in the stepdown analysis. This resulted into significant effects for key idea units on essay questions that were cued to content with mapping, stepdown F (4,128) = 3.97, p = .005; and key idea units on essay questions cued to content without mapping, stepdown F (4,126) = 2.98, p = .022. However, following redistribution of α = .05 among the set of DVs to adjust for inflated Type I error in the stepdown analysis, significant group differences were observed only on one DV, which was, key idea units in essay questions cued to content with mapping, stepdown F (4,128) = 3.97, p = .005.

Univariate contrasts. Once the multivariate null hypothesis (of no significant differences) among the treatment conditions was rejected, group differences among the p variates with significant univariate Fs were of interest. Difference matrices (using adjusted group means from Table 14 subtracted from one another), for each of the six DVs that reached significance levels in the univariate analysis were developed, and unplanned comparisons were carried out on each of the six DVs across the five treatment groups. The results of that set of analyses are summarized in Table 15. Adjusted group means that were used for the purpose of this analysis are reported alongside in Table 14.

Table 14

Adjusted Means for all Dependent Variables in the Design

DVs	Control	Low CM	High CM	Post Quest	Combined
Treatment levels					
MT Multi-choice	-.03	.09	-.58	.13	.22
Key idea units (Map)	.10	-.09	.15	-.18	.13
Rel idea units (Map)	.02	-.07	.05	-.23	.29
Key idea units (Nmap)	-.12	.06	.53	-.03	-.27
Rel idea units (Nmap)	-.32	.11	.43	-.04	-.10
FN Multi-choice	.16	-.13	-.36	.07	.20
Key idea units (Map)	-.70	.12	.63	.01	-.04
Rel idea units (Map)	-.27	.08	.64	-.11	-.18
Key idea units (Nmap)	-.23	.31	.61	-.17	-.32
Rel idea units (Nmap)	-.06	.31	.65	-.19	-.45

Note. Cell Sizes: Control=22; Low Concept Mapping=28; High Concept Mapping=22; Post-Questioning=36; Combined=32.

Table 15

Univariate Contrasts Across the Five Treatment Groups

	Dependent Variables (with adjusted critical values reported underneath)					
Contrasts	MT-MC F_{LSD}=.49 F_T=.65	IUKN(MT) F_{LSD}=.49 F_T=.64	IUKM(F) F_{LSD}=.48 F_T=.63	IURM(F) F_{LSD}=.51 F_T=.67	IUKN(F) F_{LSD}=.47 F_T=.61	IURN(F) F_{LSD}=.48 F_T=.63
Gr1 vs Gr2	—	—	+.82**	—	+.55*	—
Gr1 vs Gr3	-.55*	+.64**	+1.34**	+.91**	+.84**	+.72**
Gr1 vs Gr4	—	—	+.71**	—	—	—
Gr1 vs Gr5	—	—	+.66**	—	—	—
Gr2 vs Gr3	-.68**	—	+.52*	+.55*	—	—
Gr2 vs Gr4	—	—	—	—	-.48*	-.49*
Gr2 vs Gr5	—	—	—	—	-.63**	-.76**
Gr3 vs Gr4	+.71**	-.55*	-.63**	-.75**	-.76**	-.84**
Gr3 vs Gr5	+.80**	-.80**	-.68**	-.82**	-.92**	-1.10**
Gr4 vs Gr5	—	—	—	—	—	—

p = .05 for all tests of significance.
* = Fisher's F_{LSD} Only. ** = Tukey's F_T and Fisher's F_{LSD}

Note. Minus (-) and plus (+) signs before numbers in the table indicate the direction of difference. Minus signs mean that groups on the left-hand column are greater. Plus signs mean that groups on the r̶ ̶-̶hand column are greater. Dashes (-) represent no significant difference between the groups.

Key 1. **Midterm**:MT-MC=Multiple-choice; IUKN(MT)=Key idea units non-mapping; **Final**:IUKM(F)=Key idea units mapping; IURM(F)=Related idea units mapping; IUKM(F)=Key idea units non-mapping; IURM(F)=Related idea units non-mapping.

Key 2. Gr1 = Control; Gr2 = Low Concept Mapping; Gr3 = High Concept Mapping; Gr4 = Post-Questioning; Gr5 = Combined.

Type I error protection procedures. Protection for familywise error was provided by Fisher's test of least significant difference (LSD) and Tukey's multiple comparison procedure. The Tukey and Fisher tests are different in several fundamental ways. The Fisher test provides protection against inflating α by allowing the calculation of post hoc effects for only DVs that have produced a significant omnibus F. Thereafter, the analysis proceeds by considering only pairs, but the F-ratio is unprotected. Tukey's test allows for testing all possible pairs of group means and is designed to maintain familywise error rate at the chosen value of α_{FW} for the entire set of pairwise comparisons by the following procedure. The tests are performed by arranging the treatment means in ascending order of magnitude on the DVs. Entries within the bodies of these tables represent differences between any two treatment means. Differences are not entered for comparisons below the main diagonal of the tables since these values would be mirror images of differences appearing above the diagonal. The next step is to calculate the minimum pairwise differences between means that must be exceeded to be significant with Tukey's test. This value (F_T) is derived from several sources: q_T which refers to an entry in the table of "studentized range statistic"; $MS_{S/A}$ is the error term from the overall analysis of variance; and s is the sample size for each group. Therefore, three quantities enter into the determination of q_T : df_{error} (df associated with $MS_{S/A}$), r (the number of treatment means in the design), and

α_{FW} (familywise error rate chosen for the Tukey test). The statistic derived from this calculation is the critical (α) value for the Tukey test, which differences between group means from the difference matrix must pass before they can be declared significant. Tukey's test can be used in conjunction with the F test. The critical value of $F(F_T)$ against which F_{comp} is compared is derived from the following procedure: F_T equals q_T squared divided by 2 (Keppel, 1982).

In comparison with Fisher's test, Tukey's test is by far, the more conservative one. While reducing the number of Type I errors, Tukey's test produces more Type II errors than produced by Fisher's test. The following rationalization of these tests was developed in view of the large number of contrasts that were constructed. When both Tukey and Fisher tests agreed (i.e., both were significant) the differences were considered probable. These will be discussed as such in the following section. When the two tests disagreed (i.e., Fisher was significant and Tukey was not) the approach suggested by Keppel (1982) was used and judgement was suspended pending further investigation.

Interpretation of results. Protection against the increase of familywise error in the univariate contrasts was provided for each of the variates separately. This is an approach that is recommended by Bray and Maxwell (1982). The more conservative Tukey's test eliminated six significant effects from the univariate contrasts. However, placing such stringent controls on familywise error necessarily increases

failure to detect the actual differences between pairs of treatment groups. The cost of reducing familywise error is an increase in Type II error. Most researchers understand that there is no clear way out of this difficulty and rather than reject a null hypothesis on the basis of stringent protection against Type I error, they adopt a modified decision rule to suspend judgment, pending further investigation. Results of the univariate contrasts are reported in the following.

On multiple-choice type questions in the midterm, the low persistence mapping group (mean = .09), post-questioning (mean = .13) and the combined (mean = .22) groups, performed significantly better than the high persistence mapping group (mean = -.58). Means reported are the adjusted group means presented in Table 14. The difference between the control and the high persistence mapping group on this DV did not pass Tukey's stringent F test, in which case judgment is suspended on the null hypothesis of no significant difference between the two groups.

The high persistence mappers (Group three) who were doing the most number of concept mapping exercises had the lowest scores on multiple-choice type questions in the midterm exam in comparison with subjects in all the other treatment groups. The performance of the two mapping groups (i.e., Groups 2 & 3, low and high persistence mappers) in comparison with the other groups, on multiple-choice type questions in the final examination was equally poor (Gr2 mean = -.13 and Gr3 mean = -.36). However, these effects on the

final examination were not large enough to reach significance levels in either the univariate or the stepdown analyses. The possibility that mapping may have actually "disrupted" subjects' performance on multiple-choice type test items is discussed in the next chapter.

Concept mapping could not produce benefits on essay type questions in the short term either. Subjects in the two mapping only conditions failed to perform any better on essay questions in the midterm examination that were cued to course content on which mapping exercises had been set. Neither the univariate nor the stepdown Fs for these DVs in the midterm reached significance levels.

However, on the recall of key idea units on questions in the midterm examination which were cued to content without concept mapping exercises, the high persistence mapping group (mean = .53) performed significantly better than the control (mean = -.12) and the combined (mean = -.27) conditions. The significant difference between the high persistence mapping and post-questioning groups on this DV did not pass F_{Tukey}. Therefore, judgment is suspended on the null hypothesis of no significant difference between those two groups.

On the recall of key idea units for questions that were cued to content with concept mapping exercises in the final examination, the high persistence mapping group (mean = .63) performed significantly better than the control group (mean = -.70), post-questioning (mean = .01) and combined (mean = -.04) conditions. However, the difference between low and high

persistence mapping groups was not large enough, in which case decision is suspended on the null hypothesis of no significant difference between the two mapping groups. On this DV, the low persistence mapping condition (mean = .12), post-questioning and the combined groups also performed significantly better than the control group.

On the recall of related idea units on questions in the final examination that were cued to content with concept mapping exercises, the high persistence mapping group (mean = .64) performed significantly better than the control group (mean = -.27), post-questioning (mean = -.11) and combined (mean = -.18) groups. The significant difference between the low and high persistence mapping groups on this DV did not pass Tukey's F test, in which case decision is suspended on the null hypothesis of no significant difference between the two mapping conditions.

On the recall of key idea units for questions in the final examination that were cued to content without concept mapping exercises, the high persistence mapping group (mean = .61) performed significantly better than the control group (mean = -.23), post-questioning (mean = -.17), and combined (mean = -.32) groups. The low persistence mapping group (mean = .31) performed significantly better than the combined (mean = -.32) condition. Decision is suspended on the significant difference between the low persistence mapping group and the control, and also with the post-questioning group in the univariate analysis.

Finally, on the recall of related idea units for questions in the final examination that were cued to content without concept mapping exercises, the high persistence mapping group (mean = .65) performed significantly better than control (mean = -.06) post-questioning (mean = -.19) and combined (mean = -.45) groups. On this DV the difference between low persistence mapping (mean = .31) and the combined group was also significant. On the significant difference in the univariate analysis between the low persistence mapping and post-questioning groups, decision is suspended.

Attitudinal Data

Source of Data

The data that are analyzed in this section were collected through a questionnaire that was mailed out to subjects at the end of the study, and which enquired into subjects' attitudes towards different methods of studying. Subjects were given fifteen statements relating to various methods of studying and asked to indicate the strength of their feelings toward each on a five-point Likert scale ranging from strongly disagree to strongly agree.

Approach to Analysis

Factor analysis was used in the analysis of data that were collected. Factor Analysis (FA) is a technique for simplifying large sets of variables into smaller numbers of highly correlated factors in order to examine patterns of

correlations among them. Extraction of factors was followed by varimax rotation which served to simplify factors further by maximizing the variance of the loadings within factors.

From Principal Components Analysis (PCA), six factors with eigenvalues of more than 1 were extracted from the fifteen variables in the design. Eigenvalues and percentages of variance (in parenthesis) accounted for by each of the six factors extracted were as follows: Factor 1 = 2.348 (15.7%); Factor 2 = 1.902 (12.7%); Factor 3 = 1.505 (10%); Factor 4 = 1.411 (9.4%); Factor 5 = 1.372 (9.1%); and Factor 6 = 1.176 (7.8%). Together, these six factors accounted for 64.8% of the total variance in the design.

Each of these six factors were named based on the highest loading variables (a loading criterion of .50 was used to exclude inconsequential variables). Factor scores were then generated for each subject on the separate factors. These are the actual empirical responses weighted by the loadings for each variable loading on a factor. These factor scores, then, served as the DVs in the MANOVA that tested group differences across the design. The potential number of fifteen hypothesis tests (section IV of the post-experimental questionnaire in Appendix E) was reduced to a single omnibus MANOVA with follow-up univariates.

Interpretation of Factors

Interpretation of factors involves examination of the underlying dimension that unifies the group of variables that

load on factors. After orthogonal rotation the values in the loading matrix are the correlations between variables and the factors. Generally, only variables with loadings in excess of .30 are interpreted. The larger the loading, the stronger the variable is a measure of that factor. According to guidelines offered by Comrey (1973), loadings in excess of .71 (50% overlapping variance) are considered excellent, .63 (40% overlapping variance) are very good, and .55 (30% overlapping variance) are good; while .45 (20% overlapping variance) are considered fair, and .32 (10% overlapping variance) are rather poor.

Most of the loadings on the six factors in this analysis were greater than .63. Only four of the variables had factor loadings any lower than .63 (.50, .51, .58 and .62). Seven of the variables had factor loadings that exceeded .71. Loadings for the six factors extracted in this study are reported in Table 16.

The decision to retain factors for the purposes of further interpretation does not have to be governed solely on the basis of their variable loadings. Tabachnick and Fidell (1989) say that a researcher may be interested in retaining factors out of interest in unexpected findings. The sixth factor extracted in this analysis was not entered into the MANOVA model because the two variables that loaded on this factor (one high positive and the other high negative) could not be interpreted meaningfully within the context of this study. Moreover, it accounted for less than 8% of the total

Table 16

Rotated Factor Loadings Matrix

	Factor Loadings					
Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Var 4	.78					
Var 3	.73					
Var 15	.62					
Var 7		.66				
Var 6		.64				
Var 14		-.62				
Var 5		.50				
Var 11			.84			
Var 8				.84		
Var 9				.80		
Var 2					.80	
Var 12					-.63	
Var 1					.58	
Var 13						.88
Var 10						-.51

Note. Factor 1: Difficulty remembering facts and details; *Factor 2:* Preference for visual representation of content; *Factor 3:* Preference for thorough understanding of content; *Factor 4:* Preference for key concepts; *Factor 5:* Preference for detailed note taking and memorization; and *Factor 6:* Preference for existing order of presentation.

variance in the design. On the other hand, factor 3 which had a single variable loading on it was retained in the model because it was of potential interest in this study.

Descriptions of Factors

Five of the six factors from Table 16 were selected for entering in the MANOVA design. Variables from the attitude measure that loaded on each of these five factors are identified in the following paragraphs. Variables that loaded on Factor 1, served to identify the problem subjects were having with studying. Factors 2,3,4 and 5 seem to describe possible solutions to these problems, as seen by subjects.

Factor 1. Three variables loaded on this first factor. These were *Variable 4:* I find it difficult to fit facts and details into an overall picture; *Variable 3:* I have difficulty remembering details; and *Variable 15:* I like to follow well tried out approaches to studying. These variables, and especially variables 3 and 4 (with higher loadings), seemed to be pointing at problems subjects were having with their methods to studying, especially with remembering facts and details.

Factor 2. Variables that loaded on this factor included *Variable 7:* I like to "map out" course content in order to see how the various concepts fit together; *Variable 6:* Charts diagrams and pictures help me learn better; *Variable 14:* I do little extra beyond what is required for passing my exams; and *Variable 5:* Details are easier to remember if I use

special memory techniques. Together, the variables pointed towards possible solutions to problems of studying that were apparent in Factor 1. They also revealed a preference for visual and graphical learning strategies. *Variable 14* which loaded negatively on this factor showed that those who preferred visual and graphical learning strategies were also inclined to want more than what was necessary for passing their examinations.

Factor 3. A single variable loaded onto this factor namely *Variable 11:* I try to understand thoroughly the meaning of my course content. This variable was concerned with the depth of understanding of course content and is compatible with the loadings on Factor 2, which revealed a search for a level of understanding, beyond that which was necessary for passing exams.

Factor 4. Two variables loaded on this factor, namely *Variable 8:* I like to concentrate on key concepts only; and *Variable 9:* I remember details best if they are related to key concepts. Both the variables had extremely large loadings (.80 and .84) and pointed toward possible solutions to the problems of studying identified in Factor 1.

Factor 5. Three variables loaded on this last factor. These were *Variable 2:* I prefer to memorize what I have to learn; *Variable 12:* In trying to understand new concepts, I try to relate them to real life situations; and *Variable 1:* I like to take detailed notes when I am studying. *Variable 12* loaded negatively on this factor as it is the reverse of

variables 1 and 2 which reveal a preference for memorization and verbatim learning strategies as a solution to the problems of studying identified in Factor 1.

Descriptive Statistics

The means and standard deviations for the five factors in the MANOVA model are presented in Table 17. Variation within factors is fairly consistent across all treatments.

Analysis of Group Differences

The omnibus MANOVA examined the question: Were there significant differences between treatment conditions across these five factors? The initial test produced a significant main effect for the factor variables, Hotellings F (20, 454) = 2.02, p =.006. The multivariate effect size for Hotellings trace was .08.

Univariate analysis. Since the outcomes of the univariate and stepdown analyses were identical, only outcomes of the univariate tests are interpreted. Table 18 shows the complete results of the univariate F tests. Only Factor 2 (preference for visual representation of content) produced a significant result across the design, F (4, 119) = 4.65, p = .002.

Univariate contrasts. In order to examine this significant result more closely, univariate contrasts were carried out between all the treatment conditions for the five factors. Only one of these produced a significant result,

Table 17

Means and Standard Deviations on Factors

DVs	Treatment Levels				
	Control	Low CM	High CM	Post Quest	Combined
Factor 1					
Mean	.20	-.25	-.23	.28	-.09
SD	.70	1.21	1.07	.90	1.00
Factor 2					
Mean	.35	-.72	.08	.24	.04
SD	.87	.89	1.03	.90	1.04
Factor 3					
Mean	-.39	.41	-.02	-.09	.02
SD	.96	.96	1.04	.95	1.03
Factor 4					
Mean	.23	-.13	-.29	.10	.04
SD	.65	1.09	1.14	.83	1.19
Factor 5					
Mean	.07	.04	.15	.02	-.21
SD	.95	1.16	1.07	.94	.93

Note 1. Cell Sizes: Control=19; Low Concept Mapping=24; High Concept Mapping=20; Post-Questioning=33; Combined=28.

Note 2.Factor 1: difficulty remembering facts and details; *Factor 2*: preference for visual representation of content; *Factor 3*:preference for thorough understanding of content; *Factor 4*: preference for key concepts; *Factor 5*: preference for detailed note-taking and memorization.

Table 18

Univariate F-Tests With (4,119) DF

	Mean Squares			
DVs	Hyp.	Error	F	P =.05
Factor 1	1.50	.98	1.53	.199
Factor 2	**4.15**	**.89**	**4.65**	**.002***
Factor 3	1.79	.97	1.84	.126
Factor 4	.85	1.00	.85	.497
Factor 5	.47	1.02	.46	.762

(i.e., Factor 2) which was labelled as preference for visual and graphical learning strategies and a readiness to do more than that which was required for simply passing examinations. The source of this difference lay between Groups 2 and 3 (the low and high persistence mappers) $t = -2.79$, $P = .006$. The direction of the means (low persistence mappers = -.72; high persistence mappers = .08), (see table 17), suggests that the low persistence mappers held a somewhat negative disposition towards visual and graphical learning strategies, while the high persistence mappers were more positively disposed towards the same.

Questionnaire Data

Source of Data

The data that are analyzed in this section were collected through a questionnaire that was mailed out to subjects at the end of the study and which enquired into subjects' compliance with the various features of the instructional treatment in the study. The questions addressed the three instructional components of the design namely (a) self-assessed tests, (b) concept mapping exercises, and (c) consultant-assessed tests. Questions were posed to subjects' on compliance with the instructional activities, their reasons for non-compliance, level of difficulty with the activities, satisfaction with feedback, kind of time required to complete the exercises, and the usefulness of the activities as a method of studying.

Approach to Analysis

Descriptive statistics and ANOVA tests were requested for all the individual questions in the questionnaire. The results of only selected variables from the questionnaire are reported here, especially those that were significant group discriminators. Information from questions such as those that enquired into subjects' compliance with the instructional treatments are not reported here because that information has been included elsewhere in this document in other forms. A complete version of the mail-out questionnaire is presented in Appendix E.

Self-assessed tests. All subjects in the study were asked questions on self-assessed tests. On a four-point scale of very difficult to very easy, subjects were asked to assess how difficult it was for them to complete the self-assessed tests at the start, and then later on in the course. There were no significant differences among the groups on the degree of difficulty encountered in doing these tests. Most of them found the tests "quite difficult" to complete throughout the course (mean = 2.5). On how time consuming was it to do the tests, no significant differences across the groups were reported either. On a four point scale, the majority of them found doing the tests "somewhat time consuming" (mean = 1).

Subjects were also asked how useful were the self-assessed tests in their studies. Significant differences across the groups were observed on this question F (4,124) = 4.03, p = .004. On a four-point scale of not useful to very useful, subjects in groups 1, 3 and 4 (control group, high persistence mappers and post-questioning condition) found the tests "quite useful" (mean = 2) while those in groups 2 and 5 (low persistence mapping and combined groups) found the tests only "somewhat useful" (mean = 1).

Concept mapping exercises. Subjects in three of the five treatment groups were supplied with concept mapping exercises in their study materials and provided training in mapping skills. Only subjects in these groups were asked questions related to concept mapping exercises. On a four-point scale,

they were asked how useful were the professor's feedback on the mapping exercises they had completed. No significant differences among the groups were observed on this. Most of them found the feedback only "somewhat useful" (mean = 1).

Subjects were asked to assess how difficult it was for them to draw maps of their course content in the beginning and then later on in the course. No significant differences were found among the groups on the degree of difficulty encountered in the beginning of the course. On a four-point scale ranging from very difficult to very easy, most of them found the mapping exercises "very difficult" to draw (mean = 1.7). However, significant differences among groups were observed in the latter part of the course $F (2,69) = 5.39$, $p = .001$. Subjects in the two mapping groups who had continued to do the mapping exercises until the end of the term (i.e., high persistence mappers and the combined groups) reported finding the exercises only "quite difficult" later on in the course (mean = 2). While subjects in the low persistence mapping group (i.e., those who had stopped doing the concept mapping exercises) found the concept mapping exercises "very difficult".

Using a four-point scale ranging from very to not at all, subjects were asked to indicate how time consuming it was for them to draw concept maps. Significant differences were reported across the groups on this question, $F (2,72) = 9.27$, $p = .001$. Subjects in Group 2, the low persistence mappers, found the mapping exercises "very time consuming" to

do (mean = 3), while subjects in Groups 3 and 5 (high persistence mapping and combined conditions) found the exercises "quite time consuming" to do (mean = 2). Subjects were also asked to indicate how useful they found mapping as a method of studying. Significant differences among the groups were observed on this question F (2,72) = 4.06, p = .02. Subjects in Groups 3 and 5 (high persistence mapping and combined groups) found the mapping exercises useful in their study. On the other hand, those in Group 2 (low persistence mappers), did not find the exercises useful.

Consultant-assessed tests. On a selection of lesson tests, subjects in two of the treatment groups (post-question and combined conditions) were provided with feedback on post-questions after they had answered the questions in the tests. In the questionnaire, they were asked to assess, on a four-point scale of very easy to very difficult, how difficult it was to complete these tests in the beginning, and later on in the course. No significant differences were found among these groups on the degree of difficulty encountered. Most of the subjects found the tests "quite difficult" to complete in the beginning (mean = 2.5), although they found that the tests got "quite easy" to do later on the course (mean = 3). On how time consuming were these tests, no significant differences were observed either. On a four-point scale from very to not at all, most thought it was "somewhat time consuming" (mean = 1.5). Subjects were asked how useful the consultant-assessed tests had been in the their study. There were no significant

differences among the groups on this question. On a four-point scale from very useful to not useful, most felt that the tests were "quite useful" (mean = 2).

Summary of Results

Results of the analysis of data collected in this study have been reported in this chapter under the following broad categories.

Achievement Data

These were the outcomes of the midterm and the final examinations, and they were analyzed with multivariate and univariate procedures. The DVs were separated by multiple-choice type questions and key and related idea units on essay type questions that were cued to concept mapping exercises and those that were not. Results were as follows.

- The omnibus MANCOVA produced a significant main effect for the independent variables on the set of DVs.

- In the ensuing univariate analysis, six of the ten DVs in the design revealed significant differences when α was set at .05 level. From the midterm exam these were: multiple-choice test items, and key idea units on questions that were cued to content without concept mapping exercises. From the final exam, they were key and related idea units in questions that were cued to content with, and also content without concept mapping.

• In the stepdown analysis, with α redistributed among the ten DVs, only one of these six variables remained significant. This was key idea units on essay questions in the final examination cued to mapping exercises.

Attitudinal Data

These were collected through a mail-out questionnaire and analyzed with Factor Analysis techniques. Following PCA, six factors with eigenvalues of more than 1 were extracted, five of which served as DVs in the MANOVA that tested group differences across the design.

• Omnibus MANOVA produced a significant main effect for the five factor variables.

• In the univariate analysis only Factor 2 was significant, which was labelled as a preference for visual and graphical learning strategies. The source of this difference was located between the low and high persistence mappers. The direction of means suggested that low persistence mappers held a negative attitude towards visual and graphical learning strategies, while the high persistence mappers were more positively disposed towards the same.

Questionnaire Data

These were analyzed with ANOVA tests. A summary of the significant findings are presented in the following.

- On the usefulness of self-assessed tests, the control group, high persistence mappers and the post-questioning group found the tests "quite useful". Low persistence mappers and combined group found them only "somewhat useful".

- Concerning the difficulty of drawing concept maps, the high persistence mappers and combined group found the mapping exercises "quite difficult". The low persistence mappers found the suggested mapping exercises "very difficult" to do.

- On how time consuming drawing maps was, the low persistence mappers found the concept mapping exercises "very time consuming" to do. High persistence mappers and the combined group found the exercises "quite time consuming".

- Concerning how useful concept mapping was, the high persistence mappers and the combined groups found the suggested mapping exercises useful. The low persistence mappers did not find the exercises useful.

CHAPTER FIVE

Discussion

Synopsis of Study

The quality of teaching and learning in DE is, to a large extent, dependent on the quality of the instructional materials and support that are provided to learners. While distance educators are cognizant of this important role of the instructional materials, there has been little research undertaken on the use of instructional strategies within DE contexts which might help achieve desired learning outcomes.

Existing work on the use of instructional strategies in DE contexts has emerged mainly from a behavioral perspective, although there have been calls for a cognitive orientation as well. These are useful, but rather general approaches, and they do not offer specific guidelines on the application of instructional strategies within the constraints imposed by DE. As a result, distance education course developers have been mostly preoccupied with manipulations of standard textual design variables which have only limited potential for facilitating active learner involvement.

This study investigated the effects of concept mapping and post-questioning with feedback on cognitive performance in DE. The effects of concept mapping was compared with that of post-questioning and both conditions were pitched against a control condition which was exposed to only post-questions without feedback. Concept mapping and post-questioning, with

and without feedback, with textual design strategies held constant, comprised a combined condition.

The study was carried out in the nursing DE program at St. Francis Xavier University in Antigonish, Nova Scotia. The first student cohort (N = 140) in the program comprised the subjects in the study. The independent variables were levels of instructional strategy and dependent measures included: (a) achievement scores of subjects on multiple-choice and essay questions on the midterm and final course examinations; (b) attitudes of subjects on methods of studying; and (c) questionnaire responses on treatment variables. Multivariate statistical procedures were used to analyze achievement data, and factor analysis was used in the analysis of attitudinal data. Descriptive statistics and univariate tests were produced for the rest of the questionnaire data.

The result of the MANCOVA was a significant main effect for the overall design, indicating that differences existed among treatment conditions on six of the ten DVs (univariate analysis). In the multivariate stepdown analysis (with α set at .005) treatment group differences on only one of the DVs (i.e., key idea units on questions in the final examination that were cued to content with concept mapping exercises) was significant. While the univariate results are the most liberal interpretation of the findings, the multivariate result represents the most conservative.

Post hoc analyses followed from this overall finding in an attempt to answer more specific research questions. These

questions and their answers are detailed below. Answers are drawn from both the univariate and the multivariate stepdown analyses and they are noted as such in the discussion of the research questions and the hypotheses.

Question 1. *Would the presence of feedback produce higher cognitive achievement while textual design strategies were being held constant?* It was hypothesized that the three experimental conditions with feedback (concept mapping, post-questioning and the combined condition) would outperform the control condition (post-questioning without feedback). This hypothesis was supported in that all conditions with feedback outperformed the control condition on, at least, one measure. The following specific findings accrued from the univariate analysis of the data. A significant result was observed for low persistence mappers over the control group on the recall of key idea units for questions in the final exam that were cued to content with mapping exercises. The high persistence mappers outperformed the control group on five of the six DVs that were significant in the univariate analysis. The post-questioning with feedback and combined groups outperformed the control condition on the recall of key idea units on questions in the final exam that were cued to content with mapping.

Question 2. *Would concept mapping yield higher cognitive achievement than post-questioning when feedback was provided on both, and while textual design strategies were*

held constant? It was hypothesized that there would be a difference in favor of the mapping group and the hypothesis was supported. High persistence concept mappers outperformed the post-questioning group on four of the six DVs that were significant in the univariate analysis. In the multivariate stepdown analysis, however, the difference between the high persistence concept mapping and post-questioning groups was significant on the single predictor of group differences (i.e., key idea units mapping in the final examination).

Question 3. *Would there be a large attrition rate with concept mapping and if so, would there be differences between the performance of low and high persistence mappers?* It was hypothesized that subjects who would persist with the mapping exercises would outperform those who completed fewer mapping exercises. The hypothesis was supported. A significant result was found in favor of subjects who did more than two-thirds of the mapping exercises against those who had done less than a quarter of the suggested exercises on recall of key idea units (multivariate and univariate) and related idea units for questions (univariate only) in the final examination that were cued to content with mapping exercises. Results of LSD and Tukey *post hoc* comparisons were conflicting in regards to this result.

Question 4. *Would concept mapping produce an initial (in the midterm) decrement on recognition-type knowledge and comprehension test items?* As a result of the division of (low-high persisters) in the mapping group, this question was

reoriented to the high persistence mappers only, because it was expected that the complete treatment would produce the greatest decrement. It was hypothesized that high persistence mappers would produce lower results than the other conditions on the midterm multiple-choice test items. The hypothesis was supported. Judging from the univariate results, all treatment groups outperformed high persistence mappers on the midterm multiple-choice measure, but not on the final measure. In the multivariate stepdown analysis with a more conservative α, this finding disappeared.

Question 5. *Would a combination of concept mapping and post-questioning, produce higher cognitive achievement, than that produced by the conditions separately?* The hypothesis that the combined condition would outperform other conditions in the design was generally not supported. There was only one significant result found in favor of the combined condition, which was over the high persistence mapping condition on multiple-choice test items in the midterm exam. It should be noted, however, that all other groups outperformed the high mappers on this measure as well.

Limitations of Study

The findings of this study have to be considered in view of several characteristics of the research design which could be seen as its limitations. These are discussed in the following sections.

The fact that the study was carried out in a real distance education course with no additional resources or components for the purposes of this study, enhances its generalizability to similar DE contexts. However, because of the same reasons, there were several limitations on what would have been experimentally desirable but not practical in the circumstances imposed by such realistic contexts. Firstly, subjects in the study could not be randomly assigned to the different treatment conditions. Subjects who were given different instructional activities to do on the same lesson material had to be physically kept apart in order to avoid a confounded design. This necessitated assigning groups of subjects to the different treatment conditions according to their geographical location. Prior cognitive achievement derived from four courses in the program that subjects had taken over the year preceding the one in which the current study was set, revealed no significant difference among treatment groups.

Secondly, the separation of subjects from the concept mapping condition after the study, into two groups according to the number of exercises each had completed is certainly not normal experimental procedure. However, this step is defended on two accounts. One, a high attrition rate from the concept mapping condition was expected prior to the start of the study and when it did occur, to ignore the outcomes for almost a half of that treatment group, especially in view of evidence from the literature on attrition rates, would have

meant losing a valuable source of data. Two, this form of unearthing of interesting and unexpected findings in *post hoc* analysis is what Tukey (1977) has called "exploratory data analysis", which is useful for generating the hypotheses and planned comparisons for future studies of similar type.

Thirdly, scores on some of the DVs that were derived from the midterm and final examinations had a rather high variability. These were for "related idea units" on essay questions. A likely cause for this was that essay questions in the exams (the dependent measures), were written to elicit only a specified number of key concepts. They were not specifically asking for related concepts as well. In fact, when related concepts were mentioned, students did not earn any more marks than the maximum that was possible on the instructor's score sheet, and they lost no points either, if related concepts were not mentioned. However, when related concepts with key concepts were counted for each subject in the analysis of data as described in the methods chapter, subjects who had mentioned related concepts scored a lot more points than those who did not mention them, hence the high variability on the measure. It is possible that some of the subjects who did not mention related points may have known them but did not mention them because the questions did not ask for them.

In order to ensure high external validity, both the multiple-choice items and the essay questions in the two course examinations were drawn from a test bank that had been

developed by the authors of the prescribed textbook in the course. Selection of questions was based on the topics that were covered from the text in the course. The multiple-choice type items had been developed presumably for the larger North American population and as such the selected test items turned out to be rather low in reliability on both the midterm and final exams. The test items could not be pre-tested on a comparable sample, even if one could be found, without risking confidentiality.

Outcomes of Feedback

Feedback to distance learners is often difficult to provide. As a result, it is offered only sporadically or not provided at all. In this study, the effects of providing feedback on student learning activities (concept mapping and post-questions) was investigated and an overall positive result in favor of feedback was observed.

According to the results of the univariate analysis, the largest gains were recorded by subjects who were given feedback on concept mapping exercises and who did more than two-thirds of all the suggested mapping exercises (1.34 σ above the control), followed by subjects who had done fewer number of exercises (.82 σ). Subjects who were provided feedback on post-questions were next (.71 σ). They were followed by subjects in the combined condition who had received feedback in both formats (.66 σ). From a review of 40 studies and 58 effect sizes on the effects of intentional

feedback, Bangert-Drowns et al. (1991) reported effect sizes ranging from as low as -.83 σ to a high of 1.42 σ above the control groups. The effects of feedback provided on concept mapping in the current study compare favorably with the findings of these researchers.

There is evidence that the uncontrolled availability of feedback is related to its outcomes. Kulhavy (1977) dubbed this phenomenon as *presearch availability*. He found that when feedback could be viewed by subjects prior to doing the learning activities themselves, they demonstrated lower post-treatment achievement than the control groups. However, when feedback was controlled, subjects in the experimental groups produced much higher achievement scores than those in the control groups. Bangert-Drowns and his colleagues reported similar observations in their meta-analysis of studies on feedback cited above. They reported that when feedback was offered after the students had attempted the activities, effect sizes were much higher, but when feedback availability was uncontrolled, effect sizes dropped. In the current study, feedback was provided to subjects only after they had attempted the suggested activities and sent in their responses to their educational consultants.

Bangert-Drowns and his colleagues also reported that type of feedback provided was also an important predictor of effect sizes of feedback. Responses in the form of grades, yes and no and incorrect or correct comments were of little benefit to learners. Again, in the current study feedback on

concept mapping exercises were in the form of concept maps and on post-questions, elaborate responses to those questions. According to Bangert-Drowns and his colleagues this kind of feedback comprises "intentional" feedback which is directed at informing learners about the quality and accuracy of their responses and is similar in structure and format to the instructional activities suggested.

The results in favor of feedback suggest that quality of the learning activity on which feedback is provided is also an important consideration in inducing enhanced learning outcomes. Post-questions without feedback was clearly not very helpful as it was outperformed by all other conditions. DE course developers who routinely use post-questions without providing feedback in their materials will be well advised to take note of this finding.

The findings in favor of providing feedback were expected. Instructional activities in distance education materials are similar to graded homework assignments. Paschal et al. (1984) reviewed the literature on homework from conventional educational contexts and reported rather small effect sizes for ungraded homework (.36 σ), but substantially larger effect sizes when instructor's comments were provided on them (.80 σ). Given this finding, it would seem likely that feedback that is contingent upon specific learning activities, and which is designed to inform the learners of their errors, as was the case in this study, would produce positive results.

Feedback in this study was delivered to students by local educational consultants who were colleagues of subjects so it was available almost immediately. While this kind of local tutorial support is not commonly available in a large number of DE contexts, the presence of local tutors is not integral to the delivery of feedback to distance learners. The same quality of feedback that is possible through a local tutor can be provided via various forms of computer mediated communication and voice-mail applications as long as the cautions raised by Howard (1987) on the instructional quality of feedback and opportunities presented by technology-based delivery mechanisms are heeded.

A further point which needs to be borne in mind when interpreting the findings produced in favor of feedback here is the nature of the study sample. Subjects in the current study were all practicing registered nurses and as such, a very homogeneous sample. Groups of them often worked together in the same hospital or health center and, therefore, were frequently in contact with one another and in groups with their educational consultants who was a colleague at work. It is very likely that such a congenial environment may have facilitated the delivery of feedback to learners. Therefore, caution must be exercised in a generalization of the outcomes of this study to other DE contexts or self-instructional environments.

Concept Mapping vs Post-Questioning

The outcomes of providing feedback with two quite different instructional strategies in the current study seemed to suggest that the essential nature of the learning activity on which feedback was being provided, differentially influenced cognitive performance. An assessment of this was possible through a comparison of concept mapping and post-questioning strategies.

As a learning strategy, concept mapping permits the learner to reconstruct content to suit ones cognitive schema. As such, concept mapping has the potential for better retention and a more meaningful learning experience. It is a very involved learning activity and as such, is more time-consuming than answering questions or making lists of main points. Post-questions in contrast, do not require the same kind of reconstruction of course content in graphical form to show key and related points and the relations between them. In answering post-questions, learners are frequently engaging into a "search and reproduce" mode where they look for points sought by the questions and reproduce them, usually verbatim. Of course, questions can be asked in ways that require students to apply and analyze information rather than simply "search and reproduce" it. However, these are the kinds of questions that are often ignored by students. Consequently, DE course developers often resort to posing questions pitched at the knowledge and comprehension levels, and on which feedback is easier to provide, if at all provided.

Concept mapping offers a reprieve from the limitations of post-questioning because it is a learner centered activity and does not implicate the high degree of verbal processing that is required for answering essay-type questions. However, concept mapping entails a greater amount of time-on-task. Therefore, it may be argued that higher cognitive outcomes in favor of concept mapping is more due to the nature of the strategy itself, and the necessarily longer amount of time spent on completing mapping tasks in contrast with the time required for answering post-questions or note-taking. While this may be true, concept mapping must be seen as only one of many learning strategies that is appropriate for certain kinds of tasks and for some learners. It ought to be seen as complementing other learning strategies in instructional contexts rather than replacing them.

Once learned, concept mapping can be an enjoyable learning activity and there is evidence that mapping gets easier to do with persistence. From this perspective, it was believed that the concept mapping condition would outperform the post-questioning condition on the recall of key and related idea units when feedback was held constant. A significant multivariate result in favor of the concept mapping condition was observed, and in the univariate analysis, significant group differences were observed on four of the ten DVs in the design.

While the benefits of concept mapping were not immediately visible (i.e., in the midterm examination), the

direction of means revealed a clear trend towards higher achievement on essay type questions on the part of subjects in the mapping group (key idea units: CM mean = .15 and PQ mean = -.18; related idea units: CM mean = .05 and PQ mean = -.23). While these differences were not significant the trend towards higher achievement continued to persist in favor of mappers even on essay questions that were not cued to content with mapping exercises. In fact, the concept mapping condition outperformed the post-questioning group on the recall of key idea units on essay type questions in the midterm that were not cued to content with mapping exercises (CM mean = .53 and PQ mean = -.03). The cited means are from the adjusted means table in the results chapter (Table 14).

The trend in favor of concept mapping became increasingly prominent in the final examination producing significantly larger effects on essay type items that were cued to both content with and without mapping exercises (key idea units mapping: CM mean = .63, PQ mean = .01; related idea units mapping: CM mean = .64, PQ mean = -.11; key idea units non-mapping: CM mean = .61, PQ mean = -.17; related idea units non-mapping: CM mean = .65, PQ mean = -.19). Effect sizes from univariate contrasts in favor of the mapping condition for the four DVs were as follows: key idea units mapping = .63 σ; related idea units mapping = .75 σ; key idea units non-mapping = .76 σ; and related idea units non-mapping = .84 σ.

Apparently subjects who had persisted with concept mapping exercises until the end of the study performed considerably better on the recall of key and related idea units on essay type questions cued to content with concept mapping exercises. This comprises evidence in support of "intentional" learning. Their equally better performance on essay questions that were cued to content without concept mapping exercises is attributed to "incidental" learning due to training and practice in concept mapping strategy. This pattern of results seemed to suggest that it took some time and practice before the effects of concept mapping started to show benefits on the recall of idea units on essay questions. Presumably, once the strategy was internalized, its effects were substantially larger than that of the conventional post-questioning strategy.

These outcomes for concept mapping, however, were not unexpected. Existing research with concept mapping supports such a pattern of results for concept mapping. For example, Moreira (1977) observed the performance of his mapping students increase over the course of the semester. Novak (1990) also observed a similar pattern of results. He found that for 2 to 4 weeks there was a decline in the performance for the experimental subjects on course exams. Their averages started moving up only later, and for the mappers, scores usually ended up significantly higher than those of the others. A study by Schmid and Telaro (1990) also found that

mapping disrupted high ability learners initially and did not facilitate performance on lower level skills.

Persistence with Concept Mapping

Novak and his colleagues reported that one of the major obstacles to successful implementation of concept mapping strategy was the difficulty of drawing students away from their conventional learning practices. Several studies report this finding. Edmondson (1985) attempted to instruct a group of freshmen in learning how to learn. While twenty-one students attended the orientation session, only one remained in the program. Most said they did not have the time for such a program while others said the proposed strategies were inconsistent with the way they normally studied, and were also incompatible with what they believed was required to pass the exams. Lehman et al. (1985) also found teachers and students unwilling to attempt to use mapping and cited this disposition of participants as their major limitations. A similar negative disposition to the use of concept mapping strategy was encountered by Feldsine (1987), when he attempted to get college chemistry students to draw concept maps of material they had read. From their experiences, these researchers concluded that most students have developed idiosyncratic study habits over a period of years and are reluctant to substitute new studying techniques for those they have already found successful. They also noted that

developing a concept map often takes time and effort, and students often tend to prefer more expedient methods.

In view of these findings, it was anticipated that not all of the subjects assigned to the mapping condition in the current study would complete all the suggested mapping exercises. It was expected that mapping would be judged time consuming, not worth the effort and initially disruptive to students' pace and existing methods of study. Consequently, it was anticipated that there would be a large attrition rate from the mapping condition, and if this was going to be so, there would be a difference in cognitive achievement between the low and high persistence mappers. There was a 56% attrition rate from the concept mapping condition. Of the 50 students originally assigned to the concept mapping condition, 28 completed an average of 3 exercises, while 22 of them (44%) completed 8 or more of the 12 suggested exercises.

The suggested concept mapping exercises in the current study were optional and subjects could skip them with impunity. However, all subjects in the mapping condition had received the same training materials on how to do the concept mapping exercises and all of them did at least do a few of the mapping exercises. Having done at least a few mapping exercises and received feedback on them, those who chose to discontinue doing the concept mapping exercises comprised a unique group within the sample, different from those who had or had not been exposed to the notion of concept mapping or

the training materials that were provided. Differences in the performance of the low and high mappers was therefore of particular interest.

The low mappers (subjects from the mapping condition who stopped doing the exercises) performed significantly better than the high mappers on multiple-choice items in the midterm exam (low mean = .09 and high mean = -.58). The effect size in favor of low mappers on this DV was .68 σ. However, this pattern of result was consistent throughout the study. All the treatment conditions outperformed the high mappers on multiple-choice test items in the midterm exam. The high mappers outperformed the low mappers on the recall of key and related idea units in the final exam. Also, subjects in the combined condition were offered half the number of mapping exercises offered to the mapping only group. The mapping only group outperformed the combined condition on all the DVs that were derived from essay type questions. These results suggested that a fair amount of practice with concept mapping is necessary before the effects of the strategy are detectable.

Attitudinal data collected in the current study revealed that subjects who were exposed to concept mapping exercises and who chose to discontinue doing the mapping exercises were negatively disposed towards the orientation of the strategy. One of the factors that was extracted from the attitudinal data was categorized as representing a preference for visual and graphical learning strategies, the same kind of approach

that is called for in concept mapping. Significant variation
on this factor was found between the low and high mappers
(low mean = -.72 and high mean = .08, see Table 17). Since
these data were collected in a post-experimental condition
only, it is not known if subjects held this view towards
visual and graphical learning strategies prior to the
experiment or developed it after exposure to the treatments.

Presumably subjects who had discontinued doing the
mapping exercises were those who complained most loudly about
the excessive time requirements for mapping and how
inconsistent the strategy was with their own established
methods of studying. On the other hand, those who had
persisted with mapping exercises probably spoke most
favorably about the uses of concept mapping. Significant
differences between these groups of subjects were observed
from their responses to questions on the difficulty level,
time required to draw the maps and the usefulness of the
maps. Concerning the difficulty encountered in drawing
concept maps of course content, the low mappers said they had
found the mapping exercises "very difficult" to do for as
long as they had been doing them. The high mappers on the
other hand, said they had found the mapping exercises "quite
difficult" (not very difficult) to do. On how time consuming
they felt it was for them to draw the maps, the low mappers
said they found the mapping exercises "very time consuming"
to do, while the high mappers said they had found the mapping
exercises "quite time consuming" (less than very time

consuming). On the usefulness of mapping exercises as a method of studying, the low mappers said they found the mapping exercises were not useful in their study, while the high mappers said they found the mapping exercises useful.

Comments against concept mapping that were reiterated in the questionnaire were as follows: "This is not my usual style of studying"; "I like things to be listed and neat"; "They were too time-consuming to do and did not help my studying"; "I did not find them helpful in my studying"; "As an adult learner, I have already developed good study habits"; "I did not feel that I had a good understanding of the subject matter from identifying a few key words in the maps"; "I found concept maps more confusing than my notes"; "I did not like doing them, they were messy and hard to study from when preparing for exams"; "I found that studying from a concept map was too sketchy, and I was therefore at a disadvantage"; "I found I was spending time on something I knew I was not going to use in the future"; "I spent a lot of time on concept mapping, time wasted on something that had no value to the ultimate mark in the course"; "Concept mapping interfered with my study methods".

There were many comments made in favor of concept mapping as well, presumably from those subjects who persisted with the mapping exercises. Some of these comments were as follows: "It helped me to focus my attention on important concepts thus making it easier to understand and relate concepts to clinical situations"; "It helped me organize my

ideas and components of my course content"; "Helped me summarize the material, and allowed ease of review"; "Helped me remember important points"; "Concept mapping is teaching me better study skills"; "Its diagrammatic form was useful"; "It made the subject matter concise and to the point which I found easier to follow than the jumbled notes in the textbook"; "The idea of concept mapping conformed to my way of thinking"; "I like to write things down while I am studying and this offered me a more formal approach than lists I always make"; "I used my maps for exam review and found they saved me from having to go back to the original material in the textbooks".

Outcomes of Combining Strategies

Work undertaken by Bloom (1984) and Walberg (1984) show that instructional strategies differ in the effects they have on learning outcomes. For instance, there is evidence that one-to-one tutorial instruction can produce effect sizes equal to 2 σ above that of the control condition. Higher order questions, on the other hand, has produced an effect size no larger than .30 σ above that of a control condition. Bloom has also seen instructional strategies as affecting particular agents of change in an instructional setting. The object of change for "graded homework" for example, is the teacher and for "advance organizers" it is the instructional materials. Following from this rationalization, Bloom argued that it would make at least theoretical sense to combine

instructional strategies that are known to influence different agents of change and thus achieve enhanced learning outcomes. There is a small body of research that shows that the cognitive outcomes of combining instructional strategies can be higher than the strategies applied separately (Leyton, 1983; Nordin, 1979; Tenenbaum, 1986).

If concept mapping can produce benefits for certain kinds of skills and course content and not for others, the next logical step in the current study was to see if it could produce similar effects when presented in a combined condition with other strategies that might complement it. One group of subjects in this study was offered concept mapping and post-questioning with feedback on both, and with textual design strategies held constant. The purpose was to see if a combination of the strategies could produce cognitive achievement higher than that produced by the conditions separately (a test of Bloom's hypothesis).

On the whole the combined condition failed to outperform the individual effects of the experimental conditions. These findings, however, have to be interpreted with extreme caution as there were several difficulties with the manner in which the strategies were combined in this study.

Existing work with combining strategies have all employed mastery learning as one of the combined strategies. Although aspects of mastery learning such as feedback, modular course structure, and tutorial assistance were present in the current study, true mastery learning was not

one of the strategies that was applied here, either in a combined condition or separately. Moreover, there were several limitations with the manner in which strategies were considered as "combined" in the current study. Firstly, concept mapping exercises and post-questions were not asked in the same lesson tests. Those that included mapping exercises did not contain post-questions and vice versa. This is not the way Bloom and his colleagues went about combining strategies in their studies. The strategies in their studies were applied across the course content and throughout the teaching-learning process, not on individual parts of the course. Consequently, strategies in the combined condition in the current study could not have had additive effects as they were focussed on different parts of the course content each time a strategy was in effect.

Secondly, the selection of strategies for combining in this study was entirely arbitrary and not guided by any of the principles suggested by Bloom. Thirdly, although Bloom has reported an effect size of .30 σ for "higher order questions", not all post-questions that were posed in the lesson tests in this study were higher order questions. Fourthly, the questions that were included in the lesson tests, and the concept mapping exercises that had been set were all optional and carried no grade points. Subjects need not have done them if they did not wish to or they did not have the time to do them. Fifthly, if subjects had not done the post-questions or the concept mapping exercises, then

they would not have been given any feedback, and as such, they would have missed out on one of the essential components of the treatment. In conclusion therefore, the outcomes that have been reported on the performance of the so called "combined condition" against the other treatment conditions in the current study are highly suspect and offer no support for either of the treatments. The reported results must therefore, be interpreted with extreme caution.

Conclusions

The application of concept mapping in the current study demonstrated more than anything else, the viability of the strategy within a print-based distance education environment. The adoption of the strategy in such a context comprised its most critical test, which it passed with a good measure of success, especially when the concept mapping exercises were optional and no grade points were attached to their completion. For the students therefore, the only immediate benefit for doing the concept mapping exercises was the receipt of feedback.

Assistance with concept mapping was provided only through a self-instructional workbook. Subjects reported finding this workbook "quite helpful". Such a document can be easily prepared and provided to students either as part of their study materials or as a separate document. There were complaints about how much time it took to draw the concept maps, but there were no complaints about not being able to

draw them. The consultants supported the use of the strategy and several of them reported having begun to adopt the strategy in their own work place. Presumably, as a result of mapping, the educational consultants' advisory task became more focussed as their discussion centered on a one or two page concept map as opposed to responding to questions from students. Comments made by consultants on student developed maps demonstrated a very thorough understanding of mapping strategy on their part which they, like their students, had acquired from the self-instructional workbook.

The use of concept mapping is defensible also on theoretical grounds. The original conceptualization of the strategy is grounded in Ausubel's theory of subsumption learning. Concept maps are suited for use as advance or graphic organizers. The strategy is process oriented and learner centered. The end product of mapping is less important and subject to reorganization depending upon the use a map is put to. As a means for assisting cognitive processing, the approach surpasses other strategies such as mnemonic devices which are esoteric, idiosyncratic strategies and of no value in peer group discussions and commenting upon from instructors or tutors.

Apart from these overall comments, specific conclusions that can be derived from the findings of the current study are as follows:

Feedback. Evidence from the current study, in favor of providing feedback was overwhelming, when compared with no

feedback. In this study post-questioning without feedback comprised the control condition and it was outperformed by all the other treatment conditions with feedback. Feedback is rarely provided in DE settings on post-questions or inserted questions which do not contribute to students' grades directly. The findings of this study demonstrate the need to do so and also to provide intentional feedback in a controlled format (i.e., after the learners have attempted the activities themselves first).

The nature of learning activity. The fact that feedback produced positive outcomes was not so surprising. The interesting finding of this research is that the nature of the learning activity on which feedback is provided is a very important consideration as well. Concept mapping with feedback provided on completed mapping exercises outperformed post-questioning with feedback. This was true though, only on the multivariate stepdown analysis and on three of the DVs from the final examination in the univariate analysis.

Effects of concept mapping. There is some evidence which suggests that concept mapping has greater potential for performance on essay type questions and can cause a decrement in performance on multiple-choice items, at least initially. The high concept mappers in this study were outperformed by all the other treatment groups on multiple-choice items in the midterm examination. The benefits of concept mapping on essay-type questions are not immediately visible either.

Evidently the strategy requires a fair amount of practice before it is of any benefit to the mapper.

Subjects from the concept mapping group did not outperform those from other treatment conditions on essay type questions in the midterm exam that were cued to content with mapping exercises. But there was a trend towards higher achievement on essay type questions in favor of concept mappers which continued to become substantially distinct towards the end of the course (i.e., in the final exam). This trend in favor of subjects in the mapping condition was also visible on essay questions that were cued to content without mapping exercises. These results were significant only on the univariate tests of group differences. Presumably once skill in mapping is acquired, it is in a position to influence performance on items that are not directly related to the mapping content. The positive effects of mapping were visible on the recall of key as well as related idea units. This was to be expected as concept mapping helps to identify both key as well as related concepts along with the relationships among them.

Effects of persisting with mapping. Concept mapping is for most people a time consuming and a fairly daunting task. Experience with the use of the strategy has shown that most people do not wish to draw maps, at least in the beginning. It was expected there would a fair number of subjects in the current study who would not want to do the suggested mapping exercises, especially when there were no grade points

attached to them. As anticipated, the attrition rate from the concept mapping condition was high. The most common reasons given for not persisting with the mapping exercises were the same as those encountered by other researchers. These were that, concept mapping was too time consuming to do and incompatible with their own styles of studying and learning.

The differences between performance of subjects who persisted with mapping exercises and those who did not were to be expected. In the current study, subjects who persisted with concept mapping exercises outperformed those who did not on the recall of key and related idea units on essay type items in the final examination that were cued to content with and without mapping. This shows that a fair amount of practice is necessary before the results of mapping are detectable. However, this result was visible only on the univariate tests and it did not pass both the correction procedures applied in the analysis.

Effects of combining strategies. A small body of research from conventional educational practice has demonstrated that combining instructional strategies can produce additive effects. The combined effects of concept mapping and post-questioning with feedback provided on both were no greater than those of the same strategies applied separately in the current study. However, there were several problems with the way the strategies were combined in the study, so the results can not be taken to have not supported the hypothesis in this regard.

Implications for Practice and Research

The implications of the current study are attributable to both the practice of instructional materials development in DE, and research with instructional strategies in the context.

Existing literature on instructional materials design and development for DE contexts is replete with instances of personal and institutional experiences with particular technologies, student populations, geo-political contexts, or economic circumstances. Much of this is the result of a belief that DE is somewhat different from conventional forms of educational activity and as such, DE materials have different requirements and expectations. A great deal of effort has consequently, been devoted to the elucidation of the processes of DE materials development including the costs of its development and production, stocks, editing, printing, distribution, and also to more sensitive issues such as course designer-faculty relationships and course team dynamics.

The current research adds to this pool of knowledge by exploring the "content" of instructional materials design process. Most DE institutions now routinely employ educational technologists, course developers, instructional designers in academic capacities to work with subject matter experts in the development of materials for DE applications. While the prescribed roles of such personnel may be to provide instructional design expertise, most of them usually

end up performing a range of functions including editing and supervising the production and distribution of course materials. Often, their instructional designer's role is relegated to a secondary spot, behind that of their producer-editor's role. A very common reason for this occurrence is that many of them lack any formal training in instructional design.

Faculty and subject-matter experts in the context, often with good intentions and sometimes not, are anxious to know, what it is that the instructional designer or educational technologist can do that they themselves can not do? After all, they are the subject matter experts and have probably been teaching the content for several years. What can the instructional designer offer them now? This is a very sensitive issue and when the question is not satisfactorily answered, the credibility of the instructional designer in the context is destroyed and the role takes on a very subsidiary function.

There is no excuse for this because instructional designers have an important function especially in instructional contexts where instructors are physically not present such as in DE settings. Instructional designers have to learn to do their jobs better. Being concerned about statement of objectives, typographical and graphical access structures in text, and the style of presentation comprise rather superficial concerns. Designers have to become familiar with the "content" and "methodology" of

instructional design. By this I mean, having knowledge of a repertoire of instructional strategies (variables), their effects, strengths and weaknesses, and also how to go about implementing (designing) these strategies in a variety of instructional contexts ranging from print-based to computer-based applications and multi-media hybrid systems. Unless this depth of expertise is forthcoming from the instructional designers, course developers, educational technologists or by whatever title they are called, I am afraid such personnel will always be expendable, their contribution suspect and of only peripheral significance to the materials development process.

The implications of the current study are also important to research on various aspects of instructional materials development. In order to perform in their jobs, instructional designers and educational technologists must be engaged in doing research with instructional strategies. Relying upon evidence from conventional educational practice or one's "sound judgement" is likely to be inadequate. Instructional contexts without the physical presence of the human instructor for much of the process, introduces several variables that pose complex challenges for the instructional designer or the educational technologist. Without research evidence on the influence of particular variables on the instructional process, the designer's expertise is going to be improperly conceived and therefore poorly founded.

The current study is considered a significant contribution in this regard. Firstly, it has successfully demonstrated how selected instructional strategies can be implemented without much difficulty in a print-based distance education environment. Secondly, it has shown how educational technologists or instructional designers can go about doing meaningful and systematic research with particular instructional variables for the benefit of their learners as well as the process of instructional materials design. Thirdly, the current research project has not only demonstrated a successful application of concept mapping in a print-based DE environment, but shown that the effects of the strategy on instructor prepared measures can be positive.

While the implications of the current study for instructional design and research with instructional strategies is clear enough, the findings here have to be considered with certain characteristics of its research context in mind, which might weaken its generalizability.

Subjects in the study comprised an unusually homogeneous sample. They were all women in their thirties and most of them were married and supporting young families. All of them were registered nurses with several years of work experience and comprised a highly motivated group of learners. At the time of the research, subjects were registered in only one DE course within which this study was carried out. Their progress in the entire program, as described in the methods

chapter was highly structured, and within this course, paced by a weekly study schedule of readings and assignments.

These assignments were assessable and with the midterm and final examination marks made up the course grade. The instructional activities that were incorporated as part of the study could not be made assessable and therefore, had to be kept optional. In most DE contexts students are, neither as homogeneous nor highly motivated, in which case similar positive outcomes of concept mapping may not be as visible. Moreover, in educational contexts that are driven by performance, instructional activities that do not carry grade points are often considered distracting and unlikely to be taken seriously, no matter how good their benefits are. With less homogeneous samples and optional instructional activities, the outcomes of concept mapping may not be the same.

Recommendations for further research. In light of the findings of this study and some of the unique characteristics of the context within which it was carried out, the current research would benefit with extensions on several fronts. These are briefly outlined in the following.

- **Subjects.** Given the rather unusual characteristics of the study sample, research involving less homogeneous groups of distance learners may produce different outcomes.

• **Instructional contexts.** As Weston and Cranton (1986) point out, matching of instructional strategies with characteristics of the instructional setting is a highly complex process which requires consideration of several variables. The current study with concept mapping would benefit with its extension, not only in other DE settings but other forms of self-instructional learning environments as well.

• **Content.** Evidence from the current study and others that have preceded it has shown that concept mapping clearly has greater potential for certain kinds of learning tasks and not for others. Research can continue to explore other dimensions of this finding with the application of concept mapping with other kinds of course content such as procedural material and problem solving tasks.

• **Approaches to learning.** Existing research with concept mapping has shown that some find the strategy more palatable than others. There is a growing body of literature on learning styles and approaches to learning that should be examined for its potential in developing study skills. If, for instance, certain approaches to learning seem more preferable than others for particular kinds of contents, perhaps these could be cultivated with selective use of instructional strategies.

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APPENDIX A

Sample Lesson Material from Study Guide
(including instructional activities)

Note. Each lesson included one form of instructional activity
at the end of the lesson (i.e., either a self-assessed test,
consultant-assessed test or concept mapping exercises).

Module One
LESSON FIVE (Week 5)
Psychiatric Evaluation: Nursing History

Introduction

In all areas of nursing, assessment and evaluation are important. In the area of mental health it is of extreme importance. It includes processing the patient's non-verbal clues and integrating other information. In this lesson the role of the nurse, the knowledge and skills needed, and interviewing skills will be addressed. Stages of the evaluation, mental status examination, and other relevant data to be collected will be discussed. Disposition of the patient through nursing diagnosis will form a crucial part of the total evaluation in this lesson.

Key Concepts

The role of the nurse
Basic elements of a psychological assessment
Interviewing skills
Stages of evaluation
Collection of data
Mental status examination
Case disposition
Nursing diagnosis
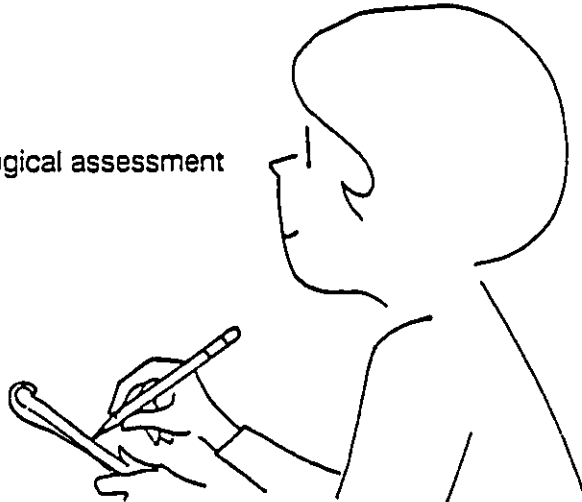
Objectives

After studying this lesson, you should be able to:

1.   Identify the basic elements of a psychological assessment interview.

2.   Describe the elements of a psychological assessment.

3.   Identify the major categories of data collection.

4. Identify the major categories of mental status examination.

5. Name the three areas considered important in making a case disposition.

Required Readings:

Barry, P. (1988). Psychosocial nursing assessment and intervention: care of the physically ill person. J.B. Lippincott Company: Philadelphia. pp. 157-168 & 213-232.

Mundinger, M. & Jaurer G. (1975) Developing a nursing diagnosis. Nursing outlook, 23, 94-98.

Stuart, G. & Sundeen, S.J. (1987). Principles and practice of psychiatric nursing. The C.V. Mosby Co.: St. Louis. pp. 187-210.

Suggested Readings:

Reynolds, J.I. & Logsdon, J.B. (1979). Assessing your patient's mental status. Nursing 79, 9 (8), 26-33.

Snyder, J.C. & Wilson, M.F. (1977). Elements of a psychological assessment. American Journal of Nursing, 77, 235-239.

Vincent, P., Broad, J. & Dilworth, L. (1976). Developing a mental health assessment form. Journal of Nursing Administration, 6, 25-28.

DISCUSSION OF LESSON

The Role of the Nurse

At one time the task of psychiatric, or psychological assessment, was ascribed to the physician, usually a psychiatrist. The holistic approach to the study of humans implies assessment of their psychological needs and potential. Nurses who are trained in caring for the patient include psychiatric evaluation as part of the assessment skills they acquire in nursing school. This evaluation is primarily a reorganization of knowledge and skills already acquired. Basic knowledge of human behavior combined with interviewing and assessment skills are the necessary tools for performing a psychological evaluation. Like most skills, it is easily learned with practice.

On page 188 of your textbook the role of the nurse is described. The role of the nurse in different settings is illustrated. Read this and answer the following question.

- **What is the difference between the role of the nurse and that of the psychiatrist in a psychiatric assessment?**

Elements of a Psychological Assessment

In order to do a psychological assessment certain tools are necessary. You need an understanding of human behavior, interviewing techniques and some understanding of psychopathology. In your manual of readings, in the article *Elements of a Psychological Assessment,* ten elements are described which make up an eclectic approach to psychological assessment. The authors ask questions at the end of each element.
Read this article now and answer the questions found at the end of each of the elements.

This is not all new material. You have already been introduced to expression of thoughts, your feelings, and interviewing skills.

Interviewing Skills

The two most important elements of a psychiatric interview are history taking and mental status examination. You have already developed your interviewing skills. It is important now to use those interviewing skills to gather the data you need to make an effective assessment. Your textbook describes interviewing skills and the art of gathering the data you need. It gives examples of hospitalized patients and a specific case of how a nurse spoke to the patient with Hodgkin's disease.

Stages of the Evaluation

In order to take a history, it is important to have a strategy for gathering the information you need. We call this "stages of the evaluation". After gathering a number of histories the process will become easier. Your textbook on pages 191-194 goes into the different stages of this evaluation.

Read these pages and answer the following question in your notebook.

- **In taking a history what should the main emphasis be?**

The Mental Status Examination

A mental status examination determines if there are abnormalities in the thinking, the feeling or behaving of the person being examined or assessed. It is not necessary to carry out a formal question and answer examination in order to evaluate a person's mental status. You could get a good idea of a person's mental status by being attentive to how he thinks, expresses himself and behaves during your normal nursing assessment process. In Barry's book (Chapter 12 pages 157-167), the importance of mental status observation and the categories of mental status evaluation are outlined. This includes:

- level of awareness and orientation
- appearance and behavior
- speech and communication
- mood or affect (feeling state)

- disturbances in thinking process, disorganization of thought process, disturbance in content of thought (delusions, phobias, obsessions), problems with memory and concentration
- problems with perception (hallucinations or distortions of reality associated with any of the senses)
- abstract thinking and judgement.

Barry also goes on to talk about assessment of suicide potential. (See Figure 6 regarding Ecology of Suicide in Provinces of Canada.) An assessment of suicide potential is necessary for a patient who is acutely or chronically depressed. This is another aspect of mental status evaluation. Mention of the word suicide gives most people an unpleasant feeling, so the word is often not used even though it should be. It is perfectly alright to ask the patient if he has ever thought about suicide and if he has a plan.

Read this assessment of suicide potential in Barry's book (pages 167-168) and answer these questions.

1. Why is it important to do a mental status evaluation?

2. Why is it very important to asses the suicide potential of your patient?

Case Disposition

After you have gathered this information you make a nursing diagnosis and a case disposition. In your textbook a brief summary of factors to consider in making a decision about a case disposition is presented. The authors give three general areas to consider: the problem, the limitations and strengths of the individual, and the treatment resources available. At this point, read page 207 of your textbook and answer the following question in your notebook.

- What, if any, similarities do you see between the psychiatric evaluation and the nursing process model regarding assessment?

Figure 6

Standardized Average Suicide Rates
Provinces of Canada (1969–71 and 1979–81)
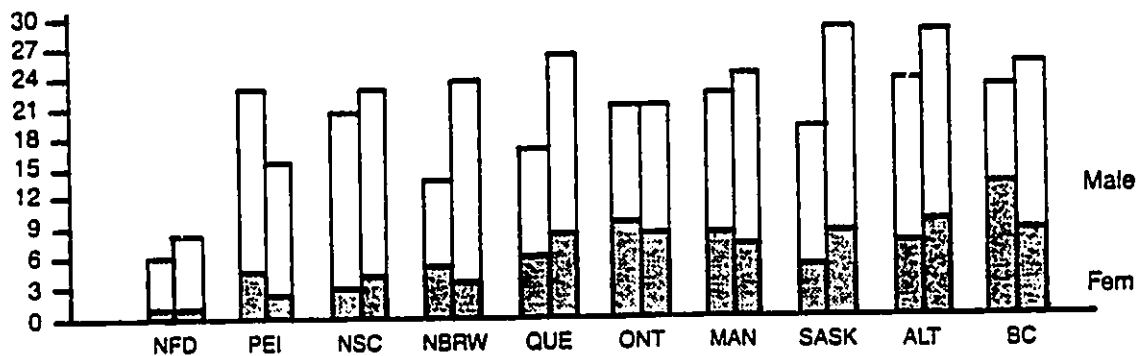
Source : Sakinofsky, I. and Roberts, R. The Ecology of Suicide in the Provinces of Canada. In B. Cooper (Ed.), Psychiatric Epidemiology: Progress and Prospects (provisional title). London: Croom Helm, in press.

Provinces with Low and High Change in
Male Suicide 1971–81: Alcohol Related
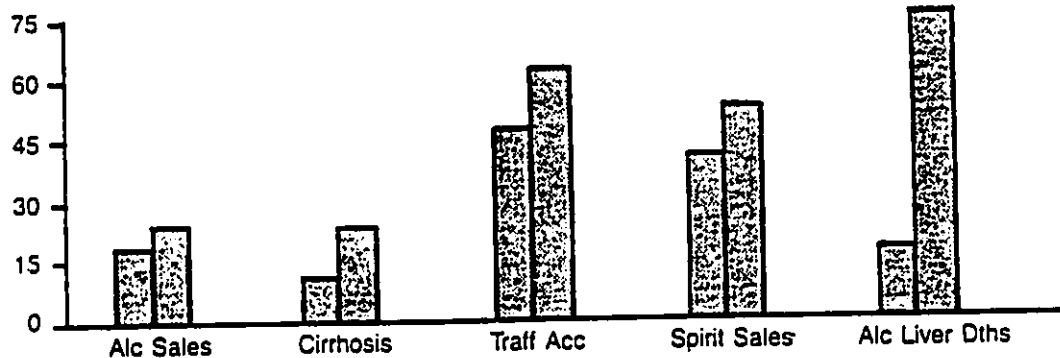
Source: Sakinofsky, I. and Roberts, R. The Ecology of Suicide in the Provinces of Canada. In B. Cooper (Ed.), Psychiatric Epidemiology: Progress and Prospects (provisional title). London: Croom Helm, in press.

Provinces with Low and High Change in
Female Suicide 1971–81: Alcohol Related
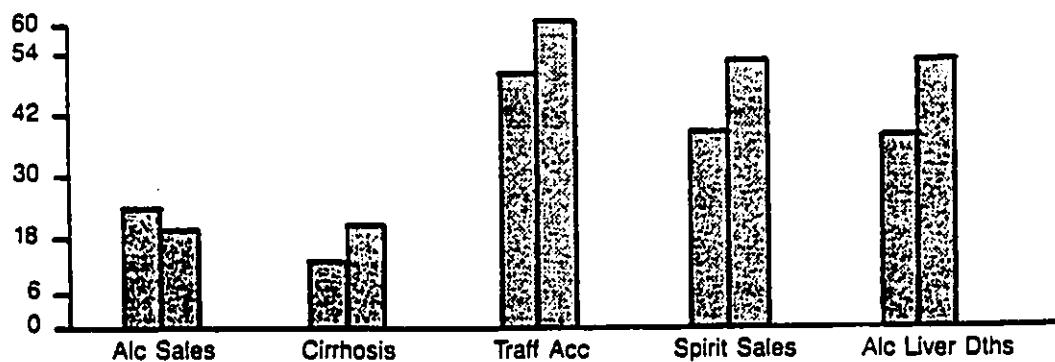
Source: Sakinofsky, I. and Roberts, R. The Ecology of Suicide in the Provinces of Canada. In B. Cooper (Ed.), Psychiatric Epidemiology: Progress and Prospects (provisional title). London: Croom Helm, in press.

Nursing Diagnosis

The nursing diagnosis is a statement of a patient's problem which is arrived at by collecting data and making inferences from this data. There is an article in your manual of readings called *Developing a Nursing Diagnosis* by Mundinger and Jauron. In this article the authors describe a broader definition of nursing, and talk about the importance of documentation and their demonstration project. They also define diagnosis and make a two-part statement, mistakes to be avoided and how to form a nursing diagnosis.

Read this article now and answer the following questions.

1. Why is it important to be able to develop a nursing diagnosis?

2. Briefly outline how this article describes the formation of a diagnosis.

SELF-ASSESSED TEST
Module One : Lesson Five (Week 5)

Instructions

Please be sure to respond to all of these questions before moving on to the next lesson. After responding check your answers in your course materials.

1. Name the stages of the psychiatric evaluation.

2. In ascertaining a patient's presenting problem, what kind of information should you try to obtain?

3. List the major categories of data that should be collected in doing a history.

4. What are the areas to be addressed in the general medical history?

5. Briefly explain how a presenting problem might be related to the patient's history?

CONSULTANT-ASSESSED TEST
Module One : Lesson Five (Week 5)

Instructions

Based on the discussion in your study materials of the "psychiatric evaluation process" respond to the following questions now and submit your completed answers to your educational consultant to receive feedback.

1. Name the stages of the psychiatric evaluation.

2. In ascertaining a patient's presenting problem, what kind of information should you try to obtain?

3. List the major categories of data that should be collected in doing a history.

4. What are the areas to be addressed in the general medical history?

5. Briefly explain how a presenting problem might be related to the patient's history?

CONCEPT MAPPING EXERCISE
Module One : Lesson Five (Week 5)

Instructions

Based on the discussion in your textbook of the "psychiatric evaluation process", do the following concept mapping exercise now and submit your completed map to your educational consultant to receive feedback and a copy of the concept map developed by your course instructor.

In order to help you develop these concept maps, you have been provided with a workbook on concept mapping. Be sure to have worked through it carefully before attempting to do the following mapping exercises.

Develop a concept map of the discussion in Stuart & Sundeen, (pp. 192-194), of the major categories of data that should be collected while taking a patient's history.

- You will probably find this mapping exercise a little more difficult than the previous two. Identifying key concepts (main points) from wordy discussions such as those you will find in your textbook will take time, and you will get frustrated. If you do, then you might be trying to take every point from the discussion to put it on your map. That is not the idea. **Try to select the main points only for your map.**

- But by now, I am sure you must be feeling a lot more comfortable with developing concept maps and probably finding the exercise useful.

- As you continue to do the mapping exercises in the coming lessons, you will be spending a lot less time than you did before on developing concept maps.

APPENDIX B

Consultant's Guide

(for providing feedback on post-questions)

POST-QUESTIONS
Consultant's Guide

Som Naidu

Developed as part of materials for
doctoral dissertation research
(July, 1990)

Concordia University
Department of Education
1455 de Maisonneuve Blvd. West
Montréal, Québec
CANADA, H3G 1M8

Introduction

Your students will be doing a number of consultant-assessed tests (CATs) in this course. This guide outlines the procedures for taking these tests, and includes forms at the end for keeping records of student progress.

Our hope is that the knowledge that will be derived from your participation in this exercise with us, will help improve the delivery of our courses in the distance education mode.

Consultant-assessed tests

These are tests that appear at the end of selected lessons in the students *Study Guide*. They comprise mainly objective and short answer-type questions and are based on the objectives of the lessons. In order to help you assess student responses and provide corrective-feedback on them, we have sent you annotated answer sheets for each of these tests.

Corrective-feedback is different from other forms of feedback, in that it is designed to correct a wrong response, by explaining the correct and incorrect answers to a question. The annotated answer sheets you have been sent, have been prepared to serve this purpose.

Procedures

The consultant-assessed tests are open-book tests and students will take them in their own time, immediately upon completing all the required work for that lesson. The submitted answers will not be graded, only corrective-feedback on them will be provided.

Instructions to students regarding the procedures for taking the CATs are given in their *Study Guide*. The procedure is as follows:

- For selected lessons in this course, students have been presented with consultant-assessed tests. These tests appear at the end of the selected lessons in the students *Study Guide*.

- Students are to take these tests immediately after completing study of the lesson material and send you their answers for assessment and feedback.

- Please note the date the test answers are received from the students on the record sheets at the end of this booklet.

- Assess the student answer sheets as soon as they are received with the help of the annotated answer sheet you have been sent. You are not required to give them a mark or grade on these tests. Give them generalized feedback and indicate their correct and incorrect responses.

- Return them their answer sheets along with a copy of the appropriate annotated answer sheet we have sent you and note your mailing date on the record sheets at the end of this booklet.

- Sending the annotated answer sheets will serve as an incentive to students for doing the CATs.

- Students may move on to the study of the next lesson or module without waiting for feedback on completed tests.

- Be sure to make a photocopy of the student answer sheets for the course professor, before returning them to the students, and please send these in to her as the students complete each test. Do not wait for these to accumulate before sending them in.

Keeping records

It is important that you keep complete records on individual student progress with the CATs on the forms provided for this purpose at the end of this booklet. Please tear off these forms and send them in to the course professor, Sister Loretta Gillis, at mid-term and at the end of the course.

Comments: In the space below please make comments about any aspect of this exercise you found particularly *interesting* or *difficult*, and also how your students coped with it.

RECORD OF CONSULTANT-ASSESSED TESTS

Student Name	Test 1		Test 2		Test 3	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

RECORD OF CONSULTANT-ASSESSED TESTS

Student Name	Test 4		Test 5		Test 6	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

RECORD OF CONSULTANT-ASSESSED TESTS

Student Name	Test 7		Test 8		Test 9	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

RECORD OF CONSULTANT-ASSESSED TESTS

Student Name	Test 10		Test 11		Test 12	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

APPENDIX C

Concept Mapping Workbook

(for students)

CONCEPT MAPPING WORKBOOK

Som Naidu

Developed as part of materials for
doctoral dissertation research
(July, 1990)

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What is concept mapping?

Concept mapping is identifying key concepts in a body of subject matter and arranging those concepts around a focal concept. It also involves linking the selected concepts by lines and labelling them to show meaningful relationships between and among the concepts.

Why do concept mapping?

Concepts depend upon their relationships with other concepts for meaning. A personal grasp of these relationships between and among concepts characterizes meaningful learning. Concept mapping, with its emphasis on linking concepts to other concepts, events and objects has been shown to be an effective means for enhancing meaningful learning.

Concept mapping skills, once acquired, can be useful in a variety of circumstances, such as in: a) reading and studying; b) planning an assignment, paper or report; c) organizing information on a presentation, and d) preparing for tests and/or examinations.

What is a concept map?

A concept map is a graphic arrangement of the key concepts in a body of subject matter with connecting lines labelled to show valid and meaningful relationships between the chosen concepts. Each concept map represents a personal expression of meaning in the selected material and as such, concept mapping is an idiosyncratic learning and working strategy which serves to satisfy a mapper's particular approach to understanding a body of selected material. Typically, a concept map comprises a number of selected key concepts, one of which is identified as the focal concept on the map. The selected concepts are linked by lines with arrows and labelled to stipulate meaningful relationships between them.

A focal concept is a concept that is of special interest to a mapper and is the focus of the particular map. On a page the focal concept can be placed at its center, on the sides, at the top or at the bottom. Usually, the focal concept is chosen from the most

general concepts in the selected material. However, the choice of a focal concept is a personal decision and a number of mappers of the same material are quite likely to differ in their choice of focal concepts. One person's focal concept may not be his/her, or another person's focal concept in another map of the same material. Figures 1, 2 and 3 which are reproduced from Novak & Gowin (1984, p. 16 and 18), illustrate this kind of shifts in focal concepts in three different maps of the same material.

Lines connecting the selected concepts on a map and labelled with valid and meaningful propositions reveal relationships between concepts. Propositions are two or more concepts linked by words to stipulate a meaningful relationship. For example, "snow is white" represents a simple concept map forming a valid proposition about the concepts "snow" and "white". Lines from one part of the map to another represent "cross links" and they reveal relationships between concepts in different parts of the map.

Figure 1. A map of the concept of water showing the focal concept "water" and related concepts.
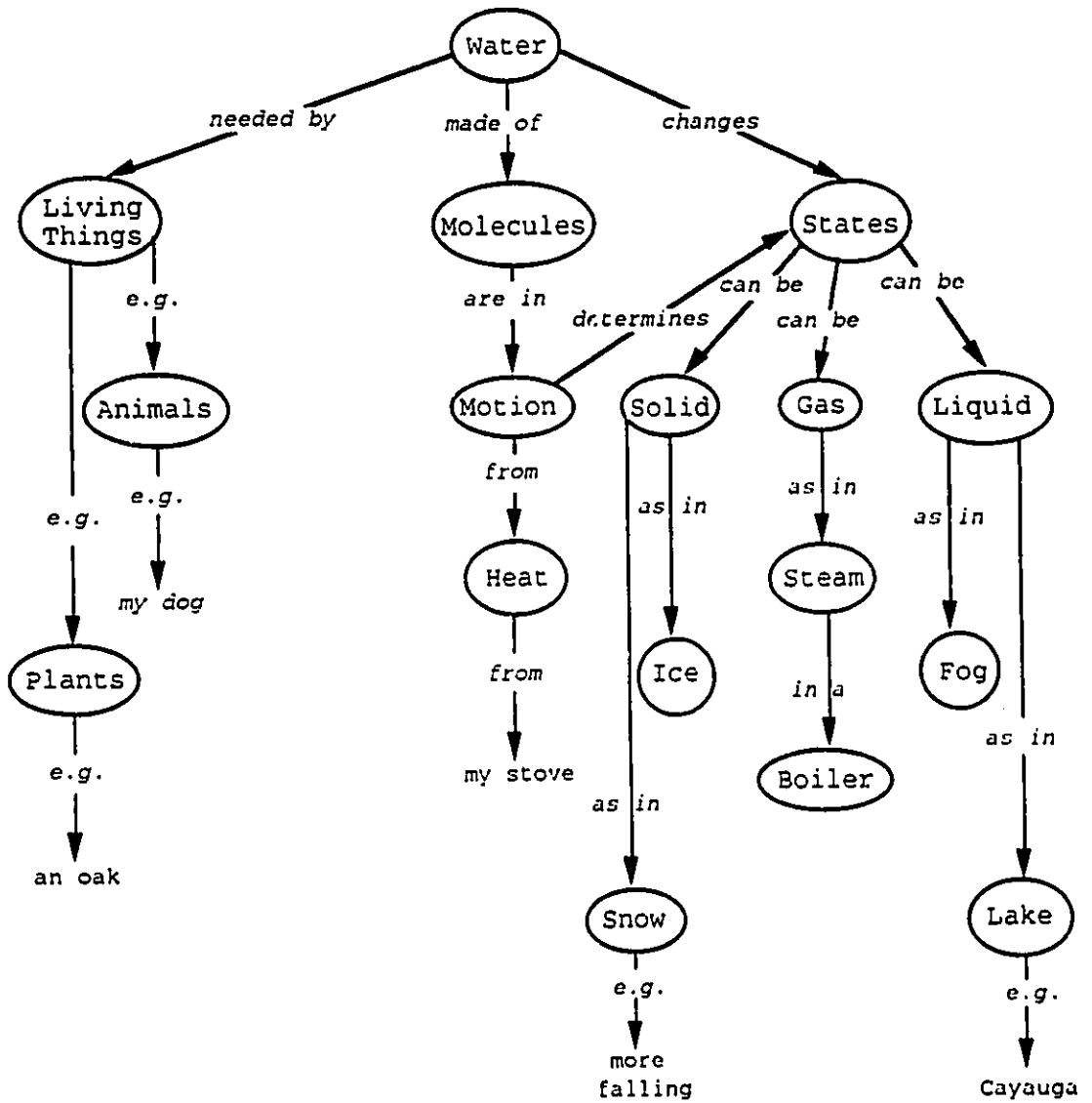
Figure 2. A partial map of the subject matter in Figure 1 with a
different focal concept - "living things".
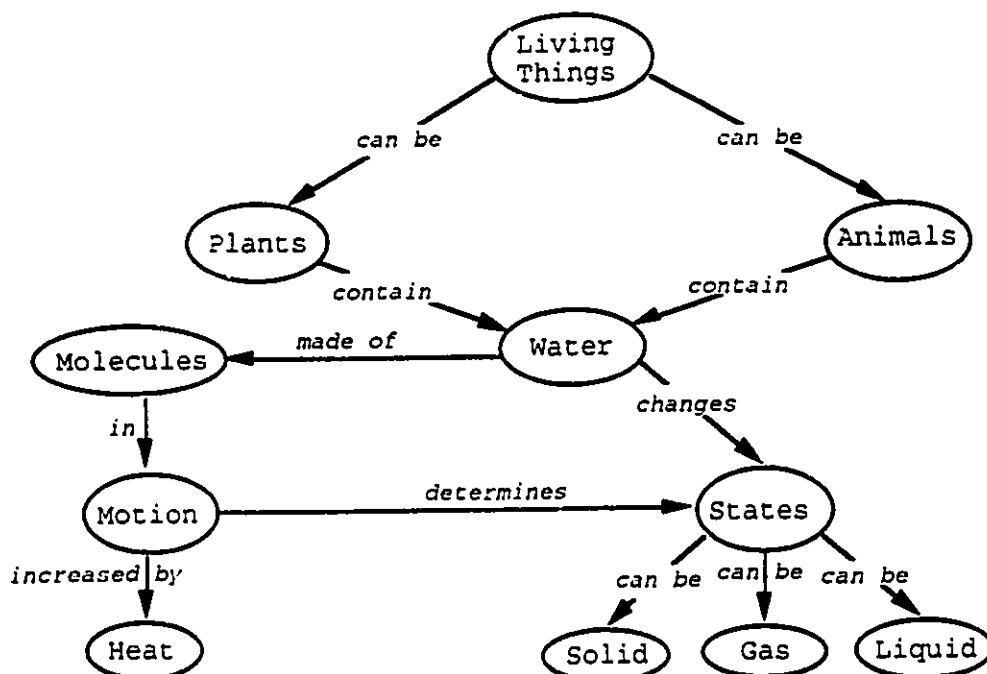
Figure 3. A partial map of the subject matter in Figure 1 with yet
another focal concept — "molecules".
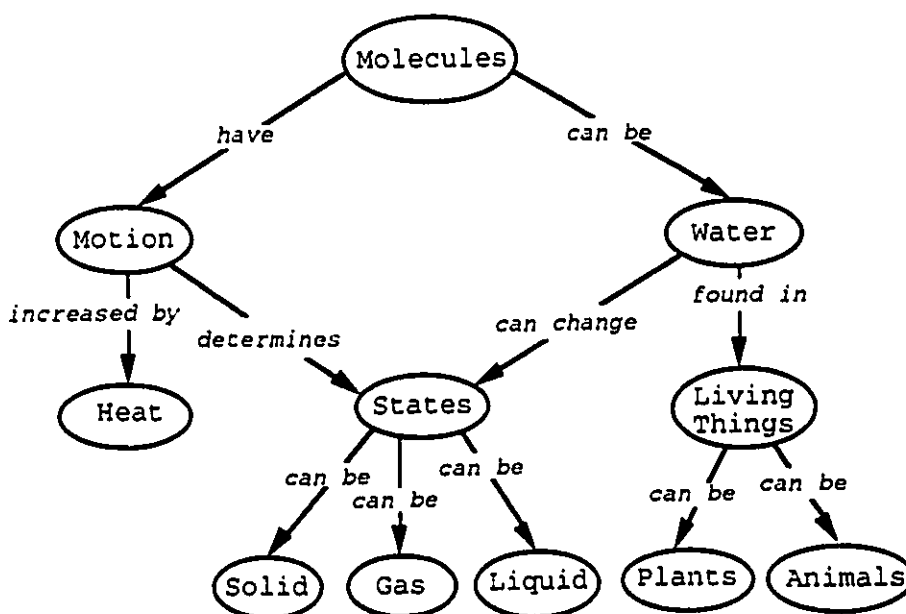
How do you develop concept maps?

Concept maps are developed by identifying key concepts, events, and objects in a body of subject matter and arranging these around a focal concept with connecting lines to show valid and meaningful relationships between and among them.

The "raw material" for the maps you are to develop will come from your study materials and these are specified in your *Study Guide*.

The procedure outlined in the following steps should be helpful to get started. I will use this procedure here to demonstrate its usefulness in the development of a concept map. Later on you will have an opportunity to develop your own map using the same procedure.

Step 1: Identify the key concepts, events and objects in the material that is to be mapped. This requires a careful reading of the selected material and separating the key concepts, events and objects from the rest of the text.

For this example, I have selected a passage from Barry, P. D. (1989). *Psychosocial Nursing Assessment and Intervention: Care of the Physically Ill Person* (2nd ed.). Philadelphia: J. B. Lippincott Company. Only a part of the selected material is reproduced below. The remainder of the text, appears on pages 32-34 of Barry's book.

As I read through the material, I made a separate list of the key concepts I identified. You might find it easier to simply highlight them in your book.

A Theory of Personality Development
Maslow's: Hierarchy of Human Needs

Abraham Maslow...believed that personality develops because of a person's need for satisfaction, happiness, and growth. Maslow believed that there are five levels of needs in human beings. He called his theory the hierarchy of human needs. The main view of his theory is that the first level of needs must be met before one can strive for the next level of needs, the second level must be met before one can strive for the third, and so on. The needs are organized according to their potency and primacy. The five needs are: 1) physiological needs; 2) safety needs; 3) love and belonging needs; 4) esteem needs; and 5) self-actualization need...

List of key concepts identified.

Key concepts:
- Maslow's hierarchy of human needs.
- Personality development — satisfaction, happiness, growth.
- Levels of human needs — potency, primacy.
- Psychological needs — food, shelter, sleep, sexual gratification, physiological equilibrium, lack of pain. Not met — death.
- Safety needs — predictable social, physical environment. If unfulfilled — emotional damage, fear.
- Love and belonging needs — family, friends, social acceptance, enduring intimacy. Essential for full social development.
- Esteem needs — self-worth, positive self-image, self-acceptance. For adults, competence, reputation, satisfaction, self-value.
- Self-actualization needs — development of full potential, motivates all human behavior.

Step 2: *Select* a focal concept from the list of key concepts and *cluster* the concepts according to the extent to which they interrelate closely. There are no fixed rules for selecting a focal concept. It satisfies your need to find meaning in the material. The clusters or groupings of concepts you will come up with, will reflect your personal judgements about closeness of association among them. Discussion with friends and colleagues may help to clarify these judgements.

If your focal concept is the same as that of the author of the material, there will exist an order there which you might want to keep. My focal concept is the same as that of the author of the

material I have chosen to map, so I am retaining the order in which the key concepts are presented there.

<u>Focal concept and clusters of related key concepts</u>.

Focal concept:
  Maslow's Hierarchy of Human Needs.

Related concepts:
Abstract Concepts:
• Personality development.
  * satisfaction.
  * happiness.
  * growth.
• Levels of human needs.
  * potency.
  * primacy.
Specific Concepts:
• Psychological needs.
  * food, shelter, sleep, sexual gratification, physiological equilibrium, lack of pain. Death.
• Safety needs.
  * predictable social, physical environment. Emotional damage, fear.
• Love and belonging needs.
  * family, friends, social acceptance, enduring intimacy.
• Esteem needs.
  * self-worth, positive self-image, self-acceptance. Competence, reputation, satisfaction, self-value.
• Self-actualization needs.
  * development of full potential, motivates human behavior.

Step 3: Arrange and *link* the focal concept and clusters of related concepts with lines. Your arrangement of the concepts for mapping is meaningful to you and is based, in part, on the focal concept you have selected. The use of arrows will help draw out the focal concept from the related concepts and communicate your arrangement of the concepts more effectively. Wherever necessary, I have used arrows in my map (see Figure 4). The focal concept and clusters of related concepts may appear in any order on your page. Another person mapping the same subject matter may well have a different and valid arrangement that is meaningful to him or her.

My arrangement in Figure 4 is obviously hierarchical, and is reflective of the nature of the selected material and choice of my

focal concept (i.e. Maslow's hierarchy of needs). However, this is by no means the only way I could have arranged the key concepts for mapping this material. I could have placed my focal concept on the side of the page, for instance, and still come up with a meaningful arrangement of the concepts.

Notice also that I have drawn ellipses around the concepts. Some of you might be inclined to use a variety of geometrical designs such as rectangles, circles and ellipses to separate the focal concept from related concepts and different clusters of concepts. Some of you may not like to use any form of geometrical designs at all, which may work just fine for you. I have chosen to use ellipses only, and their different sizes in this instance do not suggest anything special.

Step 4: Label the connecting lines on your map to show valid and meaningful relationships between the concepts. Work with one pair of concepts at a time. Once linkages are labelled, your map should be readable in the direction of the arrows.

Figure 4. Key concepts arranged, linked and labelled.
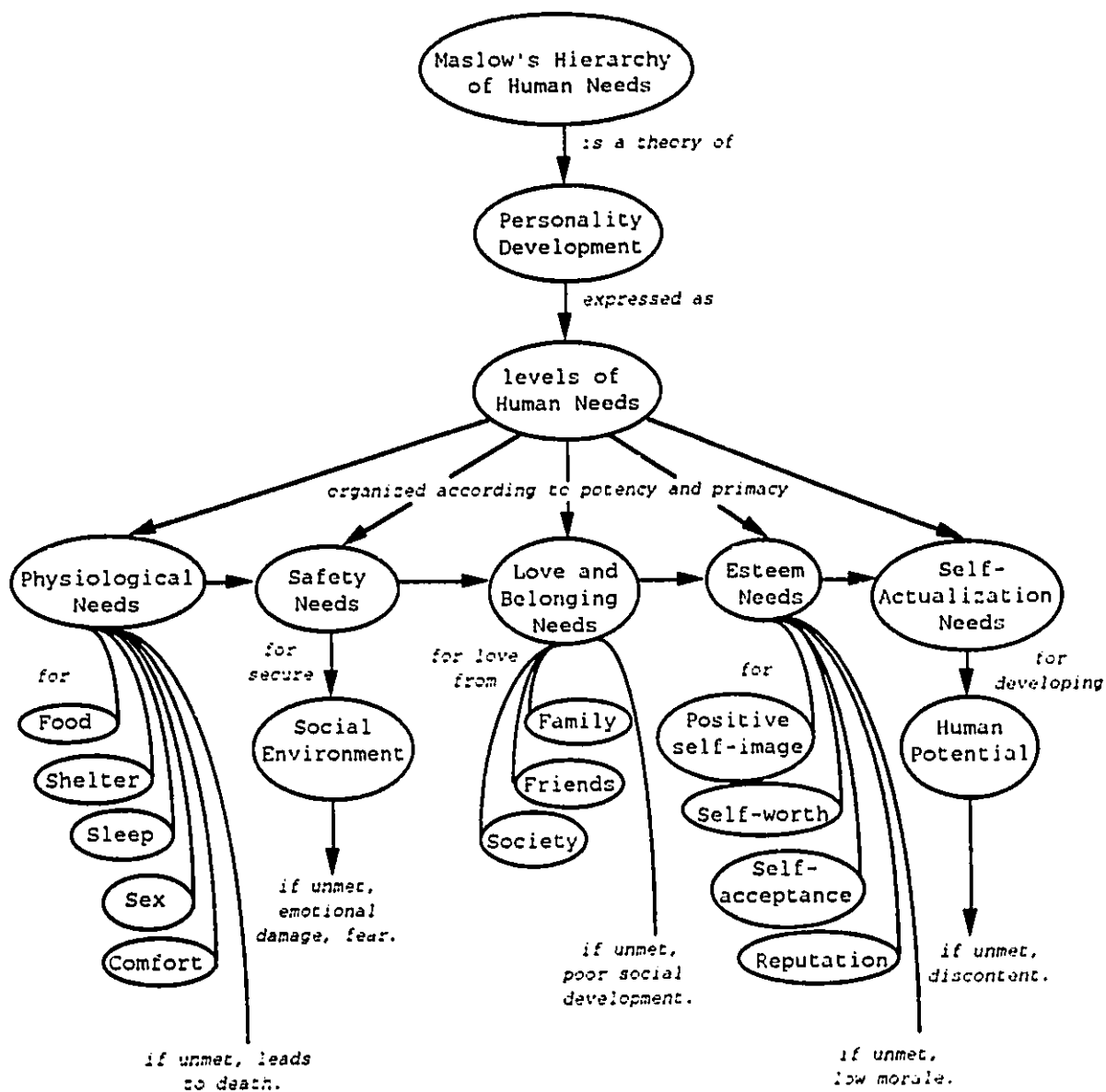
A practice exercise

For your subject matter, let us go back to *Chapter Three: Theories of Personality Development* in Barry, P. D. (1989). *Psychosocial Nursing Assessment and Intervention: Care of the Physically Ill Person* (2nd ed.). Philadelphia: J. B. Lippincott Company.

Step 1: Identify the key concepts in the material that is to be mapped. Only a small portion of the material selected for mapping is reproduced below. For the remainder of the text, refer to pages 28-29 in Barry's book. Read it through carefully before going on to do this exercise.

A part of the material selected for mapping.

Piaget: Cognitive Stages of Development

Jean Piaget...studied the intellectual stages of children's development through clinical interviews, observations and experiments. He believed that there are four stages in the intellectual development of the child...

Piaget's theories are important to nurses for many reasons. All nurses work in a pediatric setting at some time during their professional education. When patient teaching is necessary, it is important to understand the intellectual stage of cognitive development in which the child is functioning. If a nurse is preparing to teach a 9-year-old-patient with diabetes, about his illness, it is essential to avoid abstract concepts and those concepts that involve a level of reasoning that a child can not perform...

Partial list of key concepts in the selected material.

Key concepts:
- Piaget's stages of cognitive development.
- Sensorimotor stage (up to 18 months).
- Infant learns through senses.
- Attentive to things seen, and heard.
- Touches objects and explores environment.
- Able to predict outcomes of actions.
- Tests these in play.

Read through pages 28 and 29 in Barry's book and complete this list of key concepts.

Step 2: Select your focal concept and *cluster* the full list
of key concepts you have come up with, as suggested below. Since
your focal concept is the same as the author's, the related
concepts are fairly obvious and already clustered. Let us stay
with that order.

<u>Focal concept and partial list of clusters of related concepts</u>.

Focal concept:
• Piaget's stages of cognitive development.

Related concepts:
• Sensorimotor stage (up to 18 mths).
   * Senses.
   * Environment.
   * Predicts and tests outcomes.

Complete this list.

Step 3: Arrange and *link* the focal concept and clusters of related concepts with lines. Use arrows to indicate the direction in which you wish your map to be read. I have made a start for you in Figure 5 on the following page. Continue with it and complete the map. Notice that this time I have placed the focal concept (Piaget's stages of cognitive development), at the center of the page because it made good sense to me.

Step 4: Label the connecting lines on your map to show valid and meaningful relationships between the concepts.

Figure 5. Key concepts arranged, linked and labelled (next page).

References

Novak, J. D. & Gowin, D. B. (1984). *Learning how to learn*. New York: Cambridge University Press.

mother's response
by throwing bowl

e.g.

Predict and Test Outcomes of Actions

is able to

touch

sight

hearing

esp. esp.

esp. esp.

Senses

learns through

Sensorimotor stage (up to 18mths)

1st stage of growth

Piaget's Stages of Cognitive Development

explores

Environment
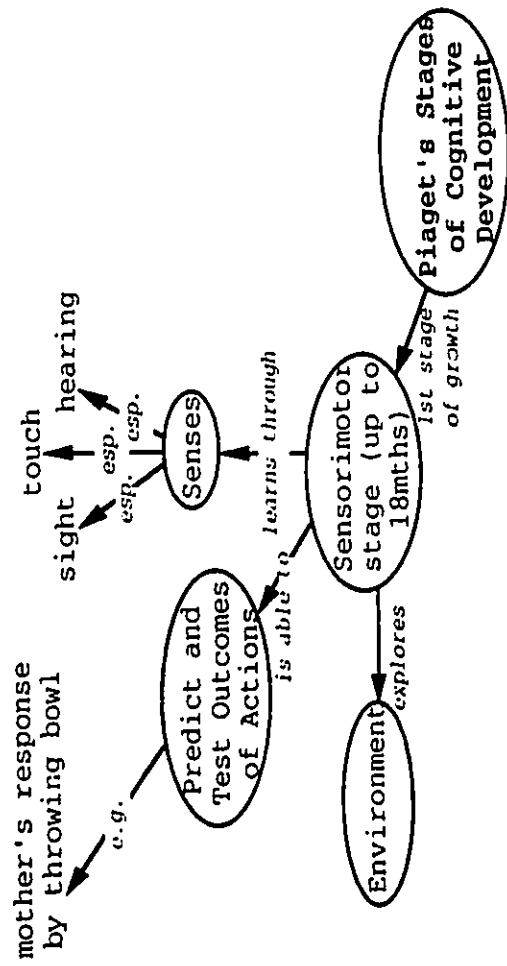
APPENDIX D

Consultant's Guide

(for providing feedback on concept mapping)

CONCEPT MAPPING
Consultant's Guide

Som Naidu

Developed as part of materials for
doctoral dissertation research
(July, 1990)

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Introduction

Your students will be doing a series of concept mapping exercises in this course. This guide outlines the procedures for concept mapping your students will follow, and your role in helping them develop the skill. It offers you guidelines for evaluating maps developed by students and includes forms at the end for keeping records of student progress.

In addition to this guide booklet, you should also have a copy of the *Student Workbook* on concept mapping, and it is advisable that you familiarize yourself with the contents of the workbook before looking through this booklet.

Our hope is that the knowledge that will be derived from your participation in this exercise with us, will help improve the delivery of our courses in the distance education mode.

Concept mapping

Concept mapping is the graphic arrangement of key concepts in a body of subject matter with connecting lines labelled to show valid and meaningful relationships between the chosen concepts. The mapping exercises your students will do in this course are specified at the end of selected lessons in the students *Study Guide*. The subject matter for mapping is drawn from the course materials provided.

Procedures

A self-instructional workbook on developing concept maps has been prepared for the students. The maps your students are to develop and submit to you will not be graded, only anecdotal feedback on them will be provided. In order to help you evaluate student developed maps and provide feedback on them, we have sent you completed maps for each of the exercises.

Instructions to students, regarding the development of these concept maps and their submission to you regularly in order to receive feedback, are given in their *Study Guide*. The procedure is as follows:

- For selected lessons in this course, students have been presented with concept mapping exercises. These exercises appear at the end of the selected lessons in the students *Study Guide*.

- Students are to do these mapping exercises immediately after completing study of the lesson material and submit the maps to you for evaluation and feedback.

- Please note the date the mapping exercises are received from the students on the record sheets at the end of this booklet.

- Evaluate the submitted maps, according to guidelines provided in this booklet. You are not required to give students a mark or grade on these mapping exercises. Give them generalized feedback on the adequacies/inadequacies, strengths/weaknesses and completeness/incompleteness of their maps, for instance, regarding the identification of the key concepts and the specification of valid relationships between the key concepts.

- Return them their mapping exercises along with a copy of the map developed by the course professor for that exercise. You have been sent these under separate cover and they should serve as incentives to students for putting in their effort first.

- Note your mailing date on the record sheets at the end of this booklet.

- Be sure to impress upon the students that the sample map you have sent them is **not** necessarily the *correct* map, but a more complete map of the subject matter, and one that they could use to examine their own effort against.

- Students may move on to the study of the next lesson or module without waiting for feedback on completed mapping exercises.

- Please be sure to make a photocopy of all student developed maps with your comments on them for the course professor. Send these in to her regularly. Do not wait for maps to accumulate before sending them in.

Guidelines for evaluating maps

Concept maps are graphical representations of the key concepts, and the relationships among them in a selected body of subject matter. For assessing student learning and providing them with feedback, concept maps are best applied as a qualitative tool and not intended to lead to a score.

We suggest you use the following guidelines for evaluating student mapping exercises and providing them with feedback. See Figure 1 for an illustration of these features in concept mapping as you read through.

Key concepts: Look for the focal and related concepts? Have they been identified clearly?

Relationships: Look for lines between these concepts, and arrows to indicate the nature of the relationships. The specific relationships should be indicated on these lines. Are the relationships indicated valid?

Cross links: Cross links reveal relationships between concepts on one section of the map with concepts on another section. Are there cross links indicated on the map? Do they show valid and meaningful relationships?

Examples: These are specific events, objects and valid instances of the key concepts represented on the map. Are these appropriately indicated?

<u>Figure 1</u>. Features of concept maps.
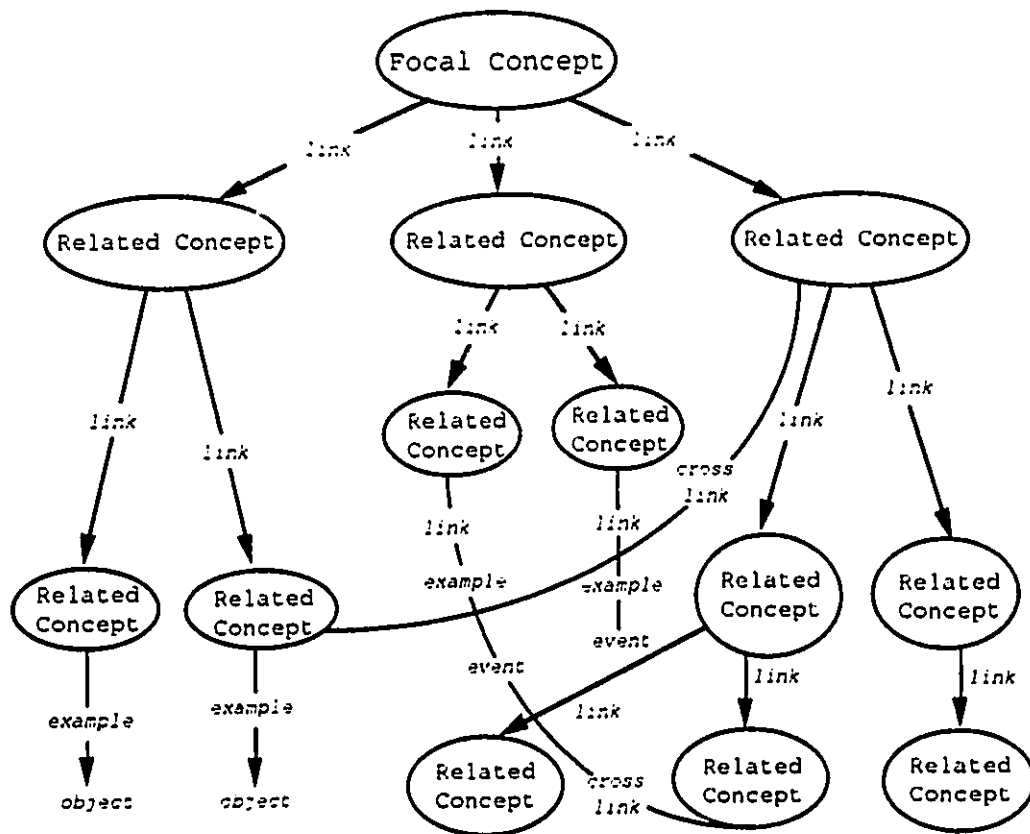
(Adapted from Novak & Gowin (1984, p. 37).

Keeping records

It is important that you keep complete records of individual student progress with these exercises on the forms provided at the end of this booklet. Please tear off and send these forms in to the course professor, Sister Loretta Gillis at mid-term and at the end of the course.

References

Novak, J. D. & Gowin, D. B. (1984). *Learning how to learn*. New York: Cambriuge University Press.

Comments: In the space below please make comments about any aspect of this exercise you found particularly *interesting* or *difficult,* and also how your students coped with it.

_____

_____

_____

_____

_____

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_____

_____

_____

_____

RECORD OF STUDENT MAPPING EXERCISES

Student Name	Exercise 1		Exercise 2		Exercise 3	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

RECORD OF STUDENT MAPPING EXERCISES

Student Name	Exercise 4		Exercise 5		Exercise 6	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

RECORD OF STUDENT MAPPING EXERCISES

Student Name	Exercise 7		Exercise 8		Exercise 9	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

RECORD OF STUDENT MAPPING EXERCISES

Student Name	Exercise 10		Exercise 11		Exercise 12	
	Date Received	Date Returned	Date Received	Date Returned	Date Received	Date Returned

APPENDIX E

Post-Experimental Questionnaire

(including attitude measure)

N200 : COMMUNITY MENTAL HEALTH QUESTIONNAIRE

General Instructions

This is not a test and your responses here will have no bearing on your assessment in this course. Please respond to all the questions and statements fully and honestly, and remember that there can be no "right" or "wrong" answers. Your responses will be kept completely confidential.

Return the completed questionnaire directly to the Program Office in the enclosed self-addressed envelope. Your co-operation in this regard will be greatly appreciated.

I. Self-Assessed Tests

In this course you have been asked to do a series of Self-Assessed Tests. These tests appear at the end of the lessons in your course manual. You were to do these tests and verify your answers to the questions yourself.

Please tell us about your experience with these tests by answering the following questions appropriately.

1. Of all the self-assessed tests you were asked to do, how many did you do?

    ☐ All   ☐ Most   ☐ Some   ☐ None

2. If you did not do all the self-assessed tests you were asked to do, please explain why?

    _____

    _____

    _____

    _____

3. How often did you verify your answers to the questions in the self-assessed tests?

    ☐ Always   ☐ Frequently   ☐ Seldom   ☐ Never

4. How often did you go back to your study material for review if your answers to questions in the self-assessed tests were incorrect?

    ☐ Always   ☐ Frequently   ☐ Seldom   ☐ Never

5. How difficult was it to do the questions in these tests?

In the beginning

☐ Very difficult

☐ Quite difficult

☐ Quite easy

☐ Very easy

Later on in the course

☐ Very difficult

☐ Quite difficult

☐ Quite easy

☐ Very easy

6. How time consuming were the tests?

☐ Very time consuming

☐ Quite time consuming

☐ Somewhat time consuming

☐ Not at all time consuming

7. How useful did you find the self-assessed tests in your study?

☐ Very useful

☐ Quite useful

☐ Somewhat useful

☐ Not useful

8. Please explain in which ways the self-assessed tests were useful to you in your study?

_____

_____

_____

_____

_____

9. Please explain in which ways the self-assessed tests were a problem for you in your study?

_____

_____

_____

_____

_____

II. Concept Mapping

For selected lessons in this course you have been asked to do Concept Mapping Exercises. These exercises appear on yellow pages in your course manual. You were to do these exercises and send your completed maps to your educational consultant in order to receive feedback on them.

Please tell us about your experience with these exercises by answering the following questions appropriately.

1. Of all the concept mapping exercises you were asked to do, how many did you do?

    ☐ All   ☐ Most   ☐ Some   ☐ None

2. If you did not do all the mapping exercises you were asked to do, please explain why?

_____

_____

_____

_____

3. For how many concept maps you submitted to your consultant, did you receive maps developed by your professor?

    ☐ All   ☐ Most   ☐ Some   ☐ None

4. How useful did you find the maps developed by your professor?

    ☐ Very useful   ☐ Somewhat useful

    ☐ Quite useful   ☐ Not useful

5. On how many maps you submitted to your consultant, did you receive written comments?

    ☐ All   ☐ Most   ☐ Some   ☐ None

6. How many maps did you develop in this course, apart from those you were asked to do?

    ☐ Many   ☐ A few   ☐ None

7. How difficult was it to do the concept maps?

    In the beginning   Later on in the course

    ☐ Very difficult   ☐ Very difficult

    ☐ Quite difficult   ☐ Quite difficult

    ☐ Quite easy   ☐ Quite easy

    ☐ Very easy   ☐ Very easy

8. How time consuming were the mapping exercises?

☐ Very time consuming   ☐ Somewhat time consuming

☐ Quite time consuming   ☐ Not at all time consuming

9. To help you do the mapping exercises, we sent you a Student Workbook on concept mapping with your course manual. How helpful did you find this workbook?

☐ Very helpful   ☐ Somewhat helpful

☐ Quite helpful   ☐ Not helpful

10. How useful did you find concept mapping as a method of studying?

☐ Very useful   ☐ Somewhat useful

☐ Quite useful   ☐ Not useful

11. Please explain in which ways the concept mapping exercises were useful to you in your study?

_____

_____

_____

_____

_____

_____

12. Please explain in which ways the concept mapping exercises were a problem for you in your study?

_____

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_____

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_____

III. Consultant-Assessed Tests

In this course you have been asked to do a series of Consultant-Assessed Tests. These tests appear on pink pages in your course manual. You were to do these tests and send your answers to your educational consultant in order to receive feedback on them.

Please tell us about your experience with these tests by answering the following questions appropriately.

1. Of all the consultant-assessed tests you were asked to do, how many did you do?
   ☐ All   ☐ Most   ☐ Some   ☐ None

2. If you did not do all the consultant-assessed tests you were asked to do, please explain why?

   _____

   _____

   _____

   _____

3. For how many test answers you submitted to your consultant, did you receive answers prepared by your professor?
   ☐ All   ☐ Most   ☐ Some   ☐ None

4. How useful did you find the answers prepared by your professor?
   ☐ Very useful   ·   ☐ Somewhat useful
   ☐ Quite useful   ☐ Not useful

5. On how many test answers you submitted to your consultant, did you receive written comments?
   ☐ All   ☐ Most   ☐ Some   ☐ None

6. How difficult was it to do the questions in the consultant-assessed tests?

   <u>In the beginning</u>   <u>Later on in the course</u>
   ☐ Very difficult   ☐ Very difficult
   ☐ Quite difficult   ☐ Quite difficult
   ☐ Quite easy   ☐ Quite easy
   ☐ Very easy   ☐ Very easy

7. How time consuming did you find the consultant-assessed tests?

☐ Very time consuming   ☐ Somewhat time consuming

☐ Quite time consuming   ☐ Not at all time consuming

8. How useful did you find the consultant-assessed tests in your study?

☐ Very useful   ☐ Somewhat useful

☐ Quite useful   ☐ Not useful

9. Please explain in which ways the consultant-assessed tests were useful to you in your study?

_____

_____

_____

_____

_____

_____

_____

10. Please explain in which ways the consultant-assessed tests were a problem for you in your study?

_____

_____

_____

_____

_____

_____

IV. Methods of Studying
The following statements relate to different methods of studying. Please circle one number on the scale to the right that best reflects your feeling towards each statement.

1=Strongly Disagree   2=Disagree   3=Unsure   4=Agree   5=Strongly Agree

1. I like to take detailed notes when I am studying. 1 2 3 4 5

2. I prefer to memorize what I have to learn. 1 2 3 4 5

3. I have difficulty remembering details. 1 2 3 4 5

4. I find it difficult to fit facts and details into an overall picture. 1 2 3 4 5

5. Details are easier to remember if I use special memory techniques. 1 2 3 4 5

6. Charts, diagrams and pictures help me learn better. 1 2 3 4 5

7. I like to "map out" course content in order to see how the various concepts fit together. 1 2 3 4 5

8. I like to concentrate on key concepts only. 1 2 3 4 5

9. I remember details best if they are related to key concepts. 1 2 3 4 5

10. In trying to understand a new topic, it is best for me to reorganize the content to suit my style of learning. 1 2 3 4 5

11. I try to understand thoroughly the meaning of my course content. 1 2 3 4 5

12. In trying to understand new concepts, I try to relate them to real life situations. 1 2 3 4 5

13. I learn things best if I follow the order in which they are presented. 1 2 3 4 5

14. I do little extra beyond what is required for passing my exams. 1 2 3 4 5

15. I like to follow well tried out approaches to studying. 1 2 3 4 5

Thank you very much for completing this questionnaire.
Please mail your completed questionnaire to the Program Office in the self-addressed envelope.