THE UNIVERSITY OF CALGARY

An Analysis of Learning Strategies used by Canadian Surgical Residents

by

Karen Elise Joughin

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF SCIENCE

DEPARTMENT OF MEDICAL SCIENCE

CALGARY, ALBERTA

AUGUST, 1998

Abstract

Relationships between learning strategies and trainee performance in the educational context of a surgical residency program cannot be adequately explored until an overview of learning strategies used by residents has been acquired. In this study, surgical residents from orthopaedic surgery, general surgery, neurosurgery and plastic surgery programs at the University of Calgary and the University of Alberta were asked by written questionnaire to report on various aspects of their learning. A qualitative analysis of the learning strategies extracted from the responses indicated that residents use a wide variety of strategies for maintaining a mental and physical state conducive to learning, as well as learning management strategies and cognitive strategies. The classification framework developed in this thesis will be helpful in the future for further analyzing the learning strategies used by Canadian surgical residents.

Acknowledgements

I wish to gratefully acknowledge the assistance of many people in this endeavour. Dr. Jean-Gaston DesCôteaux provided ideas, advice and ample support throughout the project. Not only was he a dedicated supervisor, but he also kindly participated in the gruelling task of raw data analysis, along with Dr. Jaelene Mannerfeldt. My committee members Dr. Harasym and Dr. Danzinger also must be acknowledged for their guidance and critical contributions. Dr. Jac Andrews, from the Faculty of Education, Department of Educational Psychology at the University of Calgary, Dr. Ardene Vollman, from the Faculty of Nursing at the University of Calgary and Dr. Ernie Skakun, from the Office of Medical Education at the University of Alberta assisted in the elaboration of ideas particularly during the conceptualization of this project. Dr. Scott Allen, from the Psychology Department at the University of Lethbridge, provided fresh perspective, invaluable advice and moral support. Dr. Sandy Shysh shared with me both resources and lessons learned in writing a thesis before me! Debbie Desrosiers provided a splendid transcription service and, along with Linda Smith, supported the project logistically. Dr. Erin Armstrong helped immensely with editing. I acknowledge the very beneficent contributions of the surgical residents who participated in this project. I would also particularly like to acknowledge and thank Dr. Penny Jennett and Dr. René Lafrenière who have generously and fully supported my educational efforts and the development of my career in Calgary.

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

List of Tables

List of Tables (continued)

List of Figures

CHAPTER ONE: INTRODUCTION

I. The Topic – Learning Strategies

In the field of education, researchers strive to find ways of improving efficiency and effectiveness of student learning. Since the late 1970's educational research has shown that a relationship exists between the types of learning strategies used by students (the learning behaviours which students engage in to accomplish their education goals) and academic outcomes. This observation has led to the development and implementation of learning strategy assessment procedures and learning strategy training programs in public schools and universities. The expectation is that the academic performance of students will be optimal when learning strategies used are optimal.

II. The Context - Learning in a Canadian Surgical Residency Training Program

Surgical residency programs are training programs which prepare post-graduate physicians for surgical specialty practice. The students in these programs (residents) are experienced and skilled learners, having previously met strict academic requirements for admission into medical schools and then having successfully completed academically demanding undergraduate medical programs. Candidates selected for surgical training are presumed to be highly intelligent and motivated to learn.

Residency training programs in Canada are accredited by a certifying and regulating body, the Royal College of Physicians and Surgeons of Canada. Required standards of knowledge, skills and attitudes are set by this organization. The Royal College of Physicians and Surgeons of Canada also administers certifying examinations. Therefore, training content and the evaluation of residents are standardized across programs.

The clinical tasks that surgical residents must learn, and be able to demonstrate in practice, include making diagnoses based on information acquired from patients and test results, making management decisions for patients and performing surgical procedures. (Other tasks pertaining to different specialist "roles" of the profession, for instance, communicating with patients and colleagues, are also learned by residents but these will not be addressed in this thesis). Performance of these tasks are evaluated ultimately by certifying "in-training evaluation reports" or ITER's (completed by the director of each program, assessing the clinical performance of the residents) as well as written and oral examinations relating to these tasks.

In addition to performing the clinical tasks noted above, residents are expected to pass written and oral examinations. On examinations they must recall or recognize "facts" pertaining to the practice of surgery and they must also demonstrate, orally or in writing, an understanding of various aspects of wellness and disease. They are sometimes asked to provide evidence to justify their clinical decisions. The examinations themselves are "non-clinical" tasks which the residents must perform according to a defined standard in order to become certified to practice their specialty.

Learning activities in Canadian surgical residency training programs include apprenticeship activities (clinical on-the-job training under the guidance of skilled surgeons), classroom activities (attending and presenting seminars and participating in group discussions) and independent reading. Research projects completed by residents contribute to the learning experience.

Clinical responsibilities demand much of surgical residents' awake time, frequently including weekends, day and night. Compulsory seminars and group

discussions are usually scheduled during the day or evening. Limited time for independent study is a key feature of surgical training programs despite the fact that independent study is essential for the academic success of candidates. While time may be allocated for particular learning activities, residents have difficulty controlling that time because of the unpredictable demands of clinical responsibilities. Time available to study and the huge volume of knowledge that residents must acquire over a relatively short time span have been found to be great sources of stress among medical and surgical Canadian residents (Toews et al., 1997). It is noteworthy that surgical residents often engage in learning activities while physically fatigued and hungry.

Given the high motivation and adaptability of surgical residents, despite the hardships of the surgical training program few residents experience academic difficulty. However, there appears to be little tolerance and help for those who do.

III. The Problem

Meagre guidance is currently provided by the literature for surgical residents experiencing academic difficulties or those wishing to optimize their learning. Because learning strategies play an important role in the success of academic efforts, a means of evaluating the adequacy of a resident's learning strategies would be helpful. An indication of which types of strategies are most effective for particular learning goals would also be invaluable.

Prior to this study being undertaken, a question arose regarding differences in learning strategies used, and their efficacy, at various stages of surgical training. Efforts to then design a research protocol were thwarted by a lack of information in the literature pertaining to learning strategies used by surgical residents and a lack of research

methodology to answer such questions. It became clear that the first step must be the development of a general "construct" of surgical residents' learning strategies (defining the domain and characterizing it). A reference would thereby be created for discussions and investigations subsequently.

CHAPTER TWO: PURPOSES OF THIS RESEARCH

I. Study Purposes

The purposes of this research were to provide an overview of learning strategies used by Canadian surgical residents during their training and to develop a preliminary catalogue of these strategies. Types of strategies used and an organizational framework for the "domain" of surgical residents' learning strategies were specifically sought.

II. Importance

This initial research examining surgical residents' learning strategies will be important for several reasons. First, the results of this study contribute to a general understanding of how surgical residents approach learning in the context of a surgical residency training program. Second, a rudimentary collection of learning strategies relevant to surgical training has been made available; residents might now discover and select new strategies from this collection. Third, the organizational framework created will facilitate the planning and analysis of future research into residents' learning strategies. Further work, based on the work presented in this thesis, will permit the creation of a learning strategy measurement tool relevant to surgical education which can then be used to collect quantitative data about learning strategies. Guidance, based on evidence, will ultimately be provided for residents seeking to improve their learning.

III. Generalizability of Results

The results of this study are expected to be generalizable to all Canadian surgical training programs because learning tasks and evaluation methods of all programs are quite consistent, standardized by a single regulating agency, the Royal College of Physicians and Surgeons of Canada. Generalization of results to surgical residency

training programs in the United States is likely possible to the extent that residents and their training programs are similar. The generalizability of results to non-surgical residency training programs depends on similarities and differences between the educational contexts and cognitive tasks demanded of the trainees in those programs as compared with those of trainees in Canadian surgical programs. Caution must therefore be taken in interpreting the results of this study outside of the surgical training context.

CHAPTER 3: REVIEW OF THE LITERATURE

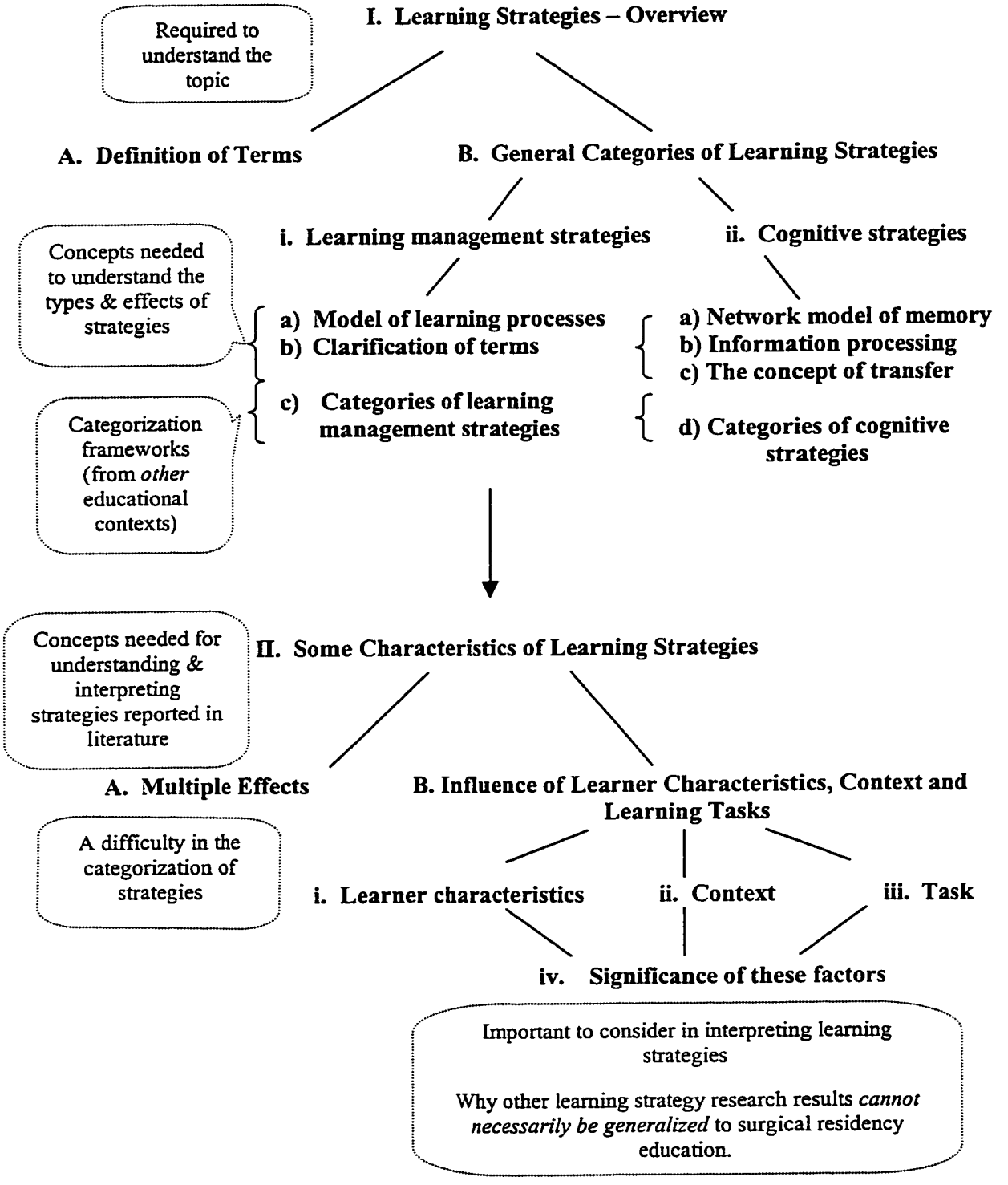


Figure 1

Map of Literature Review – Sections I. and II.

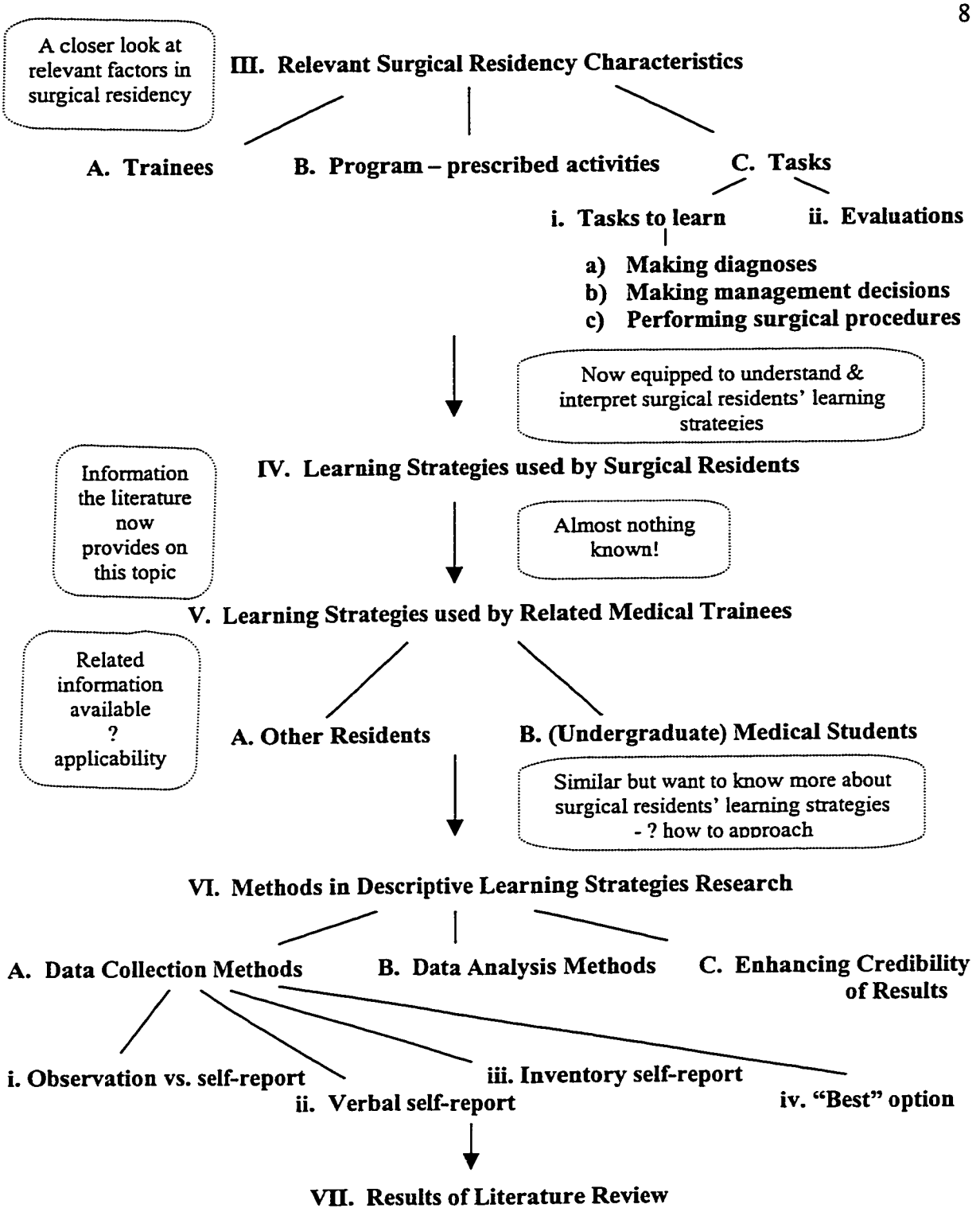


Figure 2

Map of Literature Review – Sections III. to VII.

I. Learning Strategies – Overview

A. Definition of Terms

Learning has been defined as "**a change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth**" (Gagné, 1985b). Although innumerable models of learning have been described, it is widely accepted that the process of learning requires participation of the learner on a conscious or unconscious, implicit or explicit level to receive and process sensory input and incorporate it in some form into memory. A learning activity provides the learner with exposure to sensory information and an opportunity to process it.

Just as there are many models of the learning process, there are many definitions of learning strategies (Dansereau, 1985; Gagné, 1985a; Mayer, 1988; McKeachie, Pintrich, Lin, & Smith, 1986; Nisbet & Shucksmith, 1986; Palmer & Goetz, 1988; Paris, 1988; Weinstein & Mayer, 1986). Palmer and Goetz have pointed out that most learning strategy definitions are restricted to learning methods which are *initiated by* and *chosen by* the learner (Palmer & Goetz, 1988). For purposes of this work, a learning strategy will be broadly defined as "**a set of processes or steps that can facilitate the acquisition, storage, and/or utilization of information**" (Dansereau, 1985). This "set of processes" or "steps" constitute a *method* for approaching a specific learning task or generally attaining a learning goal (Kirby, 1984). A learning strategy may be an internal activity, such as planning or carrying out a mental exercise, or it may be an overt observable behaviour (Weinstein & Mayer, 1986).

A clarification of "learning strategies" *versus* "learning styles" terminology is also helpful, as the two terms are frequently confused in the literature. For purposes of this

research project, it will be acknowledged that while "learning strategies" represent *methods* of learning (the thoughts and behaviours used to learn something), "learning styles" represent *characteristics* of the *learner* (Riding & Cheema, 1991). Learning styles can influence the choice of learning strategies used by a learner. However, the terms, as defined in this work, are not synonymous.

B. General Categories of Learning Strategies

Observations and reflection upon students' learning efforts have resulted in the identification of learning strategies used by students in many educational contexts. In order to more clearly define and describe learning strategies, many categorization systems have been developed. The groupings of strategies have been based on similarities in purpose, effects and/or activities (Dansereau et al., 1979; Derry, 1988; Jones, 1988; Kirby, 1984; McKeachie et al., 1986; Nisbet & Shucksmith, 1986; Svensson, 1977; Weinstein & Mayer, 1986).

A ubiquitous feature of broad learning strategy classification schemes has been the differentiation of strategies which *directly process information* being stored in memory, from *other* strategies. Strategies for directly processing information are often referred to as "cognitive" strategies. The term "cognition" includes learning, perceiving, comprehending, thinking, memory and attention (West, Farmer, & Wolff, 1991). Some authorities call these "primary" strategies (Dansereau et al., 1979). Regardless of the terms used, the concept of information processing or cognitive strategies is very consistent in the literature.

Strategies that have an *indirect* impact on cognitive functions are frequently referred to as "executive" strategies (Sternberg, 1983), "metacognitive" strategies

(McKeachie et al., 1986) and/or "support" strategies (Dansereau, 1985). While the terms "metacognitive", "support" and "executive" strategies are frequently used to describe particular non-cognitive strategies they are not all-inclusive, nor do they always represent the same things. This will be discussed in more detail below.

i. Learning management strategies

Learning management strategies are widely recognized as being vital to successful learning (Kirby, 1984; Lawson, 1984; Nisbet & Shucksmith, 1986; Schumacher, 1987). Characterizations of learning management strategies have been based on models of learning processes. These models have been described by innumerable authors (Büchel, 1982; Das, 1984; Gagné, Briggs, & Wager, 1992; Gagné, 1985b; Kirby, 1984; Reynolds & Shirey, 1988; Schumacher, 1987). In order to understand learning management strategies, it is useful to first introduce a simplified model of learning processes. The model will define learning management strategies and terminology from the literature can then be clarified. Using the model, the literature review of learning strategy classification schemes which follows will be meaningful. A framework for the analysis of learning management strategies used by surgical residents will also thereby be provided.

a) Model of learning processes

Common "steps" in learning processes pertaining to many educational contexts have been described in the literature. These "steps" have been described as elements of instructional design (Gagné et al., 1992; Peterson & Swing, 1983), have been listed as key components of apprenticeship learning (LeGrand & Buckmaster, 1993) and have been cited as steps taken by self-directed learners (Caffarella, 1993; Candy, 1988; Neame

& Powis, 1981; Tough, 1979). The concepts are consistent. These concepts have been synthesized into a simple model of learning process illustrated in Figure 3 below.

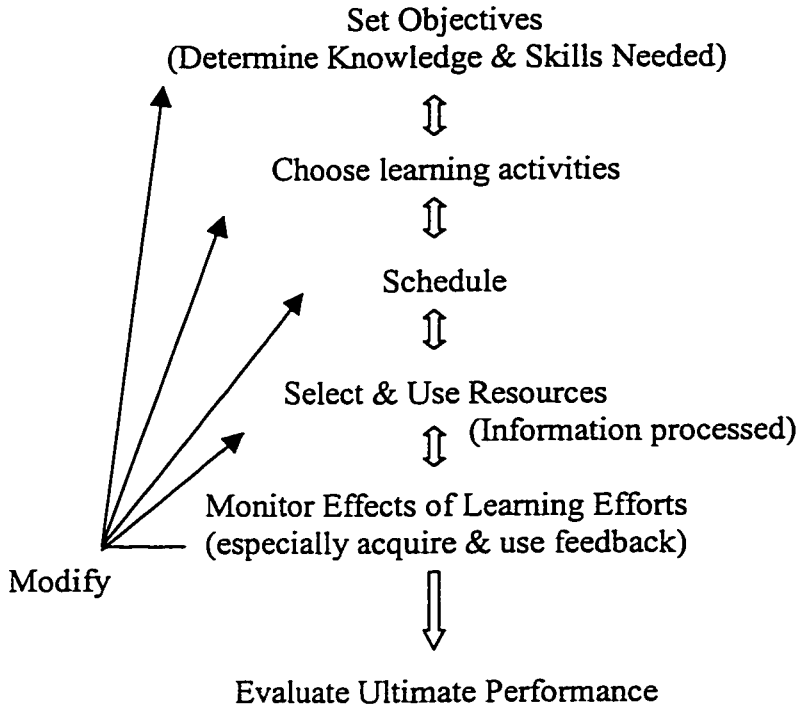


Figure 3

Model of Learning Process

While it is simple to conceptualize each component as a "step" in the learning process, it is important to recognize that they often do not occur sequentially, particularly in an adult learning situation (Caffarella, 1993; Schumacher, 1987). In a traditional classroom setting an instructor might impose structure and sequence for objectives, a learning activity plan (methods and time), resources and evaluation methods. However, adult learners in apprenticeship or other educational contexts are more inclined to make their own decisions, even when guided by adult educational programs (Candy, 1988). An

adult learner will switch back and forth as new information, resources and feedback are encountered.

b) Clarification of terminology

The steps in the learning process outlined above enable a learner to select, control and otherwise manage learning activities. Strategies for planning and regulating learning activities, including the selection and use of cognitive learning strategies, require a learner to be aware of his/her learning. For this reason, such strategies are often referred to as "metacognitive" strategies, meaning "higher" or "above" cognition (Flavell & Wellman, 1977). The term "executive control" has similarly been ascribed to processes and strategies which are used to control learning behaviour (Butterfield & Belmont, 1975).

While both terms, "metacognitive" and "executive control", are very widely accepted and used in the literature, there is considerable conflict and overlap in their application (Brown et al., 1983; Lawson, 1984; McKeachie et al., 1986; Nisbet & Shucksmith, 1986; Schumacher, 1987). However, because all designated functions of metacognitive or executive control strategies involve management of learning on some level, the term "learning management strategies" has been adopted for this thesis. All strategies falling within the realms of metacognitive or executive control strategies will be included in the learning management strategy categorization.

c) Categories of learning management strategies

In Table 1 on page 15, various categorizations of metacognitive and executive control strategies have been extracted and summarized from the literature. It can be seen that learning management strategies reflect the basic learning processes of planning,

monitoring, revising and evaluating. A framework for interpreting surgical residents' learning management strategies can be derived from the work of experts in this field.

Learning management strategies are also sometimes sub-categorized in the literature by "level". The level is determined by the strategy's relationship to cognitive processes. This is perhaps more easily explained with a few examples. Giving oneself a mock examination, a "checking" or "monitoring" strategy, is an example of a "high-level" strategy, or "macrostrategy". The learner may re-visit an area found to be deficient as a result of using this strategy. On the other hand, assessing comprehension *while reading* is an example of a "low-level" strategy or "microstrategy". It, too, is a "checking" or "monitoring" strategy. As a result of using this strategy the learner may re-read a sentence or slow down their rate of reading. In these examples, the "microstrategy" is intimately associated with the cognitive processing occurring as the learner reads. The "macrostrategy" is more general and further removed from the cognitive aspects of learning. Either may become automatic and even sub-conscious with repeated use and familiarity, (typical of expert learners in a familiar learning context with familiar tasks) (Brown et al., 1983; Lawson, 1984; Shiffrin & Schneider, 1984). Because the focus of this thesis is an overview of basic learning strategies, categories of high-level macrostrategies were of greatest interest during the investigation.

Table 1

Classifications of metacognitive or executive strategies from the literature

	setting objectives	scheduling	choosing learning activities / resources	interim assessment performance/ plan	revising plan	final assessment	other
(Brown et al., 1983) "Metacognitive"	Planning			Monitoring		Checking	
(Dansereau, 1985) "Support"	Planning & Scheduling			Monitoring			Concentration Management
(Lawson, 1984) "Executive"	Planning		Analysis	Monitoring	Modifying	Evaluating	
(Nisbet & Shucksmith, 1986) "Macro-strategies"				Monitoring & Checking	Revising	Self-testing	
"Micro-strategies"	Asking Questions	Planning					
(McKeachie et al., 1986) "Metacognitive"	Planning			Monitoring	Regulating	Monitoring	
"Resource Management"		Time Management					Study Environment, Effort Management, Support of Others
(Schumacher, 1987) "Studying Processes" (excluding cognitive)	Planning & goal setting			Monitoring and Retrieval, checking & testing			

ii. Cognitive strategies

As indicated above, information processing is one of the integral parts of learning. Strategies pertaining to information processing, or "cognitive strategies" seem to be the most frequently discussed in books and journal articles. Sub-categorizations of cognitive learning strategies in the past 20 years have been loosely based either on popular models of knowledge organization in memory or on models of information processing (storage and retrieval). Current theories are useful for predicting or explaining observed effects of using various cognitive strategies. These are reviewed below.

a) Network model of memory

The concept of memory as a "network" of associated information is so widely held that the source of the original idea is difficult to pinpoint. However, textbooks and journal articles addressing the topic of memory organization and information storage/retrieval usually anchor their discussions on the premise that units of knowledge (in the form of concrete information or abstractions, in verbal, visual or other sensory forms, derived from past situations and experiences) are linked by association in memory (Bordage, 1994; Boshuizen & Schmidt, 1990; Coles, 1990; Custers, Regehr, & Norman, 1996; De Volder & de Grave, 1989; Edmondson, 1994; Flavell & Wellman, 1977; Gagné, 1985a; Norman & Schmidt, 1992; Reese, 1977; Regehr & Norman, 1996; Schmidt, Norman, & Boshuizen, 1990; Tulving & Thomson, 1973).

Modern theorists emphasize the importance of the learner's *interpretation* of new and pre-existing knowledge in determining if or how knowledge is assimilated into memory (semantic network, or in other words, network with units linked by "meaning"). For instance, interpretation of a stimulus in the environment will determine if attention is

paid to it long enough for it to be incorporated into memory (Reynolds & Shirey, 1988). At the same time, prior knowledge is activated in order for the stimulus to be interpreted. The stimulus (information) becomes associated with the activated prior knowledge (Paris & Lindauer, 1977). The meaning attributed to the stimulus will also determine how it connects with other pieces of information in memory during processing (Flavell & Wellman, 1977).

"Constructivist" theorists believe that memory structures are dynamic, not static. According to constructivists, assimilation of new information into prior knowledge structures or, alternatively, re-processing of prior knowledge, results in a *transformation of the meaning* of both the new and prior knowledge (Merriam & Heuer, 1996; Paris & Lindauer, 1977). Relationships between the transformed knowledge and other pieces of information also change.

Recall, or "retrieval", of knowledge is believed to occur when a cue, which is in some way meaningfully related to information in memory, activates stored information and delivers it into consciousness (Tulving & Thomson, 1973). Tulving & Thomson's work (1973) showed that the relationship of the cue to the knowledge retrieved may be direct or very indirect, although the pathways of retrieval follow the linkages between pieces of information in memory. It follows, then, that the retrievability of information is enhanced by increasing the number and strength of the connections made to that information in memory; more connections result in a greater number of pathways through which information may be activated (Gagné, 1985a; Schmeck & Grove, 1979). Similarly, varying the *forms* of the information (for instance, transforming verbal information into an image or *vice versa*) in memory will increase the likelihood of

retrieval by different forms of cues (Reese, 1977). Activation by a cue of one unit of information in memory is most likely to facilitate recall of a second unit of information if the two units co-occurred in past experience (for example, information linked to the environmental context it was learned in), if they are members of a common group, if they are serially connected (for example, two sequential steps in a procedure) or if they are associated by a logical or causal connection (for example, similar rules apply to both) (Flavell & Wellman, 1977).

This network model of knowledge organization can be used not only to explain the effects of learning strategies observed but also to hypothesize the effects of strategies when the effects are difficult to study (which is frequently the case). The important role of this ubiquitous model in describing and classifying cognitive strategies is therefore evident.

b) Information processing

Thought processes involved in extracting information from the environment and incorporating it, in some form, into memory comprise "information processing", "mental processing" or "cognitive processing". These processes are the means by which memory knowledge networks are built and re-configured. Models of information processing help to simplify, for understanding, the complex interactions of the environment with human memory and interactions within memory.

Again, one popular model (see Figure 4) predominates the literature, albeit with variations in terminology and characterizations of various components. This model, derived originally from the model of computer processing of information, describes interactions between the environment and two compartments that comprise memory

(Regehr & Norman, 1996). While characterization and labelling of the compartments has changed over time, the fundamental ideas are still widely accepted. Information processing concepts described by Reynolds & Shirey (1988), Gagné (1988) and Mayer (1988), as well as the constructivist ideas of Paris and Lindauer (1977), have been graphically integrated in Figure 4:

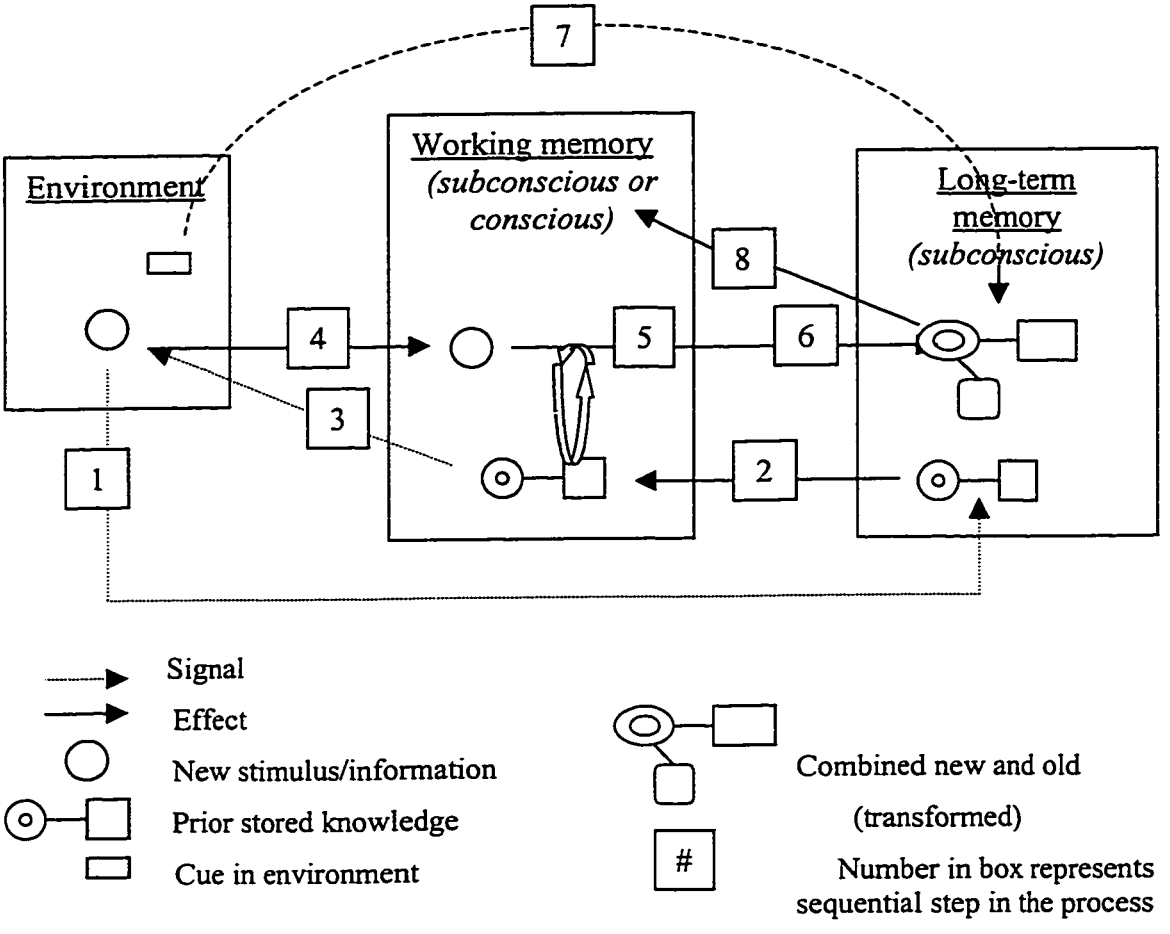


Figure 4

Basic Information Processing Model

Figure 4 illustrates the following processes:

1. Information (a sensory stimulus of any form) in the environment triggers activation of prior (related) knowledge within the long-term memory.
2. The prior knowledge is transferred into working memory and is used to interpret the new information.
3. If the new information is determined to be worthy of attention, attention is given.
4. The time and attention spent on the new information permits it to be transferred into working memory. Note: an alternate theory by R.C. Anderson (Anderson, 1982) proposes that new information proceeds directly into working memory. Attention allows it to be held in working memory longer and thus be cycled longer before transfer of the information into storage.
5. An interaction occurs in working memory between prior knowledge and new information. The degree of interaction between prior knowledge and new information determines whether the new information will be added unchanged to the long-term memory or "assimilated" (Cook & Mayer, 1983). Note: During this processing, more units of prior knowledge may be transferred from long-term memory to interact with the new information or with other units of prior knowledge. Alterations in the meaning of the new information and of prior knowledge may occur (change in shape of information unit depicted in Figure 4) during the processing according to constructivist theorists as noted above.

6. The modified information unit with its new linkages is transferred for storage into the long-term memory.
7. A cue in the environment, related in some way to the information unit, later stimulates ....
8. the retrieval of the information back into the working memory/consciousness.

These steps in information processing have been named by various authors. For purposes of this research project, the following terms will be used:

Reception & Selective perception (steps 1 & 2) (Gagné, 1985b)

Selective Attention (steps 3 & 4) (Reynolds & Shirey, 1988)

Encoding (steps 5 & 6) (Weinstein & Mayer, 1986)

Retrieval (steps 7 & 8) (any transfer of knowledge units from long-term memory to working memory where it can be brought into awareness)

It is important to recognize that the cues for activating retrieval of prior knowledge may not be overtly external. *Thinking* about what is known may be the cue that activates the transfer of additional knowledge units into working memory, leading to further processing, re-organization of knowledge and changes in meaning. The cues for recall and re-processing might simply come from a desire by the individual to review some particular topic (for instance, thinking while lying in bed trying to get to sleep).

It is also important to recognize that retrieval is not just an outcome of learning, but also can be part of the information processing system.. Each time information is retrieved (for instance, when "rehearsing"), there is a constructive change in the memory representation of that information (Paris & Lindauer, 1977). The representation becomes "richer" and is more likely to be retrieved later. Any repetition of information, even

when minimal processing is utilized (for instance, writing the same word over and over again), also enhances retrievability of the information later, presumably because the representation is "stronger". However, it follows from the model that the more processing done, the greater number and type of cues will stimulate retrieval of the information later.

The learner's environment (the study hall, a clinic, etc.) also can be represented in memory. In fact, the environment can add extraneous pieces of "information" which become deposited in working memory at the same time as information being studied. These environmental stimuli therefore can become associated with the information units being processed in the working memory. This linkage may be the basis of environmental "context-specificity" or "encoding specificity" whereby retrieval of knowledge is facilitated when the environmental setting during retrieval is similar to the environmental setting in which the knowledge was learned (Schmidt, 1993; Tulving & Thomson, 1973).

One more characteristic of memory that has been incorporated into the information processing model described here is capacity limitation. It is believed that the working memory in processing either information to be stored or information retrieved can only handle a finite amount of information. Interestingly, the limitation seems to relate to the number of units (data sets) being processed rather than the size of the units (Rohwer & Dempster, 1977). These units, known as "chunks" represent activated knowledge units (each unit containing many pieces of information linked together) that are not (yet) related to other "chunks" in working memory. By uniting two chunks into one, fewer mental resources are required and additional pieces of information may be accommodated (Kirby, 1984; Moely, 1977).

c) The concept of transfer

The ability to apply previously learned knowledge in a new situation is known as "transfer" (Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987). Problem solving in medicine requires the ability to make diagnostic and management decisions in situations not previously encountered (Coles, 1990; Regehr & Norman, 1996). Thus, the importance in medical education of knowledge acquisition in a format conducive to transfer is apparent.

Researchers have distinguished different ranges of transfer, depending on the similarity of a previously learned task to a new task. Transfer may be "near" or "far". Near transfer occurs when a new problem encountered is very similar to a previously solved problem. Knowledge gained in handling the previous problem is transferred with little modification to the new problem. This process contrasts with far transfer whereby a new problem unlike previously encountered ones must be addressed (Perkins & Salomon, 1985). In the case of far transfer, transformed knowledge is applied (principles and abstractions) to the new problem (Mayer, 1987). The more unfamiliar the problem, the more assembly of knowledge is required from different areas of the memory structure in order to fit the new situation (Spiro et al., 1987). Knowledge structures which are most amenable to transfer are highly inter-connected (from different "areas" in memory), multi-dimensional and flexible (can be variable in complexity and regularity) (Spiro et al., 1987). The more conceptual the knowledge (principles and abstractions) the more broadly applicable the information will be to different problems (Mayer, 1987).

Transfer may also be "low road" or "high road", depending on the way in which the learning occurred. Low road transfer is a consequence of performing a task

repeatedly, so that the task becomes *automatic*. Then, when confronted with a new but similar task, intuitive often subconscious generalizations are made, permitting transfer of the skill or knowledge automatically. Practice is essential for creating a consolidated *representation* (abstraction) of the familiar task which is transferable to the new task. Varied practice (variations of the task and/or practicing in different contexts) allows the transfer to have an extended (far) range (Perkins & Salomon, 1985).

High road transfer involves the *deliberate* abstraction of a task and application of principles. The learner uses rules which either have been explicitly taught or which the learner has formulated from experiences. This type of transfer requires the learner to understand the principles in relation to particular cases and to recognize situations in which the principles apply (Perkins & Salomon, 1985). For high road transfer, then, conscious effort on the part of the learner is required for an experience to generate knowledge and abstracted principles that can be transferred to a new situation later.

d) Categories of cognitive strategies

Cognitive strategies are generally categorized by their *effects* in the building of knowledge structures, relative to the four steps of information processing described above (reception/perception, selective attention, encoding and retrieval).

Strategies which primarily involve reception/perception and selective attention have received less attention in the literature than the encoding and retrieval strategies. In some broad learning strategy classification systems they are not considered at all (McKeachie et al., 1986). Attention during studying is said to depend on "state" and "process" variables, the state variables being factors such as learner motivation, prior knowledge and the structure of the reading material, which are generally considered

"fixed" (Reynolds & Shirey, 1988). (One could argue that motivation is not "fixed" and hence *can* be influenced by particular strategies). Process variables pertain to the process of studying and hence are considered to be susceptible to the influence of learning strategies.

For clarity, a summary of classified cognitive strategies from the literature which have been reported to support or influence reception/perception and selective attention is provided in Table 2 below.

Table 2

Classifications of reception/perception and selective attention strategies summarized from the literature

	Reception/Perception	Selective Attention
(Mayer, 1987)	Text-based	Reader-based
	Behavioural objectives	Shadowing
(Gagné et al., 1992)	"Selective Perception" Highlighting Underlining Advance organizers Adjunct questions Outlining	
(Reynolds & Shirey, 1988) Not formally classified, but discussed	Differentiate important from unimportant by questioning, comparing material with objectives, determining perspectives, then: Underline Outline Take notes Highlight	

Strategies that primarily affect encoding and retrieval comprise the majority of cognitive strategies discussed in the literature. As already noted above, strategies which blend and manipulate pieces of information in the working memory will also affect the retrievability of the information later. Thus, it makes sense that strategies involved in encoding and retrieval are often discussed together.

A prevalent conceptual frame for the classification of encoding/retrieval strategies is the *amount* of processing that occurs before information is stored; information may pass through working memory into long-term memory relatively unaltered or it may be altered in some way (such as re-organization within the unit of information first, or being combined with retrieved prior knowledge). Profound transformations of knowledge into new principles and re-definitions represent the highest level of processing.

A generalization that has arisen from this conceptual frame is the differentiation of strategies which are "superficial" and "deep" in their focus, corresponding to "surface-level" and "deep-level" processing. By definition, **surface-level processing has a reproducing or rote memorization focus** (minimal alteration before storage), while **deep-level processing focuses on comprehension** (Marton & Säljö, 1976a). Surface-level processing is more typically used when subject matter is unfamiliar to the learner (such as when the learner is a novice in a particular field of study) (Newble, Entwistle, Hejka, Jolly, & Whelan, 1988).

Approaches to study, or "learning styles", have also been described as "superficial", "deep" or "strategic" depending on the *tendencies* of learners to use surface-level processing, deep-level processing or a strategic combination of the two in their studies (Entwistle & Ramsden, 1983; Newble & Gordon, 1985). This categorization

scheme is mentioned because learning style inventories based on this generalization have been used in the study of medical students (Arnold & Feighny, 1995; Chessell, 1986; De Volder & De Grave, 1989; Leiden, Crosby, & Follmer, 1990b; Newble et al., 1988; Newble & Gordon, 1985; Newble & Hejka, 1991).

Table 3 on page 28 summarizes several popular classification schemes for encoding and retrieval learning strategies reported in the literature. Specific examples of strategies which belong within the broad categories, as provided by the authors, are also listed. In most cases, the authors have not subdivided their broad categories further, possibly because they intended their classification schemes to be widely generalizable to many different learning contexts. Included at the end of Table 3 are categories gleaned from three learning behaviour inventories, one created for use by undergraduate university students and the other two created for use by medical students. In these inventories, students are asked only general questions about their learning behaviour tendencies and results, and are asked very few questions about use of specific strategies. Nonetheless, it is clear that the scoring categories share the themes reported elsewhere. In all cases, groups of strategies are differentiated by how much the learner manipulates information when using the strategy.

In summary, then, experts in the field of learning strategies distinguish cognitive strategies according to the information processing steps they act on and the means by which they enhance the acquisition and recall of information. These principles may be applied to the analysis of any cognitive strategies.

Table 3

Classifications and examples of encoding and retrieval strategies summarized from the literature

	Rehearsal (repetition)	**Grouping/ organizing within pre-existing information "unit"**	**Relating information to prior knowledge**	**Retrieval**
(Entwistle, 1992)	**Surface**	**Deep**		
	Passive acceptance of ideas Memorizing facts & procedures	Aim to understand material Interact vigorously & critically with content Relate ideas to previous knowledge/experience Organize ideas within integrating framework Relate evidence to conclusions Examine logic of argument		
(Mayer, 1987) context unspecified		**Building internal connections**	**Building external connections**	
		Schema training	Note taking Elaboration Conceptualizing	
(Gagné et al., 1992) context unspecified	**Rehearsal**	**Semantic Encoding**		**Retrieval**
	Paraphrasing Note taking Imagery Outlining Chunking	Concept maps Taxonomies Analogies Rules/Productions Schemas		Mnemonics Imagery

Table 3 (continued)

Classifications and examples of encoding and retrieval strategies summarized from the literature

	Rehearsal (repetition)	**Grouping/ organizing within pre-existing information "unit"**	**Relating information to prior knowledge**	**Retrieval**
(Weinstein & Mayer, 1986) context unspecified	**Rehearsal**	**Organizing** (within information unit *or* between units)		**Elaboration**
	Basic task: Reciting Naming *Complex task:* Copying Underlining Shadowing	*Basic task:* Grouping/Ordering Taxonomies Outlines *Complex task:* Link ideas (components of whole, different types, one leads to another, analogies, different characteristics, evidence)		*Basic task:* Paired associates (words paired) Images/sentences to link paired words *Complex task:* Paraphrasing Summarizing Analogy
(West et al., 1991) context unspecified	**Multi-purpose**	**Spatial**	**Chunking (Organizing)**	**Bridging (to prior knowledge)**
	Rehearsal Imagery Mnemonics	Creating Frames (grid) Concept maps	Organizing by space, time, sequence & logic Classifying	Advance organizer Metaphor/analogy/simile

Table 3 (continued)

Classifications and examples of encoding and retrieval strategies summarized from the literature

	Rehearsal (repetition)	**Grouping/ organizing within pre-existing information "unit"**	**Relating information to prior knowledge**	**Retrieval**
(Schmeck, Ribich, & Ramanaiah, 1977) undergraduate university (extracted from inventory)	**Fact retention**	**Synthesis-Analysis**	**Elaborative**	
	Memorize (not other examples given)	Comparison of concepts Make inferences Critical evaluation Find underlying messages	Looking for reasons behind facts Associating word/idea with known words/ideas Converting facts into "rules of thumb" Thinking of practical applications of concepts	
(Tamir, Schiffmann, Elstein, Molidor, & Krupka, 1979) medical students	**Recall**	**Principles**	**Questioning**	**Application**
(Mitchell, 1994) medical students (extracted from categories in inventory)	**Memorizing**	**Conceptualizing**	**Reflecting**	
	Create mnemonic devices	Create conceptual model to understand mechanisms Formulate general impression Draw visual representation of process Use analogies/metaphors Visualize	Construct relationships to build larger concepts Review of material covered earlier Integrate material between courses Read background material to improve understanding of material	

II. Some Characteristics of Learning Strategies

Two particular characteristics of learning strategies are worthy of mention here, as they influence the analysis of learning strategies. The first is the multiplicity of effects of learning strategies. The second is the relationship of learning strategies to learner characteristics, context and tasks.

A. Multiple Effects

Cognitive and learning management strategies have multiple effects. It is therefore often difficult to definitively categorize a learning strategy by its effect. A learning strategy may belong in two or more broad categories or sub-categories.

A learning strategy may be both a cognitive and learning management strategy at the same time. For instance, the strategy of "self-questioning" might be considered both a cognitive and a learning management strategy. Recalling and assembling pieces of information from memory in order to answer a question acts as a cognitive strategy (re-processing information). On the other hand, self-questioning also provides an opportunity for the learner to determine the success of previous learning efforts, a "checking" mechanism. Self-questioning might therefore be considered a learning management strategy. The intimate relationship between cognitive processes and the learner's being aware of these cognitive processes contributes to the haziness of learning strategy categories published in the literature (Nisbet & Shucksmith, 1986).

Learning strategies *within* a broad category may belong to multiple sub-categories because of their multiple effects. An example of this is "note-taking during reading", a cognitive strategy. By writing down information perceived as note-worthy, the reader

gives extra attention to that information, which has been selected and extracted from the text. This is an "attention" strategy. At the same time, note-taking is an encoding strategy. The reader is re-exposed to the information as it is being written. Some processing of the information may also occur if the notes are written in the reader's own words rather than verbatim from the text. Note-writing may therefore be considered an "encoding" strategy (Cook & Mayer, 1983). The intent and mind-set of the reader during the activity may amplify or reduce the effect of the strategy being used.

The task of analyzing and classifying learning strategies can therefore be a difficult one. It is interesting to note how authors have classified the same strategies differently in various classification systems. It seems sensible to permit strategies to be assigned to more than one category in a classification system. In this way, the multiple purposes and effects of many strategies might be explicitly acknowledged.

B. Influence of Learner Characteristics, Context and Learning Tasks

Learning involves a very complex inter-play between learner characteristics, learning tasks and the strategies selected by the learner (Flavell & Wellman, 1977). The environment and circumstances of learning are also significant variables which affect the outcome of learning efforts (Schumacher, 1987). While it is not within the scope of this thesis to delve into the complexities of such relationships, it is important to acknowledge the roles of learner characteristics, context and tasks in determining what learning strategies will be used by a population of students.

i. Learner characteristics

Choice of both cognitive strategies and learning management strategies are influenced by a large array of learner variables. Personality characteristics have been

shown to correlate with learning strategy preferences (Entwistle & Ramsden, 1983). Motivation and self-efficacy perceptions are globally influential in the learning efforts made and time spent learning (Palmer & Goetz, 1988). Previous experiences impact the learner's determination of what approaches are successful in certain circumstances for specific tasks. In particular, prior knowledge about the task (or similar tasks), familiarity with the setting, knowledge of an inventory of strategies available and experience using strategies are important factors (Schumacher, 1987). Past experiences and interpretation of them can give rise to learning strategy "habits" or preferential "styles" (Kirby, 1984).

ii. Context

The context of learning plays a huge role in the choice of learning strategies and their effects. Of significance are the environment during a learning experience as well as the opportunities, facilities and culture of the educational program in general.

The role of the environment during learning in the cueing and recall of information later (context-specificity) has been discussed above. Environmental information becomes linked in memory to other information processed at the time. Environmental factors during learning may also affect the concentration of the learner. Such factors include noise level, room temperature and general comfort (Schumacher, 1987). Distractions in the environment may even indirectly affect the selection of learning strategy used. For instance, noisy distractions may prompt a reader to skim rather than focus during reading.

The educational program provides resources and learning opportunities to students. These inevitably impact which learning strategies are used by students. For example, consider a medical student who might wish to learn the features of a particular

disease. The student will use different learning strategies during a patient interaction than he or she will use gathering information about the disease from a textbook, because the interaction between the two resources are different and the formats of information are different. Structure of educational programs (teaching and course design) and characteristics of teachers, similarly, will affect the student's approach to learning (Newble & Entwistle, 1986; Ramsden, 1984), as will the culture in the learning institution (Gibbs, Morgan, & Taylor, 1984). Circumstances outside of the immediate educational context must not be forgotten. These circumstances may affect the time available for study and the physical and mental capabilities of the learner.

iii. Tasks

Previous studies have clearly indicated that the selection of learning strategies by students are determined by the task, the learner's perception of the task (Arnold & Feighny, 1995; De Volder & De Grave, 1989; Geiger & Pinto, 1991; Marton & Säljö, 1976b, Entwistle, 1992 #95) and the evaluation method expected (Marton & Säljö, 1976b; Newble & Jaeger, 1983) (external evaluation may be considered a learning *task*). The influence of task on learning strategy selection is likely greatest when the learner has had past experiences with the task or similar tasks. Past successes and failures, as noted above, are very influential.

Information processing strategies have been found to be most effective when the processing method closely mimics the processing used in performing the outcome task (Spiro et al., 1987). It is for this reason that cognitive strategies can be very task-specific and narrow in their applicability and domain of usefulness (Dansereau, 1985). The higher-level learning management strategies of planning, monitoring and regulating can

be generally applied to any task. However, lower level strategies that are intimately associated with cognitive processing and content can be quite task-specific (Dansereau, 1985; Kirby, 1984; Nisbet & Shucksmith, 1986).

iv. Significance of these factors

It is evident, then, that learner characteristics, context and tasks play significant roles in the choices of learning strategies made by students, and the appropriateness of those choices. Individual variation must be expected within a population of students. Variability must also be expected between populations of students which have different learner characteristics, learn in different contexts and are faced with different learning tasks.

III. Relevant Surgical Residency Characteristics

Learning strategies have been extensively studied in the contexts of public school and university education (Arnold & Feighny, 1995; Dansereau et al., 1979; Derry, 1988; Gagné, 1985a; Garner, 1988; McKeachie et al., 1986; Pintrich & Johnson, 1990; Schmeck et al., 1977; Weinstein & Mayer, 1986; Weinstein & Underwood, 1985). However, because learner characteristics, educational context and educational tasks (including final evaluation tasks) strongly influence which learning strategies are selected and used by students, a strong argument can be made against generalizing the results of those studies to surgical resident education. A much closer look at the nature of surgical education is warranted. Surgical training in Canada was introduced in CHAPTER ONE, but it is now helpful to reiterate those relevant factors which characterize learning in surgical residency programs.

A. Trainees

Surgical residents are adults and thus are expected to possess qualities of adult learners, such as being task oriented, self-directed and experienced (Knowles, 1978). These trainees also have a history of high academic achievement; they have proven themselves to be intelligent and academically successful by achieving the high grades necessary for entry into and graduation from medical school, prior to commencing their surgical training. Because of their previous medical training (a minimum of three years), surgical residents have a pre-existing medical knowledge base, including biological sciences which pertain to medical practice, knowledge of disease, principles of treatment and some clinical experience. Surgical residents are therefore "expert" in some areas within the domain of surgical knowledge as well as "novice" in other areas which are more specialized to surgical practice.

B. Program – prescribed activities

Residency education in Canada is partially based on an apprenticeship model, with residents "learning by doing" in the clinical environment in which they ultimately will use their knowledge and skills (The Royal College of Physicians and Surgeons of Canada, 1996a). In accordance with apprenticeship and cognitive apprenticeship models (Brown, Collins, & Duguid, 1989; Cervero, 1992; Collins, Brown, & Newman, 1989; Farmer, Buckmaster, & LeGrantd, 1992a; Farmer, Lippert, & Schafer, 1992b), the "masters" (staff surgeons and other health care professionals) demonstrate the skills to be learned, verbalize the thought processes behind the skills and provide feedback and support while the "apprentices" (residents) perform. Surgical residents' learning strategies therefore are expected to include the apprentice strategies of observing skill

performance (diagnostic or therapeutic), developing mental models of the procedures, reflecting on what has been observed, performing the skills, seeking feedback, self-assessing and generalizing (LeGrand & Buckmaster, 1993).

Residency education is not exclusively "apprenticeship" in nature, however. The Royal College of Physicians and Surgeons of Canada, which oversees the training of surgical residents, also regards residents as graduate university students (The Royal College of Physicians and Surgeons of Canada, 1996a). Their training programs thus also prescribe traditional academic university graduate student activities such as didactic classroom activities, small group discussions (rounds) and independent study (primarily reading). These activities are used to acquire declarative knowledge and procedural knowledge which may be subsequently used in the performance of skills on the job. It is apparent that residents are called upon to integrate "book" knowledge and practical clinical experiences in their development of clinical skills. Strategies pertaining to this integration are expected to be an important part of surgical residents' learning.

A significant factor in the learning activities of surgical residents is the amount of time spent working with patients. Clinical responsibilities frequently take precedence over other learning activities, despite the provision of "protected education time" in many programs. As a result, residents often do not have the luxury of controlling which patients they will see or how much time will be spent with them, day or night. In addition, because of the intensive time commitment of caring for patients, residents cannot spend unlimited time on independent study activities such as reading or informal group discussions. As a result, residents are expected to use resources and other study strategies which are time-efficient.

C. Tasks

Roles of specialists as defined by the Royal College of Physicians and Surgeons of Canada include that of "medical expert/clinical decision-maker", "communicator", "collaborator", "manager", "health advocate", "scholar" and "professional" (The Royal College of Physicians and Surgeons of Canada, 1996b). This thesis focuses on the development of one of these roles by surgical residents, the role of "medical expert/clinical decision-maker" in which medical problem-solving is the primary activity.

i. Tasks to Learn

Medical problem-solving is said to be comprised of four elements: data gathering, diagnoses, creating a therapeutic plan and managing the patient (Patel & Groen, 1986). These tasks are somewhat hierarchical in that the completion of the first is required for completion of the second, etc. In the education and medical literature, "data gathering" is generally considered to be an integral part of the process of "diagnosis" and thus the two will be discussed under "diagnosis". Also, because "managing patients" is so diverse, one management task was selected for focus in this work, that of "performing a surgical procedure". This task was chosen because it comprises a significant part of surgical patient care and because its profile is higher in surgical practice than in other specialist and non-specialist medical practices. In addition, surgical residents tend to enthusiastically accentuate this aspect of patient management during their training; it is obviously an aspect of practice that surgical residents find particularly interesting.

Task analysis has given rise to much information about the knowledge and cognitive processing required for the tasks of diagnosis, making management decisions and performing surgical procedures (Bereiter, 1992; Bordage & Allen, 1982; Bordage,

Grant, & Marsden, 1990; Boshuizen & Schmidt, 1990; Clarke, 1989; Custers et al., 1996; Deber & Baumann, 1992; Elieson & Papa, 1994; Elstein, 1994; Greep & Siezenis, 1989; Lippert & Farmer, 1984; Nurcombe, 1987; Nurcombe & Fitzhenry-Coor, 1987; Ramsden, Whelan, & Cooper, 1989; Schmidt et al., 1990; Weber, Böckenholt, Hilton, & Wallace, 1993). In order to facilitate the understanding of learning strategies used by surgical residents it is helpful to highlight a few general features of the information, knowledge structure and processes required for these tasks.

a) Making diagnoses

Diagnosis is essentially a categorization task (Custers et al., 1996), based on information regarding a patient's symptoms, clinical signs (found on examination or as reported by a third party) and the results of related diagnostic investigations. Clinical information includes verbal (oral or written) information, visual images (what a patient looks like or xray images, for instance), odour, feel and sound. The process is very complicated, involving the recognition of available information as meaningful, decoding of the information, accessing of relevant stored knowledge, re-interpreting new information and then seeking, gathering and integrating more information (Bordage et al., 1990). As discussed above in the section about information processing, prior knowledge is critical both for the interpretation of new information and to permit transformation of new information into something meaningful. Medical knowledge is probably a constellation of memories of past "instances", abstractions of past experiences and declarative knowledge into "prototypes", and semantic networks (networks of information linked by meaning) (Regehr & Norman, 1996).

In order to reach a diagnosis, experts typically recognize patterns or abstractions of features within the clinical information provided (Boreham, 1994; Norman, Brooks, & Allen, 1989; Patel, Groen, & Arocha, 1990). When a pattern or abstraction of features is not recognized (by expert or novices) a logical reasoning process is applied (Weber et al., 1993), which involves making inferences, generating hypotheses and making further inquiries to obtain more evidence before reaching a conclusion (Nurcombe & Fitzhenry-Coor, 1987). The reasoning process is presumed to follow pathways of linked information within knowledge networks. (In fact, ideas about the structure of medical knowledge in memory have been generated from studies in which diagnostic reasoning is mapped as subjects "think-aloud" (Bordage & Zacks, 1984; Ramsden et al., 1989)). Causal associations (association of illnesses by their similar pathophysiology) and causal rules (rules relating a sign or symptom to its pathophysiologic explanation) play a particularly significant role in diagnostic reasoning (Patel & Groen, 1986).

Diagnostic success has been shown to be dependent on the accessibility of stored knowledge, which in turn appears to be dependent on the organization of knowledge in memory (Bordage & Allen, 1982; Bordage et al., 1990). Studies of diagnostic process have suggested that medical knowledge is very complex and highly organized (Bordage et al., 1990; Bordage & Zacks, 1984; Boshuizen & Schmidt, 1990; Patel & Groen, 1986; Patel et al., 1990). Compiled knowledge, characterized by "chunking" of related units of information, is said to be most effective for making diagnoses. Elaborated knowledge, characterized by a rich set of inter-connections between pieces of information, is said to be also effective. Dispersed and reduced knowledge (unconnected ideas and little knowledge) are least effectual for making diagnoses (Bordage & Zacks, 1984).

Because no two patients are identical in their clinical presentations, residents must also be able to transfer knowledge effectively to new situations in order to be able to make diagnoses. Thus, strategies which help to develop knowledge structures known to facilitate transfer are needed for the learning of this task. Declarative knowledge (knowledge that something *is* the case) and procedural knowledge (knowledge *how to do* something) are required (Bereiter, 1992; Cervero, 1992; Schön, 1983). Also, abstraction of information into rules, prototypes or concepts is required.

Table 4 on page 42 provides a simplified summary of this task analysis of "making a diagnosis". It can be seen that typical, uncomplicated and familiar problems are diagnosed through recognition. Even though every patient is different, abstractions of the clinical presentation are recognized and the diagnosis which "fits" is recalled. (The transfer may presumably occur by low road or high road means). Atypical, complicated or unfamiliar problems require a great deal of additional knowledge about not only clinical presentations but also disease processes, causes of disease/injury and more subtle ways of differentiating various diagnoses. Relevant information must be related in memory and retrievable when needed. Cues may take many sensory forms as clinical presentations are comprised of information in many sensory formats (visual, odour, etc.). The application of principles is a key feature of making complex or unfamiliar diagnoses. It is also noteworthy that "book knowledge" and "experiential knowledge" are integrated.

Table 4

Simplified Task Analysis for Diagnosis

	Task: categorize patient problem / distinguish one disease from others	
	Typical, uncomplicated, familiar	Atypical, complex, unfamiliar
Information required - declarative	- signs, symptoms - usual "patterns" of clinical presentation for the disease	- same as typical, plus: - possible "patterns" of clinical presentation for similar diseases - other info. about disease processes, causes, link between cause and clinical features, other abstracted "rules" - relative likelihood
Information required - procedural	- how to elicit signs, symptoms - how to recognize the disease	- how to elicit signs, symptoms - how to distinguish one disease from others based on probabilities - how to "figure out" a likely diagnosis
Processing	recognize set of key features ↓ recall disease that "fits"	cues ↔ retrieve associated knowledge (concrete or abstract, facts, rules, etc.) ↕ re-process, make inferences, test, make new abstractions
Format of retrieval cues/ clinical information	- images of patient, environment - verbal spoken or written - other sounds - feel - odour	- same
Transfer required	- "book" knowledge used in patient situation - knowledge acquired from past patients used in new patient (new features and new context) - application of abstracted principles to new case	- same but more flexibility in processing required

b) Making management decisions

Making management decisions is also a task that requires integration, organization and abstraction of information. Task analysis of surgical decision making has suggested that information is typically integrated and organized into a "decision tree" (Clarke, 1989) for ease of use. Types of information integrated in this way include probabilities of diagnostic accuracy and option success/failure/complications, and knowledge of the effects of other patient variables on these probabilities. This model is based on statistically derived evidence of probable treatment success from the literature and mathematical calculation (McNeil, Keeler, & Adelstein, 1975). Management decision-making is also based on the surgeon's past experiences (Nurcombe, 1987) and biases (Christensen, Heckerling, MacKesy, Bernstein, & Elstein, 1991).

Statistically derived probabilities of treatment success from the literature can provide some guidance to the surgeon but not all possible patient variables and diagnostic uncertainties are accounted for in reported statistics. Thus, the information required to make a treatment decision includes not only knowledge of statistically derived probabilities of various treatment outcomes relating to the most likely diagnosis, but also knowledge of possible other underlying disease states which might co-occur, how these might affect outcomes and "how much" their affect might be (Elstein, 1989). Because the literature cannot provide all of this information, much information is gained from personal practical experiences and shared experiences of clinical teachers. All of this information must be integrated and much of it abstracted in order to be able to transfer the information to new clinical scenarios. A summary of the task analysis for making management decisions is provided in Table 5 below.

Table 5

Simplified Task Analysis for Management Decisions

	Task: select "best" option from a set of options, for a given diagnosis	
	Typical, uncomplicated (patient variables not influential), familiar	Atypical, complex, unfamiliar, diagnostic uncertainty
Information required - declarative	- diagnosis (any degree of specificity) - set of options associated with the disease & probable outcomes - "best" option for the disease	- working diagnosis and likelihood that diagnosis is "correct" - options for chosen disease and other diagnoses being considered - other info. about disease processes, causes, link between cause and logical treatments, other abstracted "rules" - patient variables affecting outcome probabilities
Information required - procedural	- how to match diagnosis and treatment	- how to "figure out" best options for patient to consider, given multiple variables and uncertainty
Processing	(pre-processed) diagnosis ↓ recall best treatment for the diagnosis	diagnostic processing ↔ retrieve option sets for various possibilities (concrete or abstract, facts, rules, etc.) ↕ re-process, make inferences, then weigh probabilities of success/complications/ failure in light of variables and uncertainty
Format of retrieval cues/ clinical information	- concept of diagnosis - patient and context	- same but probably "richer" more diverse set of cues in all sensory forms
Transfer required	- "book" knowledge used in patient situation - knowledge acquired from past patients used in new patient (new features and new context) - application of abstracted principles to new case	- same but more flexibility in processing required

It can be seen in Table 5 that management decisions for typical, familiar and uncomplicated problems can be made simply be recalling the "correct" decision that corresponds with the problem. Thus, the task of medical decision-making can simply involve imitation of decisions made by past teachers with similar cases (Elstein, 1989). However, as in the case of making diagnoses, the atypical, unfamiliar and complex management problems require much more knowledge and processing of information. This is when the application of principles and weighing of probabilities of success, complications and failure must occur. The decision tree, or algorithmic organization of knowledge provides structure for the processing of information and is likely to be used implicitly or explicitly whenever there is uncertainty about a correct decision (Greep & Siezenis, 1989).

Similarities between the tasks of making diagnoses and making management decisions are evident in comparing Tables 4 and 5. Both involve making a decision based on likelihood of "correctness". Primary differences relate to the types of information required for the tasks. The starting point for making a management decision is a diagnosis (however specific) and the literature does provide information regarding outcomes probabilities for various management options. The processing "fits" an algorithmic scheme. On the other hand, making a diagnosis tends to require more abstraction of a large number of relevant clinical features into one concept of injury or illness. Less concrete "probability" information is provided in the literature and hence diagnostic decisions are based more on abstract ideas. The more complex the problem, though, the more similar the processes of making diagnostic and management decisions are.

c) Performing surgical procedures

Performance of a surgical procedure necessarily involves not just cognitive processing of information, but also a psychomotor interaction between the operator and patient. The outcome of this task is tangible. The psychomotor component distinguishes this task from the other two tasks discussed above.

In order to perform a surgical procedure, particular types of declarative and procedural knowledge are required (Lippert & Farmer, 1984; Szalay, 1997). The operator must know what needs "fixing". Knowledge of tissues as well as their "usual" anatomical arrangement is a pre-requisite. The operator must understand principles of sterility. Finally, required instrumentation must be known (Kopta, 1971). Procedural knowledge required includes how to maintain sterility, how to manipulate instruments and tissues (including timing and force control) and procedural sequences. Multi-sensory information is involved. Processing of image and tactile information figure prominently.

Interestingly, psychomotor performance can never be reproduced exactly, perhaps because there is so much information to store and retrieve (Schmidt, 1975). Motor skills therefore cannot be stored "verbatim" but are stored as "representations". A "motor program" is created; the formula required to re-create a gross motor "pattern" is assembled and stored. This is not done consciously. Thus, for instance, a signature written on a large chalkboard can look like a signature written on a piece of paper, even though the chalkboard task has never before been attempted (Schmidt, 1975). It is presumed that surgical skills are similarly abstracted into "motor programs" and information is stored in this form. Motor programs for sub-units of a complex procedure

may be sequentially linked in memory, forming an "executive routine" for the procedure (DesCôteaux & Leclère, 1995).

Processing in the performance of a surgical procedure is similar to processing in diagnosis and making management decisions, except that the cues for retrieval of information are different, the nature of information processed is different and the outcome is "physical". The initiating cue here is the decision to carry out the procedure (Lippert & Farmer, 1984). If the problem is familiar, an executive routine or motor program is retrieved and put into use, resulting in the completion of the physical task. When the problem is complex or unfamiliar, making inferences and applying abstract principles play important roles in surgical decision-making, similar to other medical decision-making tasks.

One feature of processing in the performance of a surgical procedure which differs from that of diagnosis and making management decisions is the major role of new information and re-processing that occurs *during* the procedure. The surgeon is provided with a great deal of visual, auditory and tactile feedback while working. This new information is interpreted and compared with prior knowledge pertaining to patient conditions, possible tissue responses and previous outcomes (Schmidt, 1975). Adjustments in technique are made very quickly as a result of this re-processing. It is clear that executive routines are very flexible (DesCôteaux & Leclère, 1995) and transferable. Flexibility in the process is particularly required when conditions are not familiar.

A summary of the task analysis of performing a surgical procedure, as discussed above, is provided below in Table 6.

Table 6

Simplified Task Analysis for Performing a Surgical Procedure

	Task: carry out a psychomotor task, interacting physically with the patient	
	Typical, uncomplicated, familiar, "ideal"	Atypical, complex, unfamiliar
Information required - declarative	- what needs to be "fixed" (any degree of specificity) - knowledge of tissues as well as their "usual" anatomical arrangement - principles of sterility - instrumentation	- same as typical, plus: - patient conditions and possible effects (to anticipate problems) - possible actions and resultant outcomes
Information required - procedural	- procedural sequences - how to maintain sterility	- same, plus: - how to "figure out" best options for patient given multiple variables and uncertainty of outcomes
Processing	(pre-processed) management decision ↓ retrieve and implement appropriate routine	plan ↔ retrieve option sets for various possibilities (concrete or abstract, facts, rules, etc.) ↓ retrieve and implement appropriate routine ↑ ↓ feedback of conditions ↓ re-process, make inferences, then weigh probabilities of success/complications/ failure in light of variables and uncertainty
Format of retrieval cues/ clinical information	- decision to operate - patient and conditions	- same but feedback cues largely in form of images and touch (as well as sound and odour)
Transfer required	- "book" knowledge used in patient situation - knowledge acquired from past patients used in new patient (new anatomic features and new conditions) - application of abstracted principles to new case	- same but more flexibility in processing required

ii. Evaluations

Evaluations for specialty certification in Canada include an assessment of clinical on-the-job performance, a written examination and an oral examination. The written examination formats vary somewhat, depending on differences in the philosophies of the sub-specialty national evaluation committees, but include a variety of types of multiple choice questions (requiring recognition of correct responses and sometimes problem-solving), short answer questions (involving recall of facts or explanations of phenomena) and long answer questions (involving decision-making based on information provided, rationalization of decisions or explanations of phenomena). Oral examinations require candidates to recall facts, make decisions, rationalize decisions and explain phenomena. It is clear, then, that residents must be able to recall facts, given oral or written cues, be able to explain an understanding of science behind phenomena and decisions and be able to carry out the tasks of surgical practice in order to successfully complete their program.

In theory, the examinations are designed to evaluate various elements of surgical practice. Presumably the knowledge that candidates must recall on examinations is knowledge that they must be able to recall in clinical practice. "Problem-solving" on examinations is also intended to reflect problem-solving in real clinical situations. Primary differences between the tasks required in an examination context and the tasks required in surgical practice are the cues provided for information retrieval and the context (examination fright and lack of "real" environmental cues, to name a few examples). Examinations are situations in which residents are required to perform "usual" tasks, but in extraordinary circumstances. The "task" of completing

examinations therefore deserves special consideration with respect to the analysis of learning strategies.

IV. Surgical Residents' Learning Strategies

In the sections of the literature review above, the nature and some characteristics of learning strategies have been outlined. Theory has been discussed which permits an understanding of learning strategies. The significance of learner characteristics, learning context and learning tasks in the selection and use of learning strategies by students has been shown. It has been suggested that it is inappropriate to assume that learning strategies used by students in other educational contexts would be the same as those used by Canadian surgical residents. Learner characteristics, learning context and tasks pertaining to Canadian surgical training programs have been reviewed. The information needed to interpret surgical residents' learning strategies has therefore been provided. A look at the literature pertaining to surgical residents' learning strategies is now indicated.

Unfortunately, learning strategies used by surgical residents from Canada or any other country have not previously been characterized in the literature. An extensive literature search of this topic, in medical and educational databases yielded only one article pertaining to "educational methods" used by surgical residents (Wade & Kaminski, 1995). In the article, by Wade and Kaminski (1995), the authors surveyed successful American Board of Surgery candidates, asking them simply *if* they had used particular learning *resources* during training or for studying (textbooks, a particular review journal, grand rounds, preceptor guidance, review courses, science courses, Surgical Education and Self-Assessment Program (SESAP), continuing medical education (CME) lectures and "other" learning methods / resources). In essence, this was

a correlational study between learning resources used during training and the outcome scores on in-training and final American Board of Surgery examinations (no significant correlation found). No other aspects of the residents' learning strategies were studied.

No other information was found in the literature review pertaining to surgical residents' learning strategies. The need to study surgical residents' learning strategies specifically was evident. Recognizing that some similarities exist between the learners, context and tasks of surgical residents and other medical trainees, the literature pertaining to learning strategies used by other students in medicine was explored. A scaffold upon which to build an overview of surgical residents' learning strategies was sought.

V. Learning Strategies Used by Related Medical Trainees

A. Other Residents

Disappointingly, few published studies have explored learning strategies used in the context of any residency training program in Canada or elsewhere.

Issues of learning management have been raised in three published studies pertaining to residents' study habits without specifically examining learning strategies. These studies related the use by internal medicine and radiology residents of particular study materials and average number of hours studying to scores in certifying final examinations (Day, Grosso, & Norcini, 1994; Grossman et al., 1996; Slone & Tart, 1991). These studies were similar to that of Wade and Kaminski described above. No other aspects of the strategies were studied. (Interestingly, statistical analysis of data collected indicated that differences in scores were unlikely to be attributed to the selection of resources made or number of hours spent studying).

Only Mitchell and Liu (1995), studying anaesthesia residents, have attempted to identify and characterize learning behaviours in residents (Mitchell & Liu, 1995). In Mitchell and Liu's study, the authors interviewed eighteen first to third year anaesthesia resident volunteers (100% participation). Interviews were carried out casually in the hospital at "break times". All subjects were asked, "How would you describe the way you learn?". Open ended questions were used to explore certain topics, to trigger the residents' memory or clarify responses but details about these questions were not provided in the published article. Data was collected by note-taking by the interviewer during the conversation.

An analysis of the interview notes was carried out. Details of the analysis were not explained in the article except that a "cognitive profile" was created for each resident based on each resident's "intent, process and outcome of his or her learning". (These profiles represented learning styles, or general preferences). However, the "process" component of the profiles represented a characterization of the learning strategies used.

Although strategies were not itemized, examples of strategies were given in the research paper. The "memorizers" were said to use rote memorization techniques such as drills and repetition, re-reading notes. The "algorithmers" were reported to use schematics, flow charts or decision trees containing rationale. The "conceptualizers" used strategies such as visualization, developing causal explanations, connections or models and comparing and contrasting. In addition, while the "memorizers" and "algorithmers" were said not to describe metacognitive behaviours, the "conceptualizers" used reflection to assess their learning. The authors of this paper readily admitted that

residents did not restrict their strategy use to those strategies which belonged to their profile label.

Limitations of the study method (unstructured interview with inconsistent questioning), potential biases in results caused by anxiety of respondents during the interview and small sample size were acknowledged by the authors. Nonetheless, the study served to highlight three different cognitive approaches to studying used by anaesthesia residents (memorizing, making algorithms and conceptualizing). Different *degrees* of cognitive processing were thus represented. In addition, the study provided a basic methodology for exploring resident learning strategies (interview and qualitative analysis of notes).

B. (Undergraduate) Medical Students

It can be argued that medical students' learning strategies would not necessarily be the same as those of surgical residents, because the learners are at a different stage in their medical training (more novice), because the context of their educational program is different (more classroom and less on-the-job experiential learning) and because the tasks are slightly different (less emphasis on surgical skills, different spectrum of clinical problems and evaluations largely written examinations). However, it is felt that similarities (medical students are future residents, content of material and tasks overlap) justify a look at what is known about medical students' learning strategies.

Until recently, information about the learning strategies used by medical students came from studies using pre-existing inventories of non-medical origin, specifically inventory items derived from studies of non-professional college students and high school students (Andrassy & Torma, 1982; Arnold & Feighny, 1995; De Volder & De

Grave, 1989; Ferrell, 1983; Geiger & Pinto, 1991; Goldrick, Gruendemann, & Larson, 1993; Leiden et al., 1990b; Plovnick, 1975; Sadler, Plovnick, & Snope, 1978; Wentz, Wile, Zyzanski, & Alemagno, 1986). All of these inventories were designed to identify students' learning styles or general "approaches" to learning rather than exploring the students' use of specific strategies. Medical students were found to fill the spectrum of all style categories. Variable results in different studies have precluded the generalization that a particular percentage of medical students have a particular style. It is especially interesting that "deep" and "strategic" approaches have generally not correlated with high academic grades in medical students, despite the assumption that "deep" would be "better" (Newble et al., 1988). While *specific* academic task performance has been shown to correlate with the use of *specific* learning strategies (Gagné, 1985a; Paris, Lipson, & Wixson, 1983; Weinstein & Underwood, 1985), the learning style inventories are probably not sensitive enough instruments for assessing learning strategies and their efficacy. It is well recognized that each student varies strategy use according to the learning task at hand, and other circumstances (Entwistle, *et al.*, 1992). The usefulness of these learning style studies in characterizing learning strategies used by medical students is questionable.

Two cognitive preference/behaviour inventories have been designed specifically for medical students (Mitchell, 1994; Tamir et al., 1979), but only one has provided any specific information about learning strategies (Mitchell, 1994). This inventory was created by Rudolf Mitchell, who later reported on his learning behaviour study with anaesthesia residents, discussed above. The inventory, called the Cognitive Behaviour Survey, was based on medical student and faculty interviews, observations of students

and theory from the literature. Because the survey is so firmly anchored in medical students' learning context, it has credibility for this population. The survey queries students not just on their learning behaviour but also on their learning experience and their views on the nature of medical knowledge. Three scales are used to analyze results: memorization, conceptualization and reflection scales. Besides cognitive strategies, the survey also queries tendencies and frequencies of students to use particular resources, assess their own learning behaviour and study with other students.

The inventory items themselves provide clues about which learning strategies are used by medical students (last reference in Table 3, page 30). Unfortunately, details about the analysis which gave rise to the inventory questions have not been provided and thus it is difficult to know how well the survey covers the domain of learning strategies used by this population. The survey, when administered, presumably provides an indication of how much reliance medical students place on the various strategies addressed. However, in the literature this information is unavailable. Only average total scores (total scores being sums of scores, out of 7, for each scale) have been reported to date for one series of students and thus it is not possible to extract the learning strategy data out of the reported data (compiled for learning strategy, learning experience and views).

Two studies reported in the literature looked at how medical students study for examinations. One study looked at study methods for a clinical performance examination (Shirar, Vu, Colliver, & Barrows, 1992). This group created a questionnaire based on interviewing a random sample of medical students who had already completed the examination. Students were asked, among other things, how much time they had spent

studying and how they prepared for it. Data from the interviews were not shared in the journal article published. The derived final questionnaire asked students to strongly agree, agree, disagree or strongly disagree with statements about using particular textbooks, practicing with other students, reading around particular objectives, utilizing clinical experiences and doing assigned reading. One medical school class consisting of 67 students were given the questionnaire (100% participation). It was found that 65% used assigned readings, 75% used clinical experiences, 29% read around objectives, 26% made up differential diagnosis lists, 18% practiced history taking and physical examination skills with other students and 11% practiced solving made-up patient cases. Although surgical residents are not generally required to complete clinical performance examinations, clinical performance is assessed during training informally and thus these strategies may be similarly used by the surgical resident population.

The second study looked at how first year medical students studied for examinations (Razzell & Weinman, 1977). A questionnaire was administered to 100 out of 108 students in a class. This questionnaire contained specific questions about study methods, preferred textbooks and length of time spent studying in which students reported frequency of use. In addition there was one open-ended question about study strategies used (method of analysis of responses was not provided). A summary of the results is given in Table 7 on page 57.

Great care must be taken in interpreting the quantitative results based on the open-ended question responses. It is likely that not all strategies used by students were actually reported, simply because individual students might not have thought of them while completing the questionnaire. It is therefore assumed that the reported "percentage use"

of the strategies was not completely accurate. Issue might be taken with using open-ended questions to provide quantitative data in any study situation.

Table 7

Study strategies in first year medical students (Razzell & Weinman, 1977)

Responses to specific questions, 100/108 students				
Strategy	% responses regarding frequency of use			
	Very often	Often	Occasionally	Never
Discussion with students	4	32	55	9
Reading notes	75	19	4	2
Discussion with staff	0	3	42	55
Reading from textbooks	50	37	11	2
Continuous study 4 hours or more without break	19	13	30	38
Moderate time studying (2 hours) between breaks	45	33	16	6
Study 1 hour or less between breaks	25	29	34	12
Responses to open ended question about which study strategies used, 32/108 students				
Strategy	% of students responding use of strategy			
Rewriting notes & diagrams	32			
Doing past exams	22			
Self-conducted memory tests	22			
Examining specimens or models	6			
Saying aloud the information to be learned	6			
Using mnemonics and similar devices	6			
Underlining textbooks while reading	3			
Summary of textbooks while reading	3			

Surgical residents probably use all of these strategies, being former medical students. However, the frequency of use may be quite dissimilar because of the differences in learner characteristics, tasks and context alluded to above. For instance, one would expect that "discussion with staff" would be a "very often" used strategy because residents spend so much time in apprenticeship situations. Regardless, such information about learning strategies used by medical students is helpful in conceptualizing the domain of surgical residents' learning strategies and in preparing to study learning strategies in the context of surgical residency.

VI. Methods in Descriptive Learning Strategies Research

Because the literature has not provided a characterization of learning strategies used by Canadian surgical residents, and because such information was perceived to be needed, this study was undertaken. Once again the literature was consulted, this time for assistance in designing an appropriate research methodology to develop the desired overview of learning strategies used by this population of students. An appropriate data collection method and a data analysis method were necessary. In addition, particularly because descriptive studies are prone to credibility challenges, efforts were made to find the means to optimally enhance the credibility of results. Qualitative research literature was explored.

A. Data Collection Methods

Learning strategies, as defined above, are behaviours. In this research the question is asked, "what learning strategies do surgical residents use?". The research interest lay in the activities of a *population* of students and thus a cross-case (more than one subject) methodology was determined to be appropriate (Huberman & Miles, 1994).

The research question focused on *quality* rather than quantity, and hence qualitative research methods were appropriate. Because students themselves both select and carry out learning activities, the most direct sources of information were determined to be the students, as study subjects.

i. Observation *versus* self-report

One of the difficulties in studying learning strategies is that they can be lengthy or they can be so "rapid in execution that it is impossible to recapture, recall or even be aware that one has used a strategy" (Nisbet & Shucksmith, 1986). Data pertaining to behaviour have generally been acquired by one of two methods, by observation of the behaviour or by "self-report" (subjects reporting what they do) (Ericsson & Simon, 1984). Observation methodologies to study learning strategies have been essentially reserved for the study of specific strategies used under controlled, time-limited situations, such as observing the behaviour of elementary school students reading a book after having been asked to perform a particular learning task. Alternatively, audiotape or videotape recordings have been used to capture learning behaviours for study later (Garner, 1988). These time-limited and controlled methods have the disadvantage of putting the subjects into "un-natural" situations in which consenting subjects feel self-conscious (Willson, 1988). Thus, questions as to the validity of the results in studying these "experimental tasks" may be raised (McKeachie et al., 1986).

The study of cognitive and metacognitive strategies is not conducive to data collection by "direct" observation methods because these strategies are frequently internal and may even be subconscious. There are a few examples in the literature in which inferences about specific cognitive and metacognitive strategies have been made

from observations, for instance eye movements while reading a text (Garner, 1988). However, these are limited.

ii. Verbal self-report

Verbal self-report data (students explaining what they do) are the mainstay of learning strategy research. There are actually several different approaches to self-report data collection, each resulting in different kinds of information being obtained for analysis. In particular the timing of data collection and methods for cueing students to recall and report their learning strategies are critical issues.

Verbal self-report may be stimulated either by the students being asked to carry out a prescribed learning task and then reporting what they are doing as they perform the task (think-aloud reporting) or stimulated by interview questions (retrospective recall). Ericsson and Simon have pointed out that subjects queried during or immediately following the behaviour (think-aloud) recall from short-term memory, primarily (Ericsson & Simon, 1980; Ericsson & Simon, 1984). Little processing of the information has taken place before the information is recalled. As a result, subjects have little time to interpret and bias the information produced. In contrast, retrospective "probing" by interview produces information which the subjects have processed and interpreted before reporting. When the student's perception of their behaviour is of particular interest the retrospective approach is appropriate. On the other hand, the information provided by subjects retrospectively may not accurately represent what subjects actually do, but rather may represent what subjects *think* they do. Another disadvantage of the retrospective approach, as compared with the more immediate reporting techniques, is the lack of

completeness and detail in the data as subjects have forgotten various pieces of information.

The cues used for recalling behaviour largely determine what information is gathered, particularly when retrospective approaches are used. Cues activate stored knowledge, as discussed above. Contextual cues are particularly valuable. In a learning situation, contextual cues might include learning activities commonly undertaken, for instance "when you are reading, ...", or might include environmental contextual cues such as "when you are on the ward, ...". Similarly, familiar learning tasks may be used as cues, for instance "when you are learning how to ...".

It follows that in an interview setting, an interviewer's questions determine the students' responses. Open ended questions may reduce bias introduced by the interviewer, but on the other hand the respondent may "forget" to report certain behaviours. Directive questions provide more consistent assessment of all students but important information might be missed that the interviewer had not thought of asking (Garner, 1988). A combination of techniques, starting with open ended questions and finishing with directive questions might be an optimal way of collecting interview data.

A technique found in two studies encountered in the literature was collecting *written* data from *open-ended interview-like questions*, rather than oral interview-derived data (Newble & Jaeger, 1983; Shirar et al., 1992). The purpose of Newble's study was to assess medical students' opinions regarding changes in their study methods when a new type of examination was introduced. While the students were not specifically asked what methods of study they used, they were asked how their methods varied for various components of the examination. Unfortunately, comments about the quality of data

obtained or the methods of data analysis were not provided, and thus the technique could not be critically evaluated. In the study by Shirar and co-workers, their purpose was to assess how medical students prepared for clinical performance-based examinations. In order to develop an inventory of strategies pertaining to preparations for clinical examinations, the authors first asked a random sample of students how they studied for them. The results were "analyzed for similarities" and categories were devised. Again, comments about the quality of data or details about the method were not provided for critical review.

The technique of using open-ended written questions rather than an interview for data collection is appealing for several reasons. This technique might remove interviewer intimidation and bias problems, while still permitting the use of broad or specific questions. Subjects might feel less "on the spot"; they might have more time to think through their responses before providing them, which in turn might produce more complete answers. Another potential advantage is that relevant information is not buried in transcripts of verbal chatter, but rather is easily identified and extracted during data analysis. The expense of transcription is spared. Also, data from large numbers of subjects can be obtained simultaneously.

iii. Inventory self-report

Because collection of verbal report data is so labour intensive and time consuming, and because interpretation of students' responses can be difficult, written inventories have been developed to facilitate data collection in learning strategy research. In fact, much of the recent learning strategies literature has relied on pre-existing learning style and learning strategy inventories to generate descriptive learning strategies data for

analysis (Arnold & Feighny, 1995; Baker, Reines, & Wallace, 1985; Chessell, 1986; De Volder & De Grave, 1989; Ferrell, 1983; Geiger & Pinto, 1991; Goldrick et al., 1993; Kosower & Berman, 1996; Leiden, Crosby, & Follmer, 1990a; Leiden et al., 1990b; Linn & Zeppa, 1980; Newble & Gordon, 1985; Newble & Hejka, 1991; Newble, Hejka, & Whelan, 1990; Paul, Bojanczyk, & Lanphear, 1994; Sadler et al., 1978; Schmeck, 1988; Schmeck & Grove, 1979; Tan & Thanaraj, 1993; Wentz et al., 1986).

Learning strategy inventories are much less time consuming to use than interview techniques for data collection, although the development of the inventory at the outset is very time consuming and involved. In fact, inventories are usually derived at least in part from interview data. In order to produce an inventory, data are analyzed in multiple stages and distilled into inventory scales. Items are then written for the inventory. Testing of pilot and final revised inventory items are required before a final validation study is done (Entwistle & Ramsden, 1983; Mitchell, 1994; Newble et al., 1988; Pintrich, McKeachie, & Smith, 1989; Schmeck et al., 1977; Tamir et al., 1979; Weinstein, Zimmermann, & Palmer, 1988).

Once created, inventories are relatively simple to administer. They are restrictive in their scope (testing only what they were designed to test) but results have known reliability and validity *in the population for which they were designed.* However, the legitimacy of using an inventory in a new and characteristically different population is questionable.

Because inventories are relatively simple and inexpensive to administer, using a pre-existing inventory for studying learning strategies in surgical residents would be ideal. However, only one learning strategy inventory designed in any residency

educational context has ever been published (in Spanish) (Ramirez & Velazquez, 1996). This inventory deals strictly with the habits of internal medicine residents in looking up information in medical textbooks (specifically how often they do it and for what purpose). Its focus is thus very narrow. No other learning strategy inventories developed for surgical residents or any other residents have been published.

iv. "Best" option

As a result of this literature review, it was determined that the optimal methodological approach for starting to explore learning strategies in a "new" student population would be to collect self-report data using a mixture of open-ended and specific questions. Rather than using an interviewer to cue responses, written questions were felt to be potentially less intimidating and prone to bias. It was also decided that residents would feel less threatened and less rushed if asked to respond anonymously on paper.

B. Data Analysis Methods

Responses to open-ended questions are generally analyzed by qualitative analysis methods. The type of qualitative analysis that is appropriate in any study very much depends on the purpose of the research and specifically the research question. In starting to explore this relatively new area of investigation, that of surgical residents' learning strategies, it became clear that an overview would be first needed, in order to "clarify" the domain conceptually. Based on this angle, the literature was explored for methods of data analysis which would result in the extraction and organization of learning strategies into a broad conceptual framework.

It is most unfortunate that books and journal articles discussing qualitative learning strategy research tend not to report in detail their data analysis methods. "Themes" are identified and are generally grouped in a meaningful way according to a theoretical construct. The methods used to verify the results of the analysis are also rarely discussed. For this reason, a protocol of data analysis could not be found for direct application to this project. A general exploration into qualitative data analysis methods was undertaken.

Qualitative data are usually first processed into written form (such as the transcription of the audiotape, notes taken in an interview, etc.). Then, depending on the information sought in the data, the analyst will interpret the data and extract the desired information. There are three "approaches" to the extraction process (Miles & Huberman, 1994). In the first, the interpretive approach, analysts form impressions from the data. There is usually no structured process of encoding the data. In the second, the ethnographic or social anthropology approach, data consist of descriptions of behaviour. Analysts encode the data into themes. Themes are commonly based on theoretical constructs decided upon before data collection. However, a method called the "grounded theory" approach relies on the analyst to create a construct from the data itself (data interpreted into *de novo* theoretical framework). The third approach, the collaborative social research approach, involves participation of a researcher and a social group being "analyzed". The researcher and the group interact and interpret ongoing experiences together and in "real time". It appears that learning strategy research has an ethnographic flavour, being based on observations or descriptions of behaviour, and usually involving some sort of thematic interpretation of the behaviours detected.

In the ethnographic method, the coding of data (extracting the key representative points) can be a complex matter involving description or the making of inferences (Altheide & Johnson, 1994). Coding allows the data to be reduced for further analysis. The coding tactics "for generating meaning" (Miles & Huberman, 1994) which are relevant to this study of learning strategies include noting recurring patterns/themes/ "gestalts", seeing plausibility (makes sense or "fits"), clustering by the analyst's own pre-existing cognitive organization frame, compare/contrast, partitioning variables (recognizing subsets within a larger concept), generalizing particulars into broader generalizations, and making conceptual/theoretical coherence (extrapolating the "how" and "why" from the big picture). After the data is coded, the analysis typically involves identifying relationships (including similarities and differences), patterns and common sequences and then elaborating generalizations which describe or explain the whole set.

C. Enhancing Credibility of Results

Credibility of qualitative data research is a major concern. One study of qualitative research in the scientific literature reported that almost half of the time even the original researchers were unable to reproduce their results (Huberman & Miles, 1994). There are probably as many ways of interpreting data qualitatively as there are analysts interpreting it. This reality must be accepted. However, credibility may be enhanced using "triangulation" (or multiple-angulation) techniques. Five types of triangulation have been described in qualitative research: data (using many data sources), investigator (using several researchers or analysts), theory (using different perspectives to interpret a single set of data), methodological (using many methods to investigate a single problem) and interdisciplinary (having input from different disciplines) (Janesick, 1994).

The practicality of utilizing all of these types of "triangulation" is limited by time and resources. However, adherence to as many of these principles as possible will undoubtedly strengthen the validity and credibility of results.

VII. Results of Literature Review

The literature has provided information which helps define and characterize learning strategies in general. It also has provided theory which could be applied in order to understand the effect of learning strategies. The need to acknowledge learner characteristics, learning context and learning tasks in interpreting the learning strategies used by a population of students has become evident.

The literature has been consulted to find out more about surgical residents' learning strategies specifically, but almost no information is available currently. Some insight has been derived from studies pertaining to learning strategies used by other medical trainees, but the need to study and acquire an overview of learning strategies used by surgical residents has become apparent.

In preparation for this thesis, a review of the literature pertaining to research methodology suggested that an optimal approach would be to ask surgical residents what learning strategies they used in various situations. Open ended written questions were determined to be appropriate. Learning tasks and common learning activities were determined to be useful cues. No detailed approach to data analysis that could be directly applied to this project was found in the literature , but an ethnographic approach, using theory and pre-existing frameworks as a starting point to categorize the learning strategies reported, was deemed appropriate. To enhance credibility of results, it was

discovered that an ideal approach would involve many study subjects, more than one data reviewer and more than one perspective in interpreting the results.

Given the requisite background knowledge and perceptions derived from the literature review, the following research methodology was developed for acquiring an overview of learning strategies used by Canadian surgical residents.

CHAPTER FOUR: METHODS

The purpose of this research was to identify and characterize general categories of learning strategies used by Canadian surgical residents during training. The approach taken was a qualitative analysis of descriptive self-report written data collected by questionnaire from surgical residents. Because human participants were used in this research, approval was obtained from the Conjoint Medical Ethics Committee at the University of Calgary. Consent was obtained from the participants both verbally and via written consent forms, according to the requirements of the Committee.

I. Participant Recruitment

All residents in general surgery, orthopaedic surgery, neurosurgery and plastic surgery training programs at the University of Calgary and the University of Alberta were eligible participants of this study. Exclusion criteria consisted of residents who were inaccessible for completing the study (out of town or unable to be released from clinical responsibilities to attend data collecting sessions).

A meeting between the investigator and the residents was pre-arranged by each residency program training director. All eligible residents attending these meetings were asked to participate voluntarily in this study. Residents were briefed on the purposes of the study, the tasks expected of participants, the anticipated time of involvement and the plans to share results with participants following the study (see Appendix A).

Following the briefing, residents declining to participate were invited to leave, if so desired. Written (confidential) reasons for declining were requested. An attempt was also made to determine if any residents in the program were unable to attend (involuntarily excluded).

Written consent was obtained from the participants who agreed to complete the study tasks (see Appendix A).

II. Data Collection

A questionnaire was developed by the investigator to stimulate the report of learning strategies used for the learning tasks of making diagnoses, making management decisions, performing operative procedures and completing examinations (written or oral). The questionnaire used typical surgical residents' learning activities to cue recall of strategies, including aspects of reading, various elements of exam preparation, attending seminars/rounds and interacting with patients or faculty in various contexts (see Appendix B). Four versions of the questionnaire were created, each version containing the same questions but presented in a different order (see also last page of Appendix B). Questions were open-ended. The responses requested were descriptions, in sentences or in point form, of learning strategies used by the residents.

In addition to responses to questions, residents were asked to specify their current level of training in the residency program, the university being attended and the specialty program in which they were enrolled. An assurance was made that only the investigator and a professional transcriptionist would see both the demographic information and responses to the questionnaire together (making it impossible for anyone else to trace responses to individual residents).

Residents were asked to complete the questionnaire during the investigator-participant meetings. Residents who were unable to attend the meetings were also provided with consent forms and questionnaires to complete on their own time and return to the investigator.

All of the demographic information and questionnaire responses were transcribed into a data base by a professional transcriptionist. Each response was assigned a number, permitting if desired a tracing of a numbered response to the original data sheets. The responses, their assigned numbers, along with a summary of the corresponding question were printed onto separate index cards, one card for each response to each question. Demographic information was not placed on the cards. In addition, a special computerized data base was created with the same information provided (summary of question, response number and response).

III. Data Analysis

Three data reviewers were selected from the University of Calgary, Faculty of Medicine to analyze the data. They consisted of a final year Obstetrics and Gynaecology surgical resident (who had taken medical education courses at the University of Calgary and had demonstrated a strong interest and knowledge in medical education), designated data reviewer #1, the Director of the Office of Surgical Education (a surgeon who holds a Master's degree in Medical Education and has an interest in learning strategies), designated data reviewer #2, and the investigator (a surgeon), designated data reviewer #3.

The questionnaire responses on index cards and/or computer database were first *independently* examined by the reviewers. (Instructions to the data reviewers may be found in Appendix C). Learning strategies were extracted from the residents' responses and listed. Duplicate responses were identified and grouped together. Responses which contained more than one learning strategy, in the judgment of the reviewer, were re-

written on new index cards or in the computer database so that each index card / database item conveyed only one strategy. The responses were then sorted.

First, each of the strategies were sorted and categorized by themes. The themes were not pre-determined; individuals doing the sorting identified themes and then sub-grouped the strategies according to these themes. The sorting exercise was repeated as frequently as each sorter felt necessary in order to come up with a satisfactory classification system of learning strategies identified. Each reviewer was granted power to use whatever scheme he or she felt to be logical and useful. Themes and rationale for sub-grouping the strategies were marked on the backs of the cards or recorded separately. Difficulties in making decisions were also noted.

Once the responses had been sorted independently, the data reviewers met to compare results. Rationale was discussed and a consensus reached with respect to the core list of strategies derived from the responses. Reviewers were asked to comment on their assessment of the degree of uncertainty felt in identifying the learning strategies from the raw data as well as an impression of inter-rater agreement in the learning strategies extracted.

The themes felt to be important to the classification scheme were also discussed at the initial group meeting. The investigator subsequently devised a "final" classification system based on constructs derived from the literature as well as from the group discussion. A global assessment of the legitimacy of the final product was made by the three data reviewers.

CHAPTER FIVE: RESULTS

I. Data Source

Of the 8 programs invited to participate in this study, 7 program directors permitted the investigator access to their residents for recruitment. A total of 58 residents participated. Of these participants, 53 attended data collection sessions and 5 acquired and completed study questionnaires on their own time. No resident who attended any data collection session chose not to participate.

A total of 92 residents were registered in the 7 programs involved. However, not all of the 92 registered residents were *able* to participate. It was not possible to accurately quantify how many residents were unable to attend data collection sessions as compared with how many residents chose not to attend. Many residents, particularly junior residents in their first and second years of training were working at various hospitals and thus were either unable to travel or were not informed about the session in sufficient time. In addition, many residents were unable to attend sessions because of immediate patient care commitments, according to their fellow residents. Accessibility to residents for reliable follow-up information was exceedingly difficult, despite efforts made.

Program directors controlled the arrangements of meetings between the residents and the investigator. The data collection sessions were "advertised" by the program directors, by word-of-mouth and by notices in mailboxes. The timing of the data collection sessions also varied. Table 8 indicates the circumstances under which data collection sessions were provided, along with resident response rates.

Table 8

Correlation of Resident Participation Rates with Circumstances of Data Collection Sessions

Circumstances of Data Collection Session	School	Program	Participation (# residents participating / # residents registered)
Part of seminar schedule – regularly attended by all residents in program	1	A	14/19 (74%)
	1	D	4/5 (80%)
Part of seminar schedule – regularly attended by senior (3rd to 5th year) residents in program	1	B	11/16 (69%) with 10/12 (83%) of residents in years 3 - 5
Time slot ordinarily used for education, but not necessarily for teaching sessions	2	B	9/15 (60%)
	2	C	6/6 (100%)
Residents invited to attend "end of day" session	1	C	1/3 (33%)
Special session early afternoon Friday before Christmas	2	A	12/28 (43%)

Representation from the two schools and from the 5 levels (years) of training was distributed as per Tables 9 and 10 below.

Table 9

Resident Representation by School and Year of Training per Program

School	Year of training	Proportion of Residents Participating			
		Program A	Program B	Program C	Program D
1	1	3/4 (75%)	1/4 (25%)	0/1 (0%)	1/1 (100%)
	2	2/3 (67%)	2/3 (67%)	nil	0/1 (0%)
	3	3/4 (75%)	2/3 (67%)	0/1 (0%)	1/1 (100%)
	4	1/2 (50%)	3/3 (100%)	nil	1/1 (100%)
	5	5/6 (83%)	3/3 (100%)	1/1 (100%)	1/1 (100%)
2	1	1/6 (17%)	0/2 (0%)	1/1 (100%)	nil involved
	2	2/5 (40%)	3/4 (75%)	1/1 (100%)	nil involved
	3	4/4 (100%)	2/2 (100%)	1/1 (100%)	nil involved
	4	2/2 (100%)	4/4 (100%)	1/1 (100%)	1 volunteer
	5	3/11 (27%)	0/3 (0%)	2/2 (100%)	nil involved

Table 10

Representation of Resident Participation by Year of Training (Combining Programs)

	Year 1	Year 2	Year 3	Year 4	Year 5
Number of Residents Participating	7	10	13	13 (one volunteer "extra")	15
Proportion of Residents Participating	7/19 (37%)	10/17 (59%)	13/16 (82%)	12/13 (92%)	15/27 (56%)

II. Description of Data

A. Volume of Information Obtained

A total of 1508 questions were given to the residents and 1230 responses were produced. The responses were descriptive (examples in Appendix D). From the responses, the investigator extracted 2347 specific strategies, which were then generalized by theme. Duplicates were eliminated. The degree of generalization determined the actual number of learning strategies produced by the analysis. As a result, it is not helpful to report the number of strategies in the final product. The two other data analysts were not asked to enumerate the strategies identified in each response, as the process was very laborious.

B. Qualitative Description of the Data Acquired

The residents responded to the questions in point form and in sentences, describing various aspects of their study habits and approaches as well as specific strategies. It was not possible, due to the volume of raw data obtained, to include the raw data in this report (although it is available on request). A few examples of responses are given in Appendix D. Also provided in Appendix D are examples of the strategies extracted from the raw data. The strategies reported were primarily macrostrategies (as defined on page 14).

III. Strategies and Classification Systems Derived from Data

A. Products of Independent Review of Data

The strategies extracted from the residents' responses by each reviewer may be found in Appendix E. The first data analysis, by the obstetrics and gynecology resident, data reviewer #1, generated a proposed classification based on Kolb's learning cycle

processes (Kolb, 1976), which in turn is based on an experiential learning model. A differentiation between types of learning activities, time management and resources was made. The proposed classification system devised by the surgical educator, data reviewer #2, was based on a differentiation between "content-dependent" and "organizational" strategies. Within content-dependent strategies, sub-categories "dependent on meaning" and "not dependent on meaning" were identified. Also, within the category of strategies dependent on meaning, strategies used during the learning processes of "gathering information" and "self-monitoring" were differentiated. The investigator (data reviewer #3)'s first proposed classification system was based primarily on the differentiation between cognitive, metacognitive and mental/physical health strategies.

B. Assessment of Reviewer Agreement

The reviewers, upon examining the learning strategies identified by their colleagues, agreed with all of the strategies listed in Appendix E. Main difference in the independently-derived lists of strategies identified by the reviewers was the degree of generalization taken. The list produced by data reviewer #1 was determined to be the most general, while the list produced by data reviewer # 3 was determined to be the most detailed. Regardless, no errors or omissions were identified in the final list of strategies extracted from the residents' responses.

IV. Integration of Analyses

The final list of learning strategies produced by the data reviewers could be accommodated by the classification framework illustrated in Figure 5, page 79. The classification framework was based on the following constructs:

1. Differentiation of learning management strategies (planning and monitoring) from cognitive (information processing) strategies. In addition, strategies for maintaining physical and mental health were presumed to be indirectly related to learning.
2. Processes of learning (comprising of various steps: determining knowledge and skill needs, planning to cover objectives, organizing time, selecting and utilizing resources, processing information for retention and recall, and monitoring the results of learning efforts)
3. Specificity of learning strategies according to their relationships to particular tasks (general strategies applicable to learning as compared with strategies involving specific information content or specific contexts)

These constructs were represented in various ways in the final analysis. The first construct, differentiating learning management strategies from cognitive strategies resulted in these two major categories being represented in the final model, namely "Learning Management Strategies" and "Cognitive Strategies" in Figure 5. Two more categories were added, namely "Optimizing Mental and Physical State" and "Special Strategies for Exam Preparation". The latter category overlapped Learning Management Strategies and Cognitive Strategies. The second construct, the processes of learning, were incorporated specifically into the model (primarily as sub-categories of Learning Management Strategies). The task-specificity of learning strategies was acknowledged within the categorization of cognitive strategies (refer to Table 19 on page 93). Thus, the constructs identified in the preliminary analysis were incorporated into the final organization framework of learning strategies reported by residents in this study.

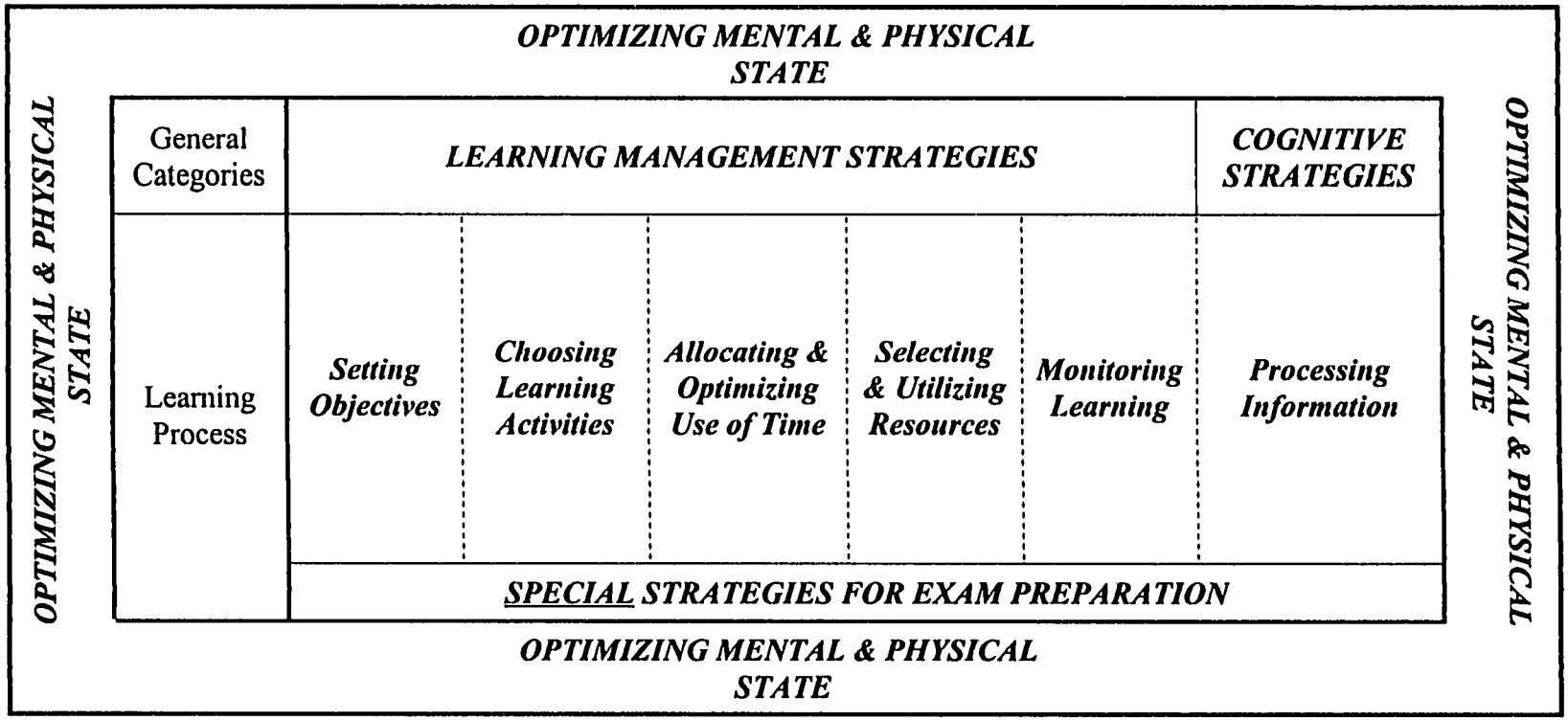


Figure 5

Model of Relationships Between Surgical Residents' Learning Strategies

Through further analysis, the reported strategies were categorized in the following ways (details provided in the Tables indicated):

A. Optimizing Mental & Physical State (see reported strategies in Table 11, page 83)

Maintaining Mental Alertness & Participation During Learning Activities

Motivating by mood adjustment

Preparing mentally for learning (mind set)

Refreshing the mind during learning activities

Refreshing the body during learning activities

Maintaining Mental & Physical Health

Maintaining mental health

Maintaining physical health

B. Learning Management Strategies (organization scheme Table 12, page 85)

Setting Objectives (see Table 13, page 86)

Determining knowledge & skills required

Collating objectives

Allocating & Optimizing Use of Time (see Table 14, page 87)

Managing study time

Managing other time (beyond training & studying)

Selecting & Utilizing Resources (see Table 15, page 88)

Resources

Criteria used in selecting resources

Strategies for finding information efficiently

(continued, next page)

Monitoring Learning (see Table 16, page 90)

Monitoring coverage of specific objectives

Acquiring feedback re: clinical performance

Acquiring feedback re: general knowledge

Using feedback

C. Cognitive Strategies (organization scheme Table 17, page 91)

Gaining & Holding Attention (see Table 18, page 92)

Criteria for selecting information to pay attention to

Strategies for extracting selected information from resource

Strategies to hold attention on selected items to facilitate transfer into working memory

Strategies to reduce *new* information volume load in working memory

Encoding/Retrieval (organization scheme Table 19, page 93)

Basic cognitive strategies (organization scheme Table 20, page 94)

Repetition/practice (see Tables 21 & 22, pages 95 & 96)

Grouping/chunking (see Table 23, page 98)

Associating information with something familiar but not meaningfully related (see Table 24, page 99)

Acknowledging or creating meaningful associations (see Table 25, page 100)

Abstracting ideas, principles and rules (deliberately) (see Table 26, page 102)

Strategies per tasks (organization scheme Table 19 & pages 103 - 108)

D. Special Strategies for Exam Preparation (organization scheme Table 27, page 109)

Setting Objectives (see Table 28, page 110)

Allocating & Optimizing Use of Time (see Table 28, page 110)

Selecting & Using Resources (see Table 29, page 111)

Monitoring Learning (see Table 29, page 111)

Cognitive (see Table 29, page 111)

Tables 11 to 29 follow. These tables contain specific strategies reported by the study participants. More detailed sub-groupings have also been provided.

A. Optimizing Mental & Physical State

Table 11

Strategies for "Optimizing Mental & Physical State"

<table>
<tr><th>Maintaining Mental Alertness & Participation During Learning Activities</th><th>Maintaining Mental & Physical Health</th></tr>
<tr><td rowspan="2"><u>Motivating by mood adjustment</u>

Punishment

• Use embarrassment in front of peers as a motivator
• Create study ultimatums (don't read certain amount = no free weekend)

Reward

• Start with interesting material
• Check off goals on a list, as they are completed (acknowledging accomplishment)
• Provide self with rewards when learning activities completed
• Provide self with rewards when learning tasks accomplished

Ensure Successful Learning

• Set realistic goals
• Work at small parts (so not overwhelmed)</td><td><u>Maintaining mental health</u>

• Set (life) priorities
• Turn on or off other aspects of life</td></tr>
<tr><td><u>Maintaining physical health</u>

Sleep

• Sleep when tired
• Sleep certain number of hours every night

Exercise

• Exercise daily / regular schedule
• Make exercise a high priority

Diet

• Make eating a high priority</td></tr>
<tr><td><u>Preparing mentally for learning (mind set)</u>

• Make an effort to concentrate on activities
• Make an effort to pay attention during rounds

(continued, next page)</td><td></td></tr>
</table>

Table 11 (continued)

Strategies for "Optimizing Mental & Physical State"

Maintaining Mental Alertness & Participation During Learning Activities (continued from previous page)
Refreshing the mind during learning activities • Change topics when studying "when bored or tired" • Work at small parts • Alternate interesting and not interesting topics • Take breaks
Refreshing the body during learning activities • Eat to stay awake • Use caffeine (coffee, other food or drink)

B. Learning Management Strategies

Table 12

Major Sub-categories of " Learning Management Strategies"

LEARNING MANAGEMENT STRATEGIES				
Setting Objectives	***Choosing Learning Activities***	***Allocating & Optimizing Use of Time***	***Selecting & Using Resources***	***Monitoring Learning***
Determining knowledge & skills required **Collating objectives**	*N/A*	**Managing study time** **Managing other time (beyond training & studying)**	**Resources** **Criteria used in selecting resources** **Strategies for finding information efficiently**	**Monitoring coverage of specific objectives** **Acquiring feedback regarding clinical performance** **Acquiring feedback regarding general knowledge** **Using feedback**

Note: Regarding the Strategies for "Choosing Learning Activities"
Clinical work, seminars and other formal teaching sessions are prescribed by training programs and are usually considered compulsory. Residents' controls over their time and activities within these contexts are perceived to be limited. No specific questions respect to choosing learning activities were asked and no strategies were reported by residents in this study.

Table 13

Strategies for "Setting Objectives"

Determining knowledge & skills required	Collating objectives
<u>Determining skills required</u> • Watch preceptors and peers in specialty working in clinical setting • Reflect on skills observed and knowledge required to perform them • Ask preceptors, seniors and colleagues what is required • Use written program training objectives	• Create and refer to an organized list of topics / objectives • Amass pre-existing sets of training objectives • Reflect on skills and knowledge identified previously as "need to know"
<u>Determining topics relevant to the specialty (what major topics must be learned)</u> • Create objectives based on issues arising in clinical experiences • Ask or observe what subjects preceptors and colleagues focus on • Use training objectives (local program, Royal College) to guide selection of topics • Use old exams to set objectives • Use standard textbook for the specialty to identify topics (ex. table of contents) • Consider all seminar topics	
<u>Determining specific knowledge required (what details must be learned within major topics)</u> • Ask preceptors, seniors and colleagues what they feel is important to know • Follow-up questions that arise that you perceive you want the answers to • Examine the content of old examinations • Use key review articles to guide studying of a topic • Use lecture notes from lecturers as indicators of what is important	

Table 14

Strategies for "Allocating & Optimizing Use of Time"

Managing study time	Managing other time (beyond & studying)
Making sure *some* time is used for study • No time schedule but study whenever time available • Plan study certain amount of total time daily or weekly • Use time schedule for study but no formal allocations of that time • Make time schedule with specific allocations for particular activities	Allocating time "outside" of training • Set priorities for time use (ignore family life / have time for family life, etc.)
Making time to cover specific objectives • No specific organization of time • Designate time per number of pages to cover • Designate time per topic	Utilizing available time fully • Use every possible minute of day • Don't sleep
Prioritizing study time • Prioritize study around learning activities with upcoming deadlines (presentation, etc.) • Set topic-time priorities (ex. weak areas, topics not recently reviewed, common questions on past exams, common clinical problems, "important" areas) • Allocate more time for unfamiliar topics than familiar topics	Maximizing efficiency of non-study activities • Do several things at once (eat in car on way to work, etc.) • Co-ordinate activities to minimize travel time • Avoid doing work perceived as "trivial"
Maximizing efficacy of study time (activity options may or may not be appropriate) • Use "best study times" to study (early am, evening, night, etc.) • Study in a preferred environment (ex. no distractions, large table, bright light, etc.) • Focus time on "relevant" items • Write notes in brief point form or noting "key words" or making rough diagrams • Split up topics for researching among members of a study group, then share results • Organize references and notes to find them easily	

Table 15

Strategies for "Selecting & Utilizing Resources"

Resources	Criteria used in selecting resources	Strategies for finding information efficiently
• Staff, other consultants, colleagues, other health care workers in practice (observation & interaction, oral and written information) • Patients (observation and interaction) • Seminar presentations • Past experiences (reflection) • Rounds (ex. morbidity & mortality rounds for outcome information) • Lecturer's notes • Xrays • Anatomical models • Surgical and anatomic atlases • General and specialized textbooks • Journal articles (basic research & review articles) • Notes (own) • MedLine abstracts • Study guides • Instrumentation manuals • Patient records • Internet resources	<u>When guidance in selecting resources is desired</u> • Ask staff, seniors and colleagues for advice about good reference sources <u>When a good clinical skills "model" is desired</u> • Pay particular attention to staff & colleagues known or judged to have excellent skills <u>When topic is new to the resident</u> • Start with general texts and review articles; advance to specialized texts and journal articles when more is known about topic • Use greater number and variety of resources when topic unfamiliar • Use staff or colleagues as resources when topic unfamiliar <u>When basic information is desired</u> • Select general text for basic information • Select review articles for basic (or detailed) information • Use text that "highlights" important points (continued, next page)	• Ask questions • Make mental notes of where to find things • Create lists of references for use later • Use a filing system for reference sources • Use an organized and indexed filing system for notes and papers • Use a computer to organize notes (ex. search for key words) • Cross-reference texts, notes and journal articles

Table 15 (continued)

Strategies for "Selecting & Utilizing Resources"

Criteria used in selecting resources (continued from previous page)
<u>When topic pertains to something rare</u> • Use journal articles when topic very new in the field or condition is rare
<u>When detail is required</u> • Use specialized text for general information • Use journal articles when fine details are needed
<u>When time is limited</u> • Select texts that "get to the point" (most information in fewest words) • Use fewest possible resources
<u>When a lot of time is available</u> • Do literature reviews when lots of time available • Use journal articles when time to look them up

Table 16

Strategies for "Monitoring Learning"

<table>
<tr><th>Monitoring coverage of specific objectives</th><th>Acquiring feedback re: clinical performance</th><th>Acquiring feedback re: general knowledge</th><th>Using feedback</th></tr>
<tr><td rowspan="2">• As studying of topics is completed, cross off from list of objectives</td><td><u>Acquiring feedback from others</u>
• Ask staff, seniors, colleagues or others for feedback on clinical performance and think about the feedback received</td><td><u>Using feedback from others</u>
• Have staff & colleagues provide feedback regarding adequacy of knowledge</td><td rowspan="2">• Set time priorities for weak areas or topics not recently reviewed
• Allocate more time for unfamiliar topics
• Pay attention to information pertaining to "weak areas"</td></tr>
<tr><td><u>Using self-evaluation</u>
Comparison with peers
• Present patient cases - compare own approach to others'
Comparison with own standards
• Note comfort level in doing clinical work
• Reflect on own performances and identify strengths and weaknesses
• Do a "debriefing" after a case - review techniques or things missed
• Teach someone how to do something, then evaluate own aptitude and explanations</td><td><u>Using self-evaluation</u>
• Compare own knowledge to knowledge of peers ex. during seminars
• Compare knowledge with perceived requirements
• Assess own responses when staff ask questions
• Review objectives and evaluate knowledge in relation to them</td></tr>
</table>

C. Cognitive Strategies

Table 17

Major Categories of "Cognitive Strategies"

COGNITIVE STRATEGIES	
Gaining & Holding Attention	***Encoding / Retrieval***
Criteria for selecting information to pay attention to	**Basic cognitive strategies**
Strategies for extracting selected information from resource	**Task-specific strategies**
Strategies to hold attention on selected items to facilitate transfer into working memory	
Strategies to reduce *new* information volume load in working memory	

i. Strategies for "gaining and holding attention"

Table 18

Strategies for "Gaining and Holding Attention"

Criteria for selecting information to pay attention to	Strategies for extracting selected information from resource	Strategies to hold attention on selected items to facilitate transfer into working memory	Strategies to reduce *new* information volume load in working memory
• Note information pertaining to "weak areas" in required knowledge • Note any information determined to be "required" • Note principles applicable to many topics • Note anticipated problems	• Decide what specific information is needed, then look for it (ex. fill gaps in knowledge or answer a self-imposed question) • Judge relevance of information (ex. recognize when new info. useful to understand something or needed clinically)	• Highlight or underline "selected" points while reading • Write down "selected" points during clinical encounters (such as key features of a patient being seen), seminars or while reading • Reflect on information	• Focus on one or two points from each case / learning session • Skim, looking for particular points rather than reading entire text • Extract only key points • Learn exceptions rather than all applications to rules

Table 19

Organizational Framework for "Encoding/Retrieval" Strategies

Basic cognitive strategies	Reported Strategies	Strategies per tasks		
		Making Diagnoses	*Making Management Decisions*	*Performing Surgical Procedures*
Repetition/practice (route to low-road transfer)		Building concept of disease	Associating options with disorders	Acquiring concept of procedure
Grouping/chunking				
Associating information with something familiar, but not meaningfully related		Learning how to differentiate different diseases	Forming approach to making decisions	
Acknowledging or creating meaningful associations		Practicing using knowledge	Practicing using knowledge	Practicing doing procedure
Abstracting ideas, principles and rules (route to high-road transfer)		Analyzing practice experiences	Analyzing practice experiences	Analyzing practice experiences

ii. Encoding/retrieval Strategies – basic cognitive strategies

Table 20

Sub-categories of "Basic Cognitive Strategy" Group

Repetition / practice	**Grouping/ chunking**	**Associating information with something familiar but not meaningfully related**	**Acknowledging or creating meaningful associations**	**Abstracting ideas/ rules/principles**
Repeating exposure to same information *Practicing doing task*	*Making lists* *Assembling information units* *Creating conceptual units*	*(No subgroups)*	*Inserting new information into prior knowledge* *Finding or making meaningful relationships*	*Making judgments* *Converting an abstract idea into a more concrete form* *Identifying principles & rules*

Table 21

"Repetition/practice" group – "Repeat exposure to same information"

Low-road transfer route when repeated many many times
Repeating exposure to "same" information
Re-expose or reproduce same thing, same resource, same sensory form • Re-read written information • Re-write word or copy notes • Make index card and carry in pocket during day to read repeatedly • Draw a copy of anatomy or deformities seen • Examine patient, then re-examine patient to reinforce it • Visualize an operation seen (review) Re-expose or reproduce same thing, different sensory form • Read out loud • Repeat information out loud • Make notes of steps of surgical procedure • Dictate an operative procedure (mental review) Re-expose or reproduce same ideas, different resources, same sensory form • Observe lots of patient-surgeon interactions in clinical setting • See lots of patients with the same medical problem Re-expose or reproduce same ideas, different resource, different forms • Use different media to learn the same material • Use different resources to learn same material • Prepare a seminar on a familiar topic • Read operative notes that staff dictate on cases attended • Read around cases • Read after seeing patient or after a seminar on a topic

Table 22

"Repetition/practice" group – "Practicing doing a task"

		Low-road transfer route when repeated many many times
		Practicing doing a task (practicing recall or doing specific task)
Recalled & Used ← Recalled	**Unspecified task application**	• Visualize layout of a page of notes or a book • Re-write notes from memory • Prepare "fill in the blanks" questions and later answer them • Make cue cards with questions, and answer repeatedly • Draw (from memory) angles, mechanical drawings • Draw (from memory) anatomy, deformities • Visualize xrays in mind • Visualize a past clinical experience • Teach others • Get patients' consents • Explain things to students (and answer their questions) • Recall past patient experiences to apply to new patient • Use principles in different clinical scenarios (real or hypothetical) • Apply recently acquired knowledge in clinical setting
	Making Diagnoses	<u>Rehearsing without doing it in "real life"</u> • Use principles in different clinical scenarios (real or hypothetical) <u>Rehearsing by doing in "real life"</u> • Look for "patterns" in patient being seen • Look after as many patients as possible (practice)
	Making Management Decisions	<u>Rehearsing without doing it in "real life"</u> • Use principles in different hypothetical clinical scenarios <u>Rehearsing by doing in "real life"</u> • Handle problems whenever possible (rather than deferring) • Look after as many patients as possible • Anticipate complications that might occur in a patient being treated (continued, next page)

Table 22 (continued)

"Repetition/practice" group – "Practicing doing a task"

	Low-road transfer route when repeated many many times
	Practicing doing a task (practicing recall or doing specific task)
Doing Surgical Procedures	<u>Rehearsing without doing it in "real life"</u> • Talk through operation out loud (heard, seen, felt) • Apply information from an old OR report to an operation in progress • Ask to dictate operative note after surgery (recall) • Visualize a procedure, step by step • Write or draw steps of procedure • Imagine "feeling" hands doing operation • Reflect on procedure just performed <u>Rehearsing by doing in "real life"</u> • Practice technical procedure in O.R. or skills lab • Increase the "amount" of operation performed by resident over time • Progress from staff telling resident what to do each step, to resident making all decisions • Use knowledge to anticipate problems in the O.R.
Examinations	• Do old exams • Do in-training examinations • Do "practice" exams (written or oral) • Ask self questions (aloud or on paper) • Do questions in study guides • Use past clinical examples when answering oral exam questions

Table 23

Strategies for "Grouping/chunking information"

Grouping/chunking information		
Making lists	***Assembling information units***	***Creating conceptual units***
• Create lists	<u>Notes/resources</u> • Create one set of notes per topic (information from various sources) • Create filing system for notes/articles based on themes (anatomic sites of diseases, "related topics", individual diseases, seminar topics, clinical presentation features) • Create an index system of notable cases seen • Note sequence of steps comprising an operation <u>Knowledge</u> • Plan reading / studying by topic • Mentally integrate information from various sources on a topic	• Create "prototype" derived from various patients seen with condition • Create an outline for a topic, then fill in details as information encountered • Collect a standard set of information on each topic, based on themes (ex. each disease: etiology, pathophysiology, clinical presentation, treatment options, etc.)

Table 24

Strategies for "Associating information with something familiar but not meaningfully related"

Associating information with something familiar but not meaningfully related
Familiar order • Create number schemes to remember numbers or certain number of points • Remember facts in alphabetical order Familiar words • Use mnemonics • Use word associations • Create rhymes Familiar sounds • Associate a song with some information • Associate other sounds with information Familiar images • Use visual images to associate with information • Create a visual image of a page of information to be recalled later • Mentally associate information with something ridiculous • Associate friends / family with particular disorders (that they don't have)

Table 25

Strategies for "Acknowledging or creating meaningful associations"

Inserting new information into prior knowledge structure	*Finding or making meaningful relationships*
Relate concepts to familiar ideas • Develop word associations that are meaningful • Associate a medical problem or issue with the image of a past patient or hypothetical patient • Associate xray image with particular problem • Recall clinical encounters to cue recall of particular clinical information or issues • When reading about a clinical task or issue, think about past clinical experiences • Use analogies to understand new concepts • Try to "understand" or "make sense" of information seen • Ask "why" • Reflect on how new information affirms or contradicts something known (explains something learned previously or agrees or contradicts previously acquired knowledge) (continued, next page)	Categories • Create lists of items with common features • Identify features / groupings / classifications within information How information fits together in bigger picture • Get overview by reading abstract (summary) before and after reading article • Note how information is organized in a textbook or article or presentation • Summarize information into an outline or "framework", then add details • Noting sequence of steps comprising a surgical procedure • Make cross-references between various related articles, texts, notes • Create "mind maps", pictures, flow charts and algorithms indicating relationships of related information Cause – effect • Relate intervention and effect observed • Relate symptom/sign to pathophysiology Compare & contrast • Compare patient seen with previous similar patients • When seeing a patient, recall recently acquired "book" knowledge and compare to patient • Compare & contrast different approaches to clinical tasks, disease presentations, management options • Visualize patient in similar and different clinical situations

Table 25 (continued)

Strategies for "Acknowledging or making meaningful associations"

Inserting new information into prior knowledge structure (continued from previous page)
<u>Insert new information into "activated" related prior knowledge</u> • Organize reading or studying topic by topic (new information added to related information just read) • Allow one topic to "lead to" looking at something related in same sitting • Read related basic science and clinical science or other related topics concurrently • Review notes before attending a seminar on a particular topic • Select topics to study according to types of cases being encountered on the current surgical rotation • Alternate reading about and doing a clinical task • Before planned clinical encounter read about all aspects of the diagnoses or treatment • Read about a problem as soon as possible after seeing a patient with that problem • Review relevant topic before seeing patient (if warned ahead of time of patient's problem) • Follow up questions with answers as soon as possible (immediate, end of day, within a week, etc.) • Ask questions related to a case *during* the clinical encounter, (linking case to responses) • Discuss a patient case and related topics with staff and colleagues • Discuss a patient case with consultants from various specialties such as radiology, pathology

Table 26

Strategies for "Abstracting ideas, principles, rules" (deliberately)

High-road transfer route		
Abstracting ideas, principles and rules (deliberately)		
Converting an abstract idea into a more concrete form	***Identifying principles & rules***	***Making judgments***
• Create visual image of an abstract process (ex. pathophysiologic process) • Create an analogy for a concept • Create an image of a disease (ex. human form with all possible signs of the disease)	• Create a standard approach to a task • Derive a patient "prototype" from various patients seen with a condition (to represent disease or management issue) • Look for rules or principles that can be applied to many situations (ex. hierarchical ladder of options) • Identify exceptions to rules	• Categorize or classify information according to its value and use • Judge "best" approach • Make decisions based on principles and rules

iii. Encoding/retrieval Strategies – strategies per tasks

a) Making diagnoses (identifying a disease)

1. Building a concept of disease from "book" information, didactic information and clinical experiences

Collecting different information about the disease from various sources

- Read "around" cases as well as "around" topics
- See lots of patients
- Discuss and ask questions about a case or topic with peers and staff
- Discuss a case with various non-surgical consultants (radiologist, intensivist, etc.)

Integrating "book" knowledge and clinical experiences in memory (reinforcement of concepts)

- See pt. with known diagnosis, read about diagnosis, examine patient again, looking for signs or symptoms that were in the reading material
- While reading, think about past experiences with patients that relate to reading content

Creating an outline of "components" of disease concept

- Use an outline from a staffperson (if can't come up with own)
- Make notes of "salient features" of patients seen
- List for each diagnosis the etiology, pathophysiology, symptoms, etc.
- Create a filing system for each diagnosis collecting etiology, pathophysiology, symptoms, etc.

Relating various "components" of disease knowledge to integrate

- Create drawings to bring together pieces of information about diseases
- Create "memory chains" of linked information
- Create "mind maps" of related information with respect to disease
- Relate symptoms & pathophysiology to "make sense" of symptoms
- Relate clinical presentation to anatomy (to "make sense" of presentation)

Creating a prototype or rules

- To recall features of a disease, visualize patient seen in past with "classic presentation"
- Create an "index" case for a disorder

- Create an imaginary person to represent a disease with all clinical signs in each body part
- Create a database of patient prototypes

2. Learning how to differentiate one diagnosis from others based on clinical presentation (problem-centred)

Comparing and contrasting disease presentations

- Compare & contrast patients seen with similar symptoms but different diagnoses
- Create a compare & contrast table for clinical presentations of different "similar" diseases
- Compare disease processes (pathophysiology) to "make sense" of differential diagnosis

Creating process or "approach" for differential diagnosis of a clinical presentation

- Develop and use a standard approach for making a diagnosis
- Create flow chart
- Use a scheme for learning possible causes of a symptom (example: infectious, ischaemic, etc.)
- Note key features which differentiate diseases rather than all features of disease
- Identify "rules" and "principles" that have broad applications

3. Practicing using knowledge in clinical scenarios

- Create scenarios and apply principles learned
- See lots of patients
- Look for "patterns" in patient being seen

4. Analyzing practice experiences

- After seeing patient, ask self how will recognize the diagnosis next time
- After seeing patient with a diagnosis, decide how will differentiate this from another disease next time

b) Making management decisions

1. Associating management options & outcomes with a group of diseases, one disease or "parts" of disease

Associating management information with a patient

- Mentally link management with patient by writing the management plan on the history & physical record
- Create patient profiles representing different types of management

Organizing for mentally associating disease, management options & outcome

- Organize information about management options by system or by anatomy
- Create classification schemes of treatment options (non-operative, operative, etc.)
- For each disease, place management information into a scheme of sub-categories
- Break down a clinical problem into parts and associate management options with the parts

Making "sense" of management options

- Think about pathophysiology of disease & its relationship to management rationale/modes of action
- Try to "understand" the treatment (why)

2. Forming an approach to making management decisions

Determining criteria for decision-making

- Base treatment decision on experience
- Select the treatment which is best blend of good efficiency and solid scientific foundation
- Judge which option has fewest complications or procedure least difficult

Analyzing options and making comparisons

- Make lists/charts of each management option for disease and probability of outcome
- Examine most accepted treatment for a disease and compare with other options
- Compare treatment options by goals, success, complications

Organizing the approach to making a decision

- Create treatment algorithms
- Create a hierarchical ladder of options (such as a reconstructive ladder)

- Create flow charts

3. Practicing using knowledge about management or making decision in clinical setting

- Mentally picture a theoretical patient with a disease and apply management information to this patient
- Deliberately use information that has been read in a clinical situation
- Try to anticipate what complications might occur in a patient being treated

4. Analyzing practice experiences

- Reflect on patient management successes & failures

c) Performing surgical procedures

1. Acquiring a concept of a procedure

Associating the procedure to clinical disorders

- Read about the clinical problem while preparing for surgical procedure
- Discuss the clinical problem of the patient with the staff during a procedure
- Before a planned procedure read about other "indications" for the same procedure
- Relate the rationale of the procedure to the nature of the disorder

Learning the "steps" of the procedure

- In preparation for upcoming procedure, read relevant anatomy and look at anatomy atlases
- Read about surgical exposure and steps involved in the operation before attending the procedure
- Mentally associate information read with steps observed in the operating room
- While assisting, pay attention to the names of the instruments and when they are used
- In the operating room, make a mental note of the "picture" of the exposure
- Observe the "flow" of the operation

Understanding & analyzing the procedure

- Relate possible complications to the procedure
- Think about the implications of the planned procedure
- Ask staff surgeons and colleagues why they use certain techniques
- Look for differences in approach between surgeons
- Judge which techniques are "best", easiest, etc.
- Try to extract principles that can be applied to various procedures

2. Practicing the procedure

Reproducing or rehearsing a procedure, non-physically

- Dictate the operative record after a case
- Visualize an operation done or seen previously, step by step
- Talk through an operation out loud
- Write or draw steps of a procedure from start to finish
- Think through part of operation that might be most difficult
- Visualize doing an operation
- Think about how hands would "feel" doing a procedure

Practicing technique physically, outside of clinical setting

- Practice technique in technical skill lab

Progression to independence in performing procedure

- Gradual increase in "amount" of operation performed by resident, to complete operation being done by resident
- Progress from staff telling resident what to do each step, to resident making all decisions
- Use knowledge & experience to anticipate possible problems
- Try to handle problems that arise when possible

3. Analyzing practice experiences

- After a procedure, reflect on anything missed, good techniques, etc.
- Review past experiences with a procedure immediately before doing the procedure
- Describe an operative procedure aloud, then review to see if anything missed

D. Special Strategies For Exam Preparation

Table 27

Special Strategies for Exam Preparation

SPECIAL STRATEGIES FOR EXAM PREPARATION				
Setting Objectives	***Allocating & Optimizing Use of Time***	***Selecting & Using Resources***	***Monitoring Learning***	***Cognitive***
Determining content knowledge required for exam **Determining exam skills required**	**Managing Study Time** **Managing "Other "Time**	**Special Resources**	**Acquiring feedback**	**Developing appropriate retrieval cues** **Practicing retrieval**

Table 28

Special Strategies for Exam Preparation – "Setting Objectives" and "Allocating & Optimizing Use of Time"

SPECIAL STRATEGIES FOR EXAM PREPARATION	
Setting Objectives	***Allocating & Optimizing Use of Time***
Determining content knowledge required for exam • Some residents don't identify particular content for exam preparation • Ask what topics will be covered on exam (peers, preceptors) and use this as a guide for study • Find out what was asked in previous exams • Try to anticipate questions that will be asked and study around them • Study topics that oral examiners are known to be "strong" in (if know who examiners will be) **Determining exam skills required** • Ask "successful" exam-takers what is required • Ask preceptors, seniors and colleagues what is required • Try doing a practice examination and determine what is required	**Managing study time** <u>Timing of studying</u> • Spend more time studying for exam than regular routine • "Accelerate " by increasing time spent studying prior to exam • Start exam studying well in advance but without specified time frame • Start exam study a specific amount of time (ex. two months) prior to the exam • Finish studying several days before exam, then spend 2 – 3 days for self-testing • Cram at the last minute before exam • Stay up late studying night before exam • Get good night's sleep night before exam <u>Setting "time per learning objective" priorities</u> • Start with topics not recently reviewed • Focus on areas felt to be weak **Managing other time** • No change in routine pre-exam compared with usual routine • Put rest of life on hold certain amount of time before exam

Table 29

Special Strategies for Exam Preparation – "Resources", "Monitoring Learning" & "Cognitive Strategies"

SPECIAL STRATEGIES FOR EXAM PREPARATION		
Selecting & Using Resources	***Monitoring Learning***	***Cognitive***
Special resources • Use exam study guides • Ask "successful" exam-takers for advice • Use past experiences with patients to assist recall or as examples in oral exam questions	**Acquiring feedback** • Do old exams & assess results • Do "practice" exams (written or oral) & get them assessed by someone or assess self • Ask for feedback from staff or seniors with respect to exam skills & knowledge • Try to answer practice questions with logical organization and assess results	**Developing appropriate retrieval cues** • Anticipate questions and study "around" them • Learn by having people ask questions (look up answers or have them give answers) **Practicing retrieval** • Do study guide questions • Do practice written & oral exams • Do old exams, if available • Ask self questions (oral or written) and respond

In analyzing and categorizing the learning strategies reported by participants in this study, then, a classification system was produced, as outlined on pages 79 to 82 and as detailed in Tables 11 to 29. The nature and relevance of reported learning strategies will be discussed in CHAPTER SIX.

CHAPTER SIX: DISCUSSION

I. Perspective of this Research Project

The purpose of this research project was to acquire an overview of the types of learning strategies being used by Canadian surgical residents (see CHAPTER TWO). The study was neither intended nor expected to produce a comprehensive list of strategies used by surgical residents, and *no* attempts were made to *quantify* the reporting of specific strategies (recognizing that it would have been inappropriate to do so). The analysis focussed only on characterizing and organizing the spectrum of learning strategies reported. An effort was made to produce a categorization framework that could be used by individual residents interested in analyzing their learning strategies.

II. Discussion of Methods

A. Insights Gained regarding Data Collection Methods

i. Selection of participants

Information was sought from residents from four different surgical specialty residency programs and in two different universities in an attempt to "triangulate" the data from multiple sources (more representation from a diverse group of surgical residents). By surveying two universities, bias attributable to "unique" school philosophy, approaches to teaching and local evaluation methods was hopefully reduced. Nonetheless, in evaluating the data produced and in generalizing the results to surgical residents at other Canadian universities, the limitations and potential biases of surveying residents from only two schools must be recognized. Unfortunately, logistical difficulties and expense precluded involvement of additional universities and surgical programs.

Care was taken not to coerce eligible residents into participating in the study, for ethical reasons. Thus, information gathering sessions were voluntary, even though a more complete survey of residents might have been possible had the sessions been compulsory. It is possible that residents attending voluntary data collection sessions represented those which were most interested in examining their learning strategies. Similarly, residents choosing not to attend might have been disinterested in their learning and hence might also use quite different learning strategies than their keener colleagues. Not all learning strategies were captured because not all residents participated.

One of the great difficulties in assessing representation of data produced by the participating residents was the failure to accurately determine reasons for residents not participating. None of the residents who attended data collection sessions refused to participate. Residents who did not attend the sessions could not be easily accessed to determine their reasons for not participating. Attempts failed because of the ethical issue of not wanting to identify to program directors which residents did and did not participate. Residents who participated were unable to "pin down" the concurrent activities of their fellow residents. Also, residents training at sites other than those where data collection sessions were held could not be directly accessed by the investigator. Program directors were very protective of their residents. Residents who did participate reported that a large number of their colleagues were unable to attend because of patient care commitments (particularly operating room service). It was not possible to quantify the effect of lack of residents' desire to participate and lack of residents' ability to participate, unfortunately. It can only be hoped that a broad spectrum of resident capabilities and interest in learning strategies was represented in the data collected.

Another pitfall in the method of participant recruitment was the program directors' control in arranging the data collection sessions. Table 8 on page 74 clearly shows that sessions held during time periods during which residents were usually freed of clinical responsibilities to meet captured the greatest proportions of residents and hence produced data which most likely represented the fullest spectrum of learning abilities and interest. It is expected that residents felt more free to attend a session at a time designated by their programs as "education time".

The circumstances of data collection from School 2, Program A were particularly illustrative of the effect on the study results of program directors' control over data collection sessions. This particular data collection session was held on the Friday afternoon before Christmas, a time during which many department Christmas parties were known to be occurring. A surgical skills lab involving the intermediate-year residents had been held immediately prior to the data collection session. Intermediate level residents had attended this lab. It can be seen in Table 9 on page 75 that 2nd, 3rd and 4th year residents were well represented but almost no 1st or 5th year residents participated. A failure of the 5th year residents to participate from this one program (3/11 or 27%) distorts the overall 5th year participation statistic (in this case the proportion of participants out of total number of registered residents) 15/27 (56%). Happily, Program A at School 1 provided an almost complete spectrum of 5th year residents for data collection. In addition, a full spectrum of 5th year residents from other programs participated (see Table 9, page 75). Circumstances of data collection were not ideal but gaps were offset by involving residents from various programs and two different schools.

It is felt that the spectrum of resident abilities and interests as well as years of training were adequately represented in the data. Deficiencies associated with poor participation by residents from some programs in particular years of training at one school were neutralized by very high rates of participation in corresponding programs and years of training at the other school (see Tables 9 & 10 on page 75). The goal was to capture learning strategies used by a full range of resident abilities and interests, years of training and programs. This goal was achieved, although first year residents were particularly under-represented (only 7 residents). First year residents often work and study outside of their own program's "domain" and hence strategies used by first year residents might be quite different than strategies they might use once they are learning what they feel that they are expected to know in their own programs. A topic for further study might be differences in strategies between years of training.

ii. Questionnaire content & data production

Limitations of retrospective "self-report data" have been discussed in the literature review above. The open-ended questions used for data collection in this study produced retrospective self-reports of learning strategies used by the resident participants. This technique permitted collection of information encompassing a wide range of resident learning activities and pertaining to the acquisition of varied knowledge and skills. The range was clearly evident in the classification scheme produced. It is unlikely that such a spectrum of residents' learning strategies would have been captured by observation or "think-aloud" techniques. Thus the purpose of this study was well-served using the retrospective self-report methodology. It should also be acknowledged that while the data produced in this study represented the residents' perceptions of what

learning strategies they had been using, the bias was felt to be completely pertinent; students' choice of strategies will be based on their perceptions. If anything, the utility of the results of this research were enhanced by the influence of residents' perspectives on the data produced.

The format of data collection was similar to a structured interview, although information was written rather than orally presented. Written responses were felt to be preferable to spoken responses in that the points were clearly indicated by the residents and were efficiently extracted from data sheets (points not "buried" in transcribed conversation). Resident participants were able to easily return to earlier responses if they thought of additional points to make during the data collection session (no time limit). The investigator observed this phenomenon. It was believed that more learning strategies were captured because of this flexibility. In addition, it is presumed that the act of writing served to reinforce and provide more time for residents to reflect on their answers.

The questionnaire itself attempted to cue and probe residents to reveal learning strategies used during different learning activities. As discussed in CHAPTER THREE above, the context of learning and the types of tasks required of students (including particularly evaluation tasks) play a significant role in determining the types of learning strategies used by students. For this reason, the questions were designed to cue residents to the contexts of their typical learning activities and to the tasks which they were expected to carry out (see Appendix B). As surgical residents primarily learn in the contexts of direct patient contact experiences (observing and doing), seminars and "rounds", formal and informal discussions with resource people (including other

residents), doing research projects and reading, references to these activities were used to cue responses to questions pertaining to learning. Similarly, the tasks of making diagnoses, making management decisions and performing surgical procedures were included in the question cues. Results indicated that the questions did effectively capture learning strategies used during the aforementioned activities and learning strategies used to enable successful completion of the aforementioned tasks (see Discussion of Results, below).

B. Critique of Data Analysis Methods

i. Selection of data reviewers

Again in keeping with principles of "triangulation" (investigator triangulation, using multiple evaluators in data analysis), three data reviewers participated in this study. The criteria for selecting the two additional data reviewers (other than the investigator) included familiarity of these "experts" with surgical learning in the context of a residency program and familiarity with principles of learning. One of the two selected, a resident in her final year of surgical training in Obstetrics and Gynaecology, was selected because of her special interest and expertise in medical education theory, her reflective nature and her insight as a resident. The other was a qualified expert in surgical education, a staff surgeon who worked with residents on a daily basis and who possessed a Master's Degree in medical education, with a special interest in learning strategies.

The importance of involving data reviewers with knowledge of medical education theory was apparent. Reviewers were required to recognize the effects of various strategies in order to identify and differentiate various learning strategies within the data. In fact, the usefulness of the resultant classification system lies in its ability to readily

identify strategies which produce a particular effect. It is suspected that the nuances of different strategy effects might not have been identified by data reviewers without the background theoretical knowledge.

ii. Methods for identifying learning strategies from the data

The methods for extracting learning strategies from the raw data were effective, as evidenced by the number of strategies extracted and the agreement between reviewers in the strategies represented by the data. The instructions given to the data reviewers provided a uniform approach. Providing options of using the computer or index cards to do the extraction and sorting was beneficial. Two reviewers preferred to use the computer and one preferred to use the index cards. Provision of these options to data reviewers involved in similar studies might be also considered in the future.

iii. Assessment of credibility

The inter-rater agreement was very difficult to ascertain using the methods of assessment chosen for this project. It was determined that the strategies independently extracted from the data "agreed" to some extent, as the most summarized list of strategies produced by one reviewer was wholly included in the next most summarized list by another reviewer, which in turn was covered by the most detailed list produced. However, it was very difficult to measure agreement, even after the reviewers re-examined their learning strategies and those extracted by their colleagues. No reviewer disagreed with any of the collective learning strategies identified. Reasons for the differences in lists resulting from the raw data analysis were attributed to differences in the amount of generalization made.

In future studies, an assessment of reproducibility might be worthwhile. Perhaps a random sampling of questionnaire responses could be re-analyzed several months after the initial learning strategy "extraction". An evaluation of intra-rater agreement and inter-rater agreement on a small number of responses might then be easier to do.

III. Development of the Classification Structure

While the primary role of the data reviewers was to extract learning strategies from the data, the reviewers' assistance was also sought in identifying themes which might be helpful to incorporate in the final organizational framework (in order for the framework to be "useful"). Therefore, each reviewer, in addition to compiling a list of strategies, proposed a classification structure based on themes that he/she recognized in the data (see Appendix E). Independent ideas were thereby obtained for consideration in the final product.

A. Themes Identified by Data Reviewer # 1 (obstetrics and gynaecology resident)

The classification system proposed by the data reviewer # 1 (see Appendix E, section I) was based primarily on Kolb's learning process model (Kolb & Lewis, 1986). This experiential learning model considers four stages in the learning process, namely "Concrete experience", "Reflective observation", "Abstract conceptualization" and "Active experimentation". Kolb's Learning Style Inventory was developed from this model in order to assist learners in assessing their preferences for various combinations of these approaches (Kolb, 1976). The data reviewer used Kolb's four categories to create her own version of Kolb's Learning Style Inventory, using the surgical residents' learning strategies. She felt that residents could use this type of classification system to

identify the strategies that they felt most comfortable with (recognizing their "style" by category). In addition, residents could then select strategies from other categories in order to enrich their learning experiences.

A second axis in this classification system consisted of the categories "Types of learning activities", "Time Management" and "Resources". The differentiation between what residents do to acquire knowledge and how they plan their learning by time correspondingly differentiated cognitive and non-cognitive (management) strategies. The Resources category might also be considered a management category.

B. Themes Identified by Data Reviewer # 2 (surgical educator)

The primary theme identified in data reviewer # 2's proposed classification system was the differentiation between information processing and "organizing" strategies. The groupings were entitled "Content Related Strategies" and "Organization of Learning Activities" (see Appendix E, section II). While the "organizing" strategies were not subclassified in this proposed classification scheme, the information processing strategies were. Two major categories, "Strategies that are not dependent on meaning" and "Strategies dependent on meaningful manipulation of concepts" differentiated rote or passive learning strategies from more active "meaningful" ones. The reviewer expressed having had difficulty in making clear differentiations because the effects would depend on what the residents were doing "in their minds".

This classification system also took into consideration different phases of the learning process. Two categories mirrored the learning process model described in CHAPTER THREE, specifically "Strategies while gathering information" and "Self-

monitoring strategies". The reviewer placed these under the broader category of Information Processing strategies.

C. Themes Identified by Data Reviewer # 3 (investigator)

This proposed classification system was also broadly based on differentiating cognitive and learning management strategies headings "Cognitive" and "Metacognitive". However, some strategies used by the residents were found not to fit into either of these two categories. Two extra categories were thereby created, namely strategies for "Optimizing mental & physical abilities" and "Managing activities outside of residency training" (see Appendix E, section III).

The "Metacognitive" strategies were subdivided according to different steps taken by a self-directed learner in the learning process. It was felt that while learning may not be a linear process, the simplification of learning processes into steps might make it easier for residents to analyze their own learning strategies and compare their strategies with those used by other residents. The investigator used these principles to create a model (see Appendix E, section III), which in turn was used to subclassify the strategies. The Information Processing process "steps" were derived from popular information processing models (Gagné et al., 1992; Mayer, 1988).

Difficulties encountered by the investigator in categorizing all of the learning strategies according to this classification scheme were similar to concerns expressed by the surgical educator in his analysis. It was recognized that the effects of a strategy depend on what is happening in a student's mind (and student's intent). A single strategy, then, was found to straddle different categories and subcategories. In addition, the task-specific strategies were felt to be inadequately emphasized. In trying to devise

the initial classification system, the investigator spent a great deal of time trying to create categories by task, but had difficulty with the huge overlap between tasks and across processes of learning. Tasks were therefore not used to categorize strategies in the investigator's first classification system. Nonetheless, an integration of this theme into the final classification system was desired.

D. Final Integration of Major Themes

The following major themes were integrated into the final categorization scheme:

1. General categories of strategies include Cognitive (Information Processing) strategies, Metacognitive (Learning Management) strategies and Mental & Physical Health strategies (which impact but are not directly involved in learning) Note: within the grouping of information processing strategies are strategies which involve meaningful manipulation of concepts and those which do not.
2. Different "steps" in learning processes are facilitated by different strategies (with some overlap).
3. Some strategies specifically target the learning of particular tasks and others are more "general" in their application.

Figure 5 on page 79 illustrates the framework of the final classification scheme produced, showing relationships between various components. First, it was acknowledged that mental and physical health affect all aspects of learning. Strategies for optimizing mental and physical capabilities were therefore diagrammatically represented enclosing all other learning strategies. Secondly, the organization scheme for all of the learning management and information processing strategies was based on simplified steps in the learning process derived from the literature. The rationale for this

format was to make the lists of learning strategies produced by this study user-friendly. It was expected that most surgical residents could easily relate these steps to their own learning experiences and perhaps even use the format to analyze their own learning. Residents seeking learning strategy ideas might then be able to find relevant strategies easily using this framework.

In analyzing the data, general and task-specific strategies were also distinguished. However, interestingly this differentiation seemed to be most relevant in the category of encoding/retrieval strategies and not so relevant to other general categories of strategies. This concept was therefore incorporated into the analysis of encoding/retrieval strategies only. Further discussion is provided below in the section pertaining to cognitive strategies.

IV. Discussion of the Types of Learning Strategies Used by Residents

As expected, the learning strategies used by surgical residents involved in this study reflected the residents' sophistication as experienced learners, the culture of Canadian surgical training programs and the nature of the tasks residents were required to learn and carry out. A discussion of the types of learning strategies used and their relevance follows.

A. Strategies for Optimizing Mental & Physical State

Strategies pertaining to mental and physical state have not been highlighted in learning strategy classifications reported previously, even though concentration and motivation strategies have been acknowledged in several (Dansereau et al., 1979; McKeachie et al., 1986; Weinstein & Underwood, 1985). However, the tremendous influence of mental and physical state on *all* aspects of learning is clear. In the context of

a surgical residency, such factors may be particularly relevant. Stresses related to volume of work, long hours, criticisms from teaching faculty and sleep deprivation have a significant impact on residents' lives (Badger, Chesebro, & Hartman, 1987; Butterfield, 1988; Levin, 1988; Toews et al., 1997) and hence probably also impact residents' learning capabilities.

While no specific questions were asked in the questionnaire about strategies for optimizing mental and physical state (their significance not being recognized before the study was completed), a large number of residents reported using such strategies (see Table 11, page 83). It is interesting and perhaps not surprising that residents simply volunteered these strategies. It is likely that the residents, being highly health conscious, recognized that the culture of residency training tends to be counter-productive to good health (Peterkin, 1991) and effective learning. Regardless of the reason for reporting these strategies, it was because of the residents' initiative in responding to the study questionnaire that the importance of these strategies was realized. It is certainly appropriate to highlight these strategies in any discussion of surgical residents' learning strategies.

The subcategories of strategies gleaned from the residents' responses were "motivating by mood adjustment", "preparing mentally for learning", "mind refreshment during learning activities", "managing learning-related stress", "body refreshment during learning activities" and "maintenance of health in general" (see Table 11, page 83).

i. Motivating by mood adjustment

It is generally known that surgical residents are highly motivated individuals (unlikely to endure the hardship of the training program without great motivation). The

motivation strategies placed in the "Optimizing Mental & Physical State" category focussed on motivation by adjusting mood. (Aspects of motivation more closely relating to content of learning materials, such as looking for relevance of content to encourage attention, were placed in the "Information Processing" category). The motivation strategies reported by the residents dealt primarily with punishment and reward systems. Positive and negative experiences are known to be excellent sources of motivation (Griffin, 1988). In addition, ensuring successful learning is a recognized motivational strategy (Wlodkowski, 1990) which was represented in residents' reports by "setting realistic goals" and "working at small parts at a time".

ii. Preparing mentally for learning

The two strategies which fell under this category pertained to making an effort to concentrate and pay attention. These strategies are not unique to residents, certainly, and in fact are recommended strategies in Dansereau's learning strategy training program (Dansereau et al., 1979). It is likely that residents use many more strategies to prepare and direct attention to their learning tasks at hand, but because the question was not specifically asked, they were not reported in this study.

iii. Mind "refreshment" during learning activities

Because volume overload and huge time commitments for studying are well-recognized burdens of residency training, as alluded to above, the strategies of changing topics, alternating interesting and not interesting topics and taking breaks during studying were logical ones for residents to use to "refresh" their minds and probably reduce stress as well. The concept of working on small parts might also be considered a way of keeping the mind refreshed, although a perhaps stronger effect is to counter-act feelings

of overwhelming (hence additional placement of this strategy in the "Motivation" section). This is a good example of a strategy with multiple effects belonging in two sub-categories.

iv. Managing learning-related stress

Stress-reducing strategies were not specifically queried in the questionnaire, either, but might be considered learning strategies as well. Stress experienced during a learning activity such as performing an operation or being quizzed by a clinical preceptor likely affects the quantity and quality of learning that occurs. Deliberately controlling stress during learning activities and putting the experience into perspective, two strategies reported by residents, might arguably then be considered learning strategies. It is important to recognize that while these strategies have been included in this project, stress management strategies were not fully represented because they were not specifically sought. An interesting and relevant avenue of investigation in future might be an analysis of stress management strategies in surgical residents as they pertain to learning.

v. Body "refreshment" during learning activities

While there was deliberately no attempt made to quantify learning strategies reported, the strategies of "eating to stay awake" while studying and "using caffeine" to stay alert were noted to be reported by a huge number of the residents participating in this study. Neither of these strategies were reported in any of the learning strategy inventories or training programs found in the literature. It is possible that they might not be included because they are perceived as undesirable, or perhaps because they are not perceived as learning strategies. Regardless, they appear to be widely used strategies to

enhance the productivity of surgical residents' work and studying. Sleep deprivation is a common condition in residents, including surgical residents, and residents feel pressured to use as much of their non-clinical time as possible to study (Scher & Peoples, 1990; Toews et al., 1997). It follows then that stimulation by the act of eating (beware post-prandial sedation) and use of a stimulant in food or drinks are strategies used by this population of students.

vi. Maintenance of health in general

Maintenance of mental and physical health also pervaded the questionnaire responses of the surgical residents. Although the strategies reported were non-specific, the themes related to paying attention to all aspects of life, getting sleep, getting exercise and eating. Again, these concepts "fit" the context of residency training described above.

B. Learning Management Strategies

Because of the breadth of this research project, attention was directed at macrostrategies in the questionnaire. As a result, the learning management strategies reported by residents in this study represent "higher level" strategies, being quite general and far removed from the intricacies of cognitive processing. Attention was focussed on what residents did and/or how they decided to do what they did. Queries which prompted reporting these strategies included questions about how learning was approached in various contexts, how the residents decided what to study, if residents used time management "tricks", what and how resources were selected and how residents checked their learning. The "any other tricks" question also produced some learning management strategies. (See Appendix B). In some cases, responses to questions not specifically

intended to elicit the reporting of these types of strategies nonetheless prompted residents to report additional learning management strategies.

i. Setting objectives

Several themes became apparent in examining the reported learning strategies that dealt with setting objectives (see Table 13, page 86). First of all, *observation* of peers, seniors and clinical preceptors, *reflection* upon those observations and *questioning* colleagues and preceptors were the means by which residents determined objectives (particularly clinical skills and major topics). Both apprenticeship models of learning and models of professional education indicate the importance of asking the coach, observing (modeling), and reflecting in order to formulate a concept of the tasks required (LeGrand & Buckmaster, 1993; Schön, 1983; Schön, 1987). Because surgical residents are professionals in training and spend much of their time in apprenticeship learning situations, it is not surprising that objectives pertaining to major topics and professional skills were determined in these ways.

Objectives were also derived from guidelines provided by the training programs, from old examinations, from lecturers and from the literature (standard texts, review articles). These sources of information were used to identify major topics and decide what detail was important to know. Because residents are expected to know facts, theories and rules required for professional practice (Schön, 1983), again it is not surprising that they would use standard texts pertaining to their specialty not just as a source of information but also to provide an outline of topics required for the specialty. Lecturers and experts writing review articles were also relied upon to provide the expertise in identifying to residents what was important to know about a particular topic.

There were a few strategies reported which involved collating objectives into a list or "package". Presumably monitoring of learning would also be facilitated later if a checklist of objectives was created. The creation of a set of objectives would also serve to compartmentalize and "define" the domain of the specialty for the residents.

ii. Allocating and optimizing use of time

Questions which were intended to elicit "scheduling" and other time management strategies included requests for a description of study routines (regular and pre-exam routines), how residents organized and planned studying time in the context of examination preparation and time management "tricks". Scheduling and time management of clinical responsibilities were not included in questions because residents rarely have the luxury of controlling time spent in that environment. (A study examining time management strategies in more detail might in the future produce a more complete inventory). Questions pertaining to "approaches" to learning provided additional time management strategies for analysis.

In the category of "Allocating & Optimizing Use of Time" sub-categories were derived from themes noted in the responses. Major themes were "Managing Study Time" and "Managing Other Time" (beyond training and studying). Minor themes were "allocation of time by prioritizing", "maximizing efficiency and effectiveness of time use" and "using time fully". Some residents did not use scheduling strategies at all ("No time schedule" and "No specific organization of time").

While a wide variety of strategies were reported, not all strategies were necessarily useful (for example, "don't sleep" could hardly be perceived as a useful strategy). However, insufficient evidence is provided in the literature to critically

evaluate the strategies used by the participating surgical residents. Few studies have attempted to show that particular time management strategies were beneficial. In fact, two studies of residents (internal medicine) relating number of hours spent studying for final examinations and the % time spent using particular resources with results on final written certifying examinations suggested that a true correlation was unlikely (Day et al., 1994; Grossman et al., 1996).

Common sense and experience suggest that it might be "good" to schedule time fully, prioritize and ensure that all objectives are covered in a timetable. Nonetheless, because of the realities of a surgical resident's unpredictable clinical responsibilities, coupled with a lack of evidence in the literature (Brown et al., 1983), such an inference cannot be legitimately made at this time. Similarly, a paucity of information in the literature about time management learning strategies make a comparison of surgical residents' strategies to those of students in other contexts very difficult.

iii. Selecting and utilizing resources

The content and context of surgical residency education require students to use resources that are highly specialized and somewhat unique. This was evident in the strategies for "Selecting & Utilizing Resources" reported by residents in this study (see Table 15, page 88).

Resources identified by the students included human resources, specifically colleagues, preceptors and patients in clinical settings. Residents not only observed them but also interacted with them. This is typical of apprenticeship education and professional training in which students learn by observing and doing (Brown et al., 1989; LeGrand & Buckmaster, 1993; Schön, 1987). Both declarative ("what") and procedural

("how") knowledge were gained from interactions with people during many learning activities, such as clinical encounters, formal "rounds", seminars and informal discussions. Resources used also included written materials, images (xrays) and forms (anatomic models).

Clinical tasks require processing of visual information in the form of complex images, in contrast to written examinations which cue and demand information in "verbal" form. Thus, while resources providing written information were predictably used by the surgical residents, it was also logical that residents used resources such as surgical and anatomic atlases (pictoral), xrays and instrumentation manuals which provided information in the form of images (see Table 15, page 88). In addition, patient diagnostic and management tasks require surgical residents to learn and utilize information in various other sensory forms, in particular auditory, olfactory and tactile forms. Learning resources used, therefore, must provide an array of sensory information. Residents use patients, anatomic models and multi-media (Internet) resources.

Criteria used in selecting resources demonstrated the sophistication of surgical residents as learners (see Table 15, page 88). Residents judged the quality of their resources, including human resources, and utilized them accordingly. They also asked for the opinions of others in judging the best resources to use for particular learning tasks. Choices depended on whether or not the topic was new to the resident, if the topic was common or rare, if basic or detailed information was desired and how much time was available.

Included in the "Resource Selection & Utilization" category were "Strategies for Finding Information Efficiently". These strategies also hallmark experienced learners,

who will store information "externally" for use in future (Flavell & Wellman, 1977). Noting where to find references, creating reference lists, organizing references and notes in a filing system, and creating complex cross-referencing systems reflected also the capacity of surgical residents to compartmentalize and organize related units of information. It is likely that the organization scheme, which not only facilitated retrieval of information from resources later, also reflected the organization of topics in memory. Some of these strategies were therefore categorized in the "Information Processing" section because the act of organizing references, in effect, also organized the concepts in the residents' minds.

iv. Monitoring learning

Surgical residents not only tracked their "coverage" of training objectives, but they were proficient seekers of feedback to monitor their learning progress (see Table 16, page 90). In the clinical setting, preceptors traditionally quiz the residents and provide ample invited and uninvited feedback about clinical performance or general knowledge. However, residents were found to also *seek* feedback from preceptors, seniors and colleagues and reflect on this feedback. Self-evaluation strategies reported were creative and involved self-comparison with peers as well as self-evaluation according to the residents' own perceived attributes and deficiencies.

A noteworthy strategy reported for self-evaluation was teaching. The context of hospital-based residency training and contact with medical students provides surgical residents with opportunities and expectations to teach. Teaching is an excellent example of a strategy which has many effects. Residents used teaching to find out how well they could recall information and how well they could explain what (if) they understood.

Teaching is also an information processing strategy, serving to stimulate recall of previously learned information and reprocess it.

There was some evidence that surgical residents modified their learning activities based on their interpretation of feedback. Residents determined areas of "weakness" and "unfamiliarity", assigning more attention to and time spent studying these areas. Not a lot of information was obtained from the residents in this study about if or how they decided which learning strategies were effective and ineffective or how this affected their planning. This would be an interesting area to explore in future investigations.

C. Cognitive Strategies

The starting point for the analysis of cognitive strategies was the separation of strategies for "Gaining and Holding Attention" from those for "Encoding/Retrieval" (see Table 17, page 91). This sub-categorization was based on the information processing models and classification schemes from the literature discussed in CHAPTER THREE.

i. Gaining and holding attention

This group of strategies was readily identified in the residents' descriptions of their learning strategies (see Table 18, page 92). As discussed in the literature review, reception and selective attention strategies primarily affect the time spent on information and how long the information is held in working memory for processing. Often, attention strategies involve some retrieval of related knowledge from the long term memory, in order for the new information to be interpreted as relevant and useful and hence worthy of further time spent on it.

Surgical residents reported using strategies which served to identify what was important and relevant, listed under the subcategories "Criteria for selecting information

to pay attention to" and "Strategies for extracting selected information from resource" (see Table 18, page 92). Information selected for attention included topics or information that residents felt to be relevant to their objectives as well as topics which were felt to be "weak areas" (the result of self-assessment).

Another set of strategies recognized in the data were those listed in the category "Strategies to hold attention on selected items to facilitate transfer into working memory". These strategies included highlighting and underlining, which served to slow down reading and direct specific attention at the text which was felt to be important. In addition, note-taking of selected points during clinical encounters, seminars or while reading also caused residents to hold attention on particular pieces of information for longer periods of time. (Note-taking strategies have multiple effects; this is just one).

Also identified in the data were a group of strategies which served to reduce the load of incoming information into memory, so that the important points would not be lost in a sea of information. These were listed under the heading "Strategies to reduce new information volume load in working memory". Residents apparently recognized the value of focussing in order to gain the most from a lot of information encountered at one time. This perceptiveness probably reflects the sophistication of these experienced learners. It is particularly necessary in the context of a surgical residency for residents to prioritize their time spent (which is in short supply) as well as reduce their information load in any way possible.

It is noteworthy, too, that the strategies listed in the "Gaining and Holding Attention" category were derived from both clinical learning and "book" learning experiences.

ii. Encoding/retrieval

The "Encoding/Retrieval" strategies were by far the most challenging to analyze and categorize because of the wide diversity of strategies used, the multiple effects of various strategies reported, and the complexity of learning tasks to which the strategies were related in the analysis. In order to sort these into some sort of meaningful organizational structure, two important concepts from the literature were used. One concept was the concept of "information processing". The other concept was the importance of learning tasks in the selection of learning strategies by learners (see Table 19, page 93).

Models of information processing and previously published classification systems for cognitive strategies permitted identification of several "basic" strategies which are known to facilitate information storage and retrieval and which are generalizable across learning tasks. The basic cognitive strategies reported in the literature and identified in the residents' data (see also Table 20, page 94) were:

1. Repetition/practice
2. Grouping/chunking
3. Relating new information to something familiar but not meaningfully associated
4. Acknowledging or making meaningful correlations
5. Abstracting concepts

All of these basic cognitive strategies were used by surgical residents to enhance their abilities to store or recall simple and concrete as well as complex and abstract information.

The relevance of required tasks in the selection of learning strategies has been clearly established, as discussed in CHAPTER THREE, and as recognized by the data reviewers. In looking at the cognitive learning strategies reported by the surgical residents, the intent, effect and appropriateness of learning strategies used in learning how to make diagnoses, make management decisions and perform surgical procedures was apparent. Many of the strategies were specific to one of these three tasks while others were more general in their applications. (It must be kept in mind that the specific strategies reported could be generalized into more widely applicable strategies, but it was felt to be useful to include both general and specific strategies).

Wanting to highlight basic cognitive strategies which are valuable methods for storing and retrieving knowledge, while also wishing to indicate cognitive strategies used by surgical residents for learning the tasks of making diagnoses, making management decisions and performing surgical procedures, *both* perspectives were employed in the analysis of the cognitive strategies. In fact, even though there was an overlap in strategies between the two analytical schemes, some strategies "fit" more logically into one scheme than the other (see Table 19, page 93). With two analytical frameworks available to guide the approach, a resident or faculty member may explore strategies which generally enhance memory or may examine strategies which are specifically useful to develop knowledge structures and skills for the aforementioned tasks.

It must be recognized that within each category of cognitive strategies, numerous *additional* themes were found in the data. Initially, attempts were made to integrate all of these themes into the classification system. However, these sub-categories and sub-sub-categories detracted from the clarity of the important concepts within the frames. Thus, in keeping with the purpose of this study to provide an overview, the final two classification structures produced were deliberately simplified.

a) Basic cognitive strategies

1. Repetition / practice

Repetition and practice certainly are highly valued techniques in learning related to all tasks, from rote recall to using rules and principles in complex problem solving. As discussed in CHAPTER THREE, repetition of exposure to information, by some unknown mechanism, strengthens the representation of the information in memory, making it more accessible for retrieval later. Practice, which involves retrieval of information, results in constructive changes of that information's representation in memory (including the addition of the practice event itself to the knowledge network). Accordingly, in this analysis, the two concepts of "Repeat exposure to same information" and "Practice doing task" were differentiated (see Table 20, page 94). In theory, "Practice doing task" strategies would particularly enhance performance in those tasks later, being highly congruent.

The "Repetition/practice" strategies reported by surgical residents strongly reflected the contexts of their learning. Strategies reported pertained to learning activities such as reading, seminars, clinical experiences and even the teaching of students and

patients (see Table 21, page 95). The strategies also reflected the learning tasks of the residents, as will be discussed below.

The strategies placed in the sub-category "Repeat exposure" were characterized simply by multiple encounters with the same or conceptually the same information (one could argue never exactly the same). This effect was achieved in many ways (see Table 21, page 95) In some cases, residents observed or replicated the same information in the same format as it had been first encountered, such as re-reading or re-copying information (so that they would see it again) or such as re-examining a patient (so that they saw, heard, smelled, felt the same thing again). Residents also reported using different resources to learn the same material, again reinforcing the information by repetition. Several examples of using different sensory formats to encounter or review the same information (or conceptually the "same" information) were also reported. These included reading out loud, whereby residents would hear as well as see the information, and alternating reading about and doing an operation, whereby residents would see the information in text format as well as in the multi-sensory "real life" format. Regardless of their context, task application or complexity, all of these strategies presumably served to "strengthen" the memory representation of information or concepts for surgical residents.

The "Practice doing task" strategies involved residents actually doing tasks required of them, either in their entirety or in part (see Table 22, page 96). Practice occurred in "real" clinical settings (ex. clinic, operating room) as well as "mock" settings (ex. surgical skills lab). Practice recalling information was reported for purposes of patient diagnosis or management (ex. recalling past patient experience while looking after

new patient or mentally rehearsing a surgical procedure) and for purposes of preparing for examinations (ex. make cue cards with questions and answer repeatedly or use past clinical examples when answering oral exam questions) involving recalling or recognizing concrete pieces of information (ex. fill in the blanks) to abstracting from past experiences (ex. recalling past patient experiences for "use" in managing a new patient).

2. Grouping/chunking

In theory, grouping strategies primarily serve the purpose of packaging large volumes of information into information units. As described in the literature review, working memory has a limited capacity. However, the capacity is limited not by volume, but rather by the number of "units" of information that can be accommodated in the working memory at one time. Thus, when information is packaged into units, more information can be accessed at once and more information can be processed simultaneously.

The surgical residents involved in this study were found to utilize such strategies (see Table 23, page 98). The strategies reported were amenable to categorizing by the amount of thought and conceptualizing that went into creating the information units. The units created were simple (such as lists) or highly complex (such as prototypes, representing abstract inter-related features and ideas) information units. A third intermediate category of strategies was recognized, whereby residents assembled various pieces of information in one place (such as a file), defining an information set rather than a more intricate conceptual unit.

Because surgical practice requires the manipulation of complex concepts (concepts of disease, variables affecting outcomes of management, long highly variable

operative procedures) it was not surprising that residents reported using these strategies. The strategies reflected the nature, content and context (clinical, book work) of their learning (see Table 23, page 98).

3. Associating information to something familiar, but not meaningfully related

Strategies by which information in any form is associated deliberately with something familiar (also in any form) provide a mechanism for integrating knowledge in pre-existing memory structures and also providing cues for retrieval of that information. The retrieval cues might not be appropriate, but cues are developed nonetheless. It easier to recall something familiar than trying to recall something unfamiliar and hence the familiar provides a pathway to the unfamiliar.

Surgical residents used a number of "artificial" association techniques to aid retrieval of information (see Table 24, page 99). Because the associations created by these strategies were not meaningful, there seemed to be no conceptually *useful* way of sub-categorizing the group of strategies, suffice to say that information was associated with either a familiar sequence, words, sounds or images (no *major* sub-categories identified). (No direct evidence was found in the literature to indicate whether or not these meaningless associations are more effective when the sensory forms of the information to be remembered and the item with which the information is associated are the same. However, if such a correlation exists, it might be useful to sub-categorize these strategies accordingly).

Surgical residents are required to learn lists of potential complications (without missing any major types) and popular classification systems from the literature (ex.

classifications of fractures). For these types of tasks, the association strategies would be appropriate, although based on theory about cues and retrieval, meaningful associations might be more effective. The diversity of sensory associations reported was interesting, perhaps reflecting the diversity of sensory forms in which surgical information appears.

4. Acknowledging or creating meaningful associations

As noted above, the association of information leads to integration of new or changed information within pre-existing knowledge structures and establishes pathways through which cues stimulate information retrieval. Meaningful associations facilitate a "natural" integration of new ideas and the development of relevant, appropriate cues.

The demands of surgical practice required the residents participating in this study to build complex knowledge networks and make choices based on the relationships of options. The relevance of residents acknowledging and creating meaningful relationships was therefore obvious. True to form, the surgical residents were found to use many strategies in this category (see Table 25, page 100).

When learning new information, they reported associating the new information with prior knowledge. This association was achieved either by relating the new information encountered to familiar ideas or by deliberately seeking out new related information when particular knowledge was "active" in the working memory. Residents made concrete associations (ex. associating an xray image with a particular disorder) or very abstract conceptual associations (ex. using analogies to understand new concepts), in keeping with their needs.

The residents also used relationships between ideas to reformulate their knowledge into larger concepts or more useful knowledge structures for their work. The

data analysis indicated that the residents categorized (identified common features), examined how information fit into larger concepts (such as a surgical operation), related cause and effect (particularly relevant in rationalizing diagnoses or management) and used compare/contrast techniques (a particularly congruous structuring of knowledge for making decisions). Again the strategies reported reflected the "book learning" as well as "on-the-job training" contexts of a surgical residency.

5. Deliberate abstracting of ideas, principles, rules

Abstraction involves taking a concrete stimulus (visible, touchable, smellable, palpable) or memory of something concrete (object or event) and deriving an impression or idea from it. As discussed in CHAPTER THREE, abstraction either sub-consciously through frequent exposure or practice, or consciously and deliberately, by reflection and thoughtful analysis, permits transfer of knowledge to new situations. Thus, abstraction is an important means by which surgical residents learn to handle complex or unfamiliar clinical situations.

In this study, surgical residents were found to manage abstract ideas, create practical rules and use abstraction in different ways (see Table 26, page 102). Sadly, not a large *number* of abstraction strategies were reported, although it is suspected that residents use these types of strategies frequently, by necessity. The concept of abstraction itself is abstract, and hence residents may not have thought to report such implicit mind activities. Regardless, three categories of abstraction strategies were derived from the data. First, residents converted abstracted ideas into more concrete forms, presumably to simplify them or make them easier to explain (as residents are required to rationalize and justify their observations and decisions). For instance a visual

image was created from an abstract process. Second, residents developed rules and principles that could be applied in particular circumstances. The creation of a "prototype" was an example. Third, residents applied principles and rules in making judgments and decisions, of course. The abstraction strategies reported, then, related directly to the nature of the tasks that the surgical residents were required to learn and the ever-changing patient profiles that they encountered.

b) Strategies per tasks

The task analyses for making diagnoses, making management decisions and performing surgical procedures (see CHAPTER THREE) indicated that particular prerequisite learning was required in order for these tasks to be successfully completed. Declarative and procedural knowledge, the development of appropriate cues for retrieval, and transfer were deemed essential components of learning pertaining to these tasks. Encoding/retrieval strategies used by the surgical residents in this study indicated processes through which these requisite components were acquired.

The examination of the data from the perspective of task learning (including both "book" learning and on-the-job apprenticeship-like learning), revealed four general themes. First, residents developed a concept of the task and of the knowledge required for the task. Second, residents developed procedural knowledge pertaining to the task (how to). Third, residents practiced actually doing the task. Fourth, residents analyzed the results of their practice and thereby added new information to their knowledge bases pertaining to the tasks. These processes provided a framework within which the encoding/retrieval strategies could be analyzed from the perspective of tasks (see pages 103 to 108).

1. Making diagnoses

1. Building a concept of disease ("disease" being any disorder, including malformation, illness or injury) – Within the group of strategies used by residents to build a concept of diseases, a variety of sub-categories were identified. These sub-categories were: collecting different information about the disease from various sources, integrating "book" knowledge and clinical experiences, outlining the components of the "disease concept", integrating various components into a larger concept of the disease, and creating prototypes or rules (abstracted ideas of disease). The sub-categories represented additional processes whereby the concepts of a disease were developed in the minds of the residents. These processes seemed almost hierarchical; *before* a prototype or rules could be abstracted, the resident would have to integrate disease knowledge into a big picture, and in order to organize the big picture, an outline of the "components" would have to be envisioned, etc. The level of sophistication of prototypes and rules would likely reflect the level of expertise of the resident pertaining to a particular topic.

The context of surgical residency education was clearly influential in the types of specific encoding/retrieval strategies reported for developing a concept of disease. In particular, the apprenticeship situation gave rise to a large number of strategies using patient encounters to gain knowledge. As a result of using experiences to develop knowledge about diseases, stored knowledge could be expected to take various forms, including memories of sounds, images, touch and odours. Whole concrete or abstracted "instances" were incorporated into memory, a form of knowledge known to be useful in the task of making diagnoses, as mentioned in the literature review. Integration of

"book" knowledge and knowledge gained from patient encounters also were strategies used which typified professional education (Schön, 1987).

2. Learning how to differentiate one diagnosis from others – The procedural aspects of making diagnoses were developed by the residents using strategies that facilitated differentiating one disease from another by *comparing and contrasting* various aspects of diseases, and using strategies which led to the development of an *approach* to making diagnoses. The strategies reported fit clearly into each of these two sub-categories of strategies.

As discussed in the literature review, making diagnoses is a categorization task which involves recognizing or figuring out which specific disease or category of disease a patient's clinical presentation belongs to. It therefore makes sense that surgical residents used comparing and contrasting strategies. They compared patient presentations (helpful in recognizing categories of disease) and the pathophysiology of disease processes (helpful in figuring out a category of disease when unclear).

The process of creating a list of differential diagnoses from a clinical presentation was learned by developing procedural steps, standardizing an approach and extracting or learning rules that could be directly applied. Missing from the list of strategies derived from the residents' data, was the strategy of eliciting from observations of staff and colleagues a method for making various diagnoses. Residents undoubtedly did this, even subconsciously, but perhaps did not recognize it as a strategy. The abstraction of rules and principles was a strategy that enabled high-road transfer of knowledge.

The strategies reported within both of the sub-categories reflected the theories of professional education whereby "book" and knowledge gained from experience, as well

as declarative and procedural knowledge were integrated (Bereiter, 1992; LeGrand & Buckmaster, 1993; Schön, 1987).

3. Practicing using knowledge in clinical scenarios - A small number of strategies were reported in this category, but surgical residents in their day to day activities practice using their knowledge in clinical situations a great deal. Learning strategies reported were the "creation of scenarios for practice applying principles" and "seeking patterns of clinical presentations in patients seen". Nonetheless, because of the heavy on-the-job experience, residents passively or actively learned by practicing. Seeing a large number of patients served to facilitate low-road transfer and residents by necessity practiced transferring knowledge to difficult and new patient problems.

4. Analyzing practice experiences - While it might be argued that this process was almost a metacognitive one, the information gained from analyzing experiences provided residents with additional knowledge, which then became integrated in the knowledge network. Two strategies reported by residents exemplified this theme. Implicitly, feedback from experiences in the form of recognizing errors and successes likely also contributed to the development of knowledge which enabled the residents to successfully make diagnoses.

2. Making management decisions

1. Associating management options & outcomes with disease – This theme, derived from the residents' data, conceptually seemed to parallel the creation of a disease concept in the task of making diagnoses. Of course, disease and treatment are intimately related. Thus, defining the relationships between disease and management served to create a larger concept, that of surgical problems and surgical practice.

Making management decisions can be as "simple" as recalling a "best option" for an uncomplicated case of a particular disorder, or may be complex, involving the weighing the risks and benefits of various options, given confounding patient variables and unknown outcomes (see CHAPTER THREE). Whether simple or complex, the association between a diagnosis (or diagnostic category) and management options must be made. Surgical residents reported three general approaches to making the association. One approach was to associate patients, hypothetical or real, abstracted or concrete, and presumably with a known diagnosis, with management plans. Cues for retrieval management plans might thereby by created (recall a patient, recall a management plan or recognize a patient profile, recall a management plan). A second approach was to link diseases and management options together. Examples of this approach included grouping systems or anatomic sites with particular management options, categorizing management options and relating management options with various "parts" of a clinical problem. Cues for retrieval of management options, then, would be various aspects of a clinical problem. The third approach was to relate management options to disease by "logic". By making "sense" of particular management options, based on, for instance, pathophysiology, the residents would be equipped to make inferences about management options when confronted with a complicated problem.

2. Forming an approach to making management decisions - This process represented developing the "procedural" knowledge required for making management decisions. Again, making choices about management can involve simple recall in "simple" cases or complicated analyses of the probabilities of management outcomes and factors affecting outcomes. The residents reported various means by which an approach

to making a management decision was developed, namely determining the criteria for decision-making, analyzing options and making comparisons, and organizing the approach to making a decision.

In the strategies for determining criteria on which to base a decision, residents reported using experience (including what they observed faculty doing and what they observed the results to be). Low-road transfer to new straight-forward patient problems might then have occurred by these residents seeing numerous patients with similar disorders managed by staff in much the same way. Reflecting on experiences might also give rise to ideas about criteria for selecting management options. Abstraction and judgment were also indicated in these strategies.

Because making management decisions required residents to analyze (especially compare) management options, residents reported comparing various options with respect to goals, probabilities of success and probabilities of complications. These were compartmentalized by some residents according to disease, thus creating a "package" for each disease including options and their various probabilities of outcome. (This type of packaging was a chunking strategy).

Developing a procedural approach was made explicit using strategies for "organizing the approach to making a decision". In keeping with the processing used to make management decisions as noted in the literature review, residents created treatment algorithms, hierarchical ladders and flow charts. Using these strategies required residents to integrate their knowledge about disease and management options in order to create a plan for the task at hand.

3. Practicing using knowledge about management or making decisions in clinical setting - As noted in the discussion of making diagnoses, practicing the tasks of surgical practice is a job requirement of being a surgical resident. Ample opportunity, welcome or not, was therefore provided to the residents who participated in this study, for practicing the task of making management decisions. Purposeful practice strategies were reported by the residents, including using hypothetical patient scenarios, consciously applying knowledge acquired in reading to clinical situations (another example of the integration of "book" knowledge and experiences) and using knowledge to predict outcomes. In all cases, knowledge was brought by the residents into a clinical context (real or hypothetical), serving to develop appropriate cues for future retrieval.

4. Analyzing practice experiences - Again, as discussed in the "Making Diagnoses" section, *reflecting* on the experiences of doing the task contributed to residents' learning of the task. Re-processing of the information gained in the experiences would amplify the representation of the experience in the residents' memories as well as provide means for developing new connections in the knowledge network. While a large number of specific strategies were not reported, this category of encoding/retrieval strategies was worthy of inclusion, being recognized as very valuable one.

3. Performing surgical procedures

1. Acquiring a concept of a procedure - Even though surgical procedures are by nature quite different than the more "purely" cognitive tasks of making diagnoses or management decisions, similar learning processes appeared to be represented in the residents' reported learning strategies for this task, when compared with strategies

pertaining to the other two tasks. Fundamental was the development by residents of the concept of a surgical procedure and its relationship to a disorder.

Again, the concept of this form of patient management blends inextricably with the concept of the disorder which it is intended to address. Malformation, injury or other disease results in "abnormal" anatomic structure (ex. tissue friability in the face of inflammation, or a broken bone) which must be predicted and handled appropriately when encountered surgically. The surgeon must thus not only "know" the procedural steps and sequence that are required to manage the disorder, but must also be prepared to look for particular associated problems intra-operatively and manage them as well. An understanding of the disorder as it relates to the planned procedure is important, as is an understanding of the procedure itself (its goals, steps and sequence). The concept of a procedure, therefore includes *both* declarative and procedural knowledge.

The concept of a surgical procedure was developed by residents by associating the procedures to the clinical disorders, learning the "steps" of the procedure and analyzing the procedure. Linking clinical disorders with associated procedures was achieved by acquiring information about both concurrently and by relating the rationale of a procedure to the nature of the disorder. The mechanics of the procedure were conceptualized by reading text and examining drawings or photographs as well as by observing (hopefully before ultimately doing). Visualization strategies were mentioned by residents who were required to "translate" written text descriptions of a procedure into images in reality. In fact, most of the strategies involving conceptualizing the "steps" of a procedure were visual in nature. Sequence was also a component. By combining knowledge of disease, relationships with anatomy and knowledge of the mechanics of a

procedure, analysis strategies permitted residents to predict complications, make judgments and otherwise extract principles that facilitated the transfer of knowledge pertaining to performing a surgical procedure.

2. Practicing the procedure – The task analysis for performing a surgical procedure revealed the importance of seeing and doing a procedure for the development of mental representations of motor skills. Furthermore, information gained during the execution of the procedure is processed almost immediately with resulting adjustments in the technique. Thus, practicing a procedure is a particularly integral part of *developing* the knowledge networks required for performing the procedure unaided later.

The steps and sequencing of a surgical procedure may be rehearsed non-physically, and indeed surgical residents took advantage of this. Again, not surprisingly visual strategies were used. Procedures were rehearsed mentally by visualizing what had transpired in an operation encountered or visualizing a hypothetical operation, step by step. "Making drawings of surgical procedures" was also a visual rehearsal technique. "Talking through an operation out loud" and "thinking about how hands would "feel" doing a procedure" were examples of rehearsal strategies that used other sensory modalities, the latter being particularly congruous to the task.

Practice actually performing the procedure was achieved in technical skills laboratories (perhaps also in less formal settings) as well as in "real" clinical settings. As motor skills and judgment developed, residents apparently increased their level of participation in performing surgical procedures, ultimately carrying out the entire procedure without intervention from faculty. Another two strategies noted, pertaining to developing knowledge from experience were to anticipate problems and to actually

handle problems whenever possible. Rich experiential knowledge was thereby developed.

3. Analyzing practical experiences - Finally, reflection on practical experiences was reported as a strategy for learning how to perform surgical procedures, just as it had been for learning the other two tasks. It is important to recognize that much of the new knowledge pertaining to the *motor skills* of performing surgery occurs almost sub-consciously during a surgical procedure and is not recognized as a learning strategy *per se*. However, reflection upon experiences can make explicit some of these lessons learned, reinforcing them, as well as leading to a re-formulation of the knowledge gained in practicing the task.

D. Special Strategies for Exam Preparation

The special strategies used in preparing for examinations, as reported by the surgical residents in this study, straddled all of the learning management and cognitive strategies (see Table 27, page 109). The strategies reported for exam preparation also duplicated many strategies reported for learning generally.

Evaluations "in the field" require the residents to demonstrate their proficiencies in performing as surgeons clinically on a day-to-day basis. Preparations for the in-training performance evaluations thus were expected to be the same as preparations for practice. Similarly, written and oral certification examinations demand that residents be able to recall or recognize the requisite knowledge for surgical practice, in addition to performing some of the tasks of surgical practice and rationalizing decisions made. Thus, it was not surprising that reported strategies for preparing for examinations were similar to those reported for "other" learning.

The learning strategy model constructed in this project and illustrated in Figure 5 on page 79 was based on an assumption that all learning management and cognitive strategies served to prepare residents for their examinations. However, also acknowledged were a small number of strategies that were especially pertinent to, or used specifically for exam preparation. These "extra" strategies accommodated the reality that written and oral certification examinations are held *outside* of the *context* of practice and that the exams are given high priority (high stakes). These special exam preparation strategies fell into the same learning management and cognitive strategy categories as had been identified in analyzing the rest of the strategies.

i. Learning management strategies (for exam preparation)

a) Setting objectives

It can be seen from Table 28 on page 110 that some residents perceived that the examinations covered the same material as their preparations for surgical practice generally. Other residents sought specific examination objectives (presumably for "special" attention). It is also possible that some residents felt that examinations covered *different* objectives than were need for surgical practice. Regardless, specific examination objectives were sought from much the same sources as had been used to determine objectives in general (old examinations, peers and preceptors, the residents' own perceptions). Another interesting strategy included was the strategy of covering topics peculiar to the anticipated oral examiners. Exam performance skills were also perceived by the residents to be important skills to acquire, and they used old examinations, practice examinations and the counsel of their seniors to determine what skills they would need.

b) Allocating & optimizing use of time

Study time was allocated in much the same fashion, using similar strategies as had been described for learning in general (see Table 28, page 110). However, because the time of examinations are generally known, residents defined their studying time-lines more clearly for examinations. Strategies were described in reference to the exam, for instance "accelerating" time spent up to the exam, starting targeted study a particular amount of time before the exam, or "cramming" before the exam. The prioritization of time and topics were specifically addressed in exam preparation but the strategies themselves were similar to those used to apportion time in general study.

As indicated in Table 28 on page 110 , some residents reported not changing their "outside" life schedules in relation to exams, while others completely sacrificed their "outside" life prior to examinations. It is likely that the sacrifice was related largely to the importance of examination in question. High-stakes examinations which are responsible for certifying the candidates likely have more impact than low-stakes examinations such as in-training self-assessment examinations. In the reporting of these strategies the residents did not specify which examinations they were referring to.

c) Selecting & using resources

The sources of information reported for learning were not different than generally used, except for the use of examination study guides (likely because the format of information would mimic the format of cues in anticipated examinations), the use of successful exam-takers as a resource and the conscious framing of knowledge acquired from clinical encounters into oral examination questions (see Table 29, page 111). The

resources otherwise were not specialized for exam preparation, nor did they appear to be used any differently.

d) Monitoring learning

The overlap of the monitoring strategies for exam preparation and those for general learning was virtually complete, because practice examinations and self-questioning as well as feedback from others were perceived as highly useful regardless of the goals. However, the use of examinations (real or hypothetical) for monitoring progress and specifically determining areas of weakness was particularly relevant for examination preparation because of the obvious congruity between the two tasks.

ii. Cognitive strategies (for exam preparation)

Cognitive strategies which were particularly apt for exam preparations targeted the development of appropriate cues for information retrieval in that specific setting. By formatting objectives as possible exam questions and learning the responses in that context, exam-like cues were created (see Table 29, page 111). In addition, practicing retrieval of information by doing practice examinations (while also providing monitoring opportunities) also permitted residents to reformat their knowledge in a manner conducive to future examination retrieval. In this manner, processing was as congruent with the required tasks as possible and success in the "task" of completing examinations later was facilitated.

V. Implications of Results

The examination of learning strategies used by the Canadian surgical residents participating in this study has given rise to an analytical framework comprised of three major categories and a "special" category. The three major categories, "Strategies to

optimize mental and physical state", "Learning management strategies" and "Cognitive strategies", are recognized to be key elements in successful learning. Thus, when a resident is experiencing academic difficulties and an assessment of learning strategies is indicated, strategies belonging to these three categories should be explored.

The relevance of including strategies for maintaining mental and physical health in an assessment of learning strategies was suggested by the residents' questionnaire responses. These strategies have significant implications in terms of residents' learning capabilities. Residents and their supervisors must recognize that learning activities will be most effective when residents are relaxed, alert and adequately nourished. While these strategies are not traditionally included in learning strategy inventories, it may be quite appropriate to include these in any inventory produced in the future for evaluating surgical residents' strategies.

Each of the sub-categories of "Learning management strategies" in the analytical framework produced in this thesis represents a step in the learning process. Although no documented evidence is currently available to suggest causes for surgical residents' academic failure, examples of unsuccessful residents anecdotally suggest that learning management strategy counseling might have been helpful. Consider, for instance, a resident who is known to have excellent general knowledge but fails the final oral certifying examination because he/she was missing critical knowledge in one particular area. The resident may not have realized that he/she *needed* knowledge in that particular area, an objective setting error, or the resident may have used inadequate checking/monitoring strategies (therefore "missing" the fact that required knowledge was

deficient). Although this thesis has not provided information about "optimal" learning management strategies, an *approach* to critically assessing them has been introduced.

The examination of the cognitive strategies reported by residents in this thesis highlighted two important principles. First, residents (not surprisingly) use basic cognitive strategies known generally to enhance knowledge acquisition and retrieval. These strategies are worthy to share with residents, especially when residents are looking for ways to "improve their memory". Specific strategies discovered in this study, relevant to surgical residency training, may be suggested. Second, the learning of the clinical tasks of making diagnoses, making management decisions and performing surgical procedures involves the use of strategies congruent to these tasks. Residents assimilate and associate appropriate declarative and procedural knowledge acquired from reading, from discussions and from clinical experiences. Practice applying knowledge and assessing the results of practice play major roles in the learning of clinical tasks as well. In assessing cognitive strategies used by Canadian surgical residents, then, attention should be paid to basic cognitive strategies as well as to task-related strategies.

The "special" category of "Special strategies for exam preparation" is probably not as crucial, because strategies belonging to the other three categories also serve to prepare residents for examinations. Nonetheless, it is likely that the use of strategies in this category do help residents optimize their examination results. Residents experiencing difficulties specifically in completing examinations might benefit from an assessment and modification of their learning strategies belonging to this category.

The learning strategies reported by Canadian surgical residents in this thesis can therefore be used to provide samples and suggestions to residents seeking assistance in

their learning. In addition, any assessment of learning strategies in this student population should include an assessment of mental and physical health strategies, learning management strategies and cognitive strategies. Special strategies for examination preparation, although not as critical, may also be worthy of consideration.

CHAPTER SEVEN: SUMMARY AND CONCLUSIONS

I. Summary of Thesis Evolution and Results

The primary goals of this thesis were to develop an overview of the types of learning strategies used by Canadian surgical residents and to build a preliminary catalogue of these strategies. The need for this work was discovered when questions were raised about the appropriateness of particular learning strategies used by surgical residents at various levels of training. The literature provided essentially no reference point for such a study and very little guidance in terms of an optimal approach. Thus, before correlative research could comfortably (and legitimately) be undertaken in this area, it was deemed essential that surgical residents' learning strategies be first understood and the domain of learning strategies used in the context of surgical training be defined. By elucidating the domain of learning strategies used by Canadian surgical residents and devising a framework for the analysis of these strategies, future research in this area was expected to be greatly facilitated.

In order to be able to understand the learning strategies reported in this study, the literature pertaining to processes of learning was consulted. Models of learning processes indicated that essential elements included setting objectives, designating time for learning, selecting learning activities, choosing and using resources, processing information and monitoring learning progress. With the exception of processing information, these elements were recognized as "learning management". Strategies relating to each of these elements were called "learning management strategies". Information processing was probed further from the perspectives of how knowledge is

captured, formulated, stored and retrieved. Strategies affecting these processes were recognized to be "cognitive strategies".

It became clear from the literature review pertaining to learning strategy work in other educational contexts that characteristics of learners, context of the learning and the learning tasks themselves strongly influenced the choices of learning strategies made by learners. This meant that the results of learning strategy research in one educational setting could not be readily generalized to other educational settings. A specific look at surgical residency was therefore indicated. As well, the importance of examining the learners, the learning context and the tasks of surgical residency training became apparent.

An examination of Canadian surgical residents and their training programs was undertaken. Residents were revealed to be expert and experienced learners. The training program was characterized by on-the-job training as well as prescribed learning activities and independent study, heavy work loads, significant time constraints, high volume of material to learn and sleep deprivation. The "core" clinical tasks examined were making diagnoses, making management decisions and performing surgical procedures. Doing examinations (written and oral) was also recognized to be a surgical residents' "task", although similar to and overlapping with the other three tasks (different cues for retrieval of information being the main difference). The task analyses indicated that declarative and procedural knowledge were necessary for successful task completion and that knowledge had to be "transferable", or in other words applicable to new situations such as new patients or new problems not previously encountered.

The literature was also consulted for assistance in planning how to gather the information desired (what learning strategies residents were using) and how to analyze it. It was determined that the best approach to capture a broad overview of strategies from the population would be a structured "interview" of residents on paper, using open-ended questions. A method of "triangulation" (using several sources of data and several data analysts) was also determined to be ideal. No "best" data analysis method was determined from the literature review, but the value of using a pre-existing framework was evident and the desirability of using themes in the data to sub-categorize was also noted.

The study was descriptive in nature. Surgical residents from four different surgical specialty training programs in two Canadian universities participated. A questionnaire, consisting of open-ended questions about what strategies were used for learning pertaining to the aforementioned tasks and in clinical or "study" situations, was administered to the participants. Three data reviewers extracted learning strategies from the residents' responses and identified key themes that they felt were important in interpreting the strategies. A final detailed analysis was then carried out using these themes and a framework derived both from the literature and from themes in the data.

The results were derived from 58 out of 92 residents registered in 7 of the 8 training programs. While attempts to determine the reasons for non-participation failed because of confidentiality issues, a wide spectrum of representation from the four programs and from all levels of training was captured. The three data reviewers agreed with the final list of strategies extracted and generalized from the data. Major themes incorporated into the final analysis included a differentiation between learning

management and cognitive strategies, a categorization framework based on elements in the learning process and recognizing the specificity of learning strategies according to their relationships to particular tasks.

In the final analysis, a model was created (Figure 5, page 79) which highlighted the role of strategies for optimizing mental and physical state, which also differentiated learning management from cognitive strategies and which sub-categorized the learning management strategies into the major categories of strategies for setting objectives, allotting and optimizing use of time, selecting and using resources and monitoring learning. Further categorization of the learning management strategies was based on themes identified in the residents' responses. The cognitive strategies were sub-categorized into the major categories of strategies for gaining and holding attention and for encoding/retrieval. The encoding/retrieval strategies were analyzed using two different perspectives, both being very valuable. One perspective was the "basic" cognitive strategies recognized to enhance knowledge acquisition and retrieval and the other perspective was the approach for learning the tasks of making diagnoses, making management decisions and performing surgical procedures. Finally, the overlap of strategies used in preparing for examinations with all of the above mentioned strategies used in learning was acknowledged. A few strategies that were particularly pertinent to or specialized for examination preparation, and categorized using the same analytical framework, were reported.

II. Generalization of Results to Canadian Surgical Residents

It is believed that the results of this study may be legitimately generalized to the population of Canadian surgical residents, because of the standardization of Canadian

training programs (contexts and tasks) and evaluations by the Royal College of Physicians and Surgeons of Canada. Differences in characteristics of residents accepted into different university surgical training programs (specifically between the two schools utilized in this study and other Canadian schools) will be assumed to be of minimal significance. There is insufficient evidence available from programs or from the Canadian Resident Matching Service to make a full assessment.

It is unknown whether or not the cultures of surgical training programs in other countries such as the United States are sufficiently similar to that of Canadian surgical training programs, to be able to generalize the result of this study to those contexts. It is suspected that the basic analytical framework produced in this thesis, derived from theory, would be applicable and many of the categories derived from the data would also be applicable.

III. Conclusions

The results of this study have demonstrated that Canadian surgical residents are sophisticated learners, using strategies to manage their learning (setting objectives, allotting and optimizing use of time, selecting and using resources and monitoring their learning) as well as cognitive strategies (for gaining and holding attention and for encoding/retrieval of information). Included in the cognitive strategies used are basic strategies known to generally enhance memory structure building and information retrieval. The same learning management and cognitive strategies generally used by surgical residents are also used in preparing for examinations, although modifications are made for the specific attentions felt to be needed for successful examination completion. In addition to learning management and cognitive strategies, these perceptive residents

use strategies for optimizing their mental and physical condition, clearly an important factor in the residents' learning capabilities.

The analysis revealed that the learning strategies noted above reflect the particular stresses and demands of surgical residency training in Canada as well as their prescribed learning activities and the tasks that they are required to learn. These strategies permit residents to learn from their clinical and study experiences, developing transferable knowledge which ultimately enable them to function as surgical practitioners.

IV. Future Research

This research study has drawn upon theories of learning and knowledge about learning strategies in other educational contexts in order to develop an overview of the learning strategies used by surgical residents. The lists of learning strategies produced in this study are by no means comprehensive and no quantification of learning strategy use was attempted. While it would be exciting to dive into the realm of correlative research in order to determine "optimal" learning strategies in specific learning situations, the equipment is not yet available for such work. However, a starting point has been created.

Two avenues of research are suggested following this thesis. First, case studies of residents who are "failing" in their programs and/or who fail the Canadian surgical certification examinations will provide useful information about what kinds of academic difficulties most frequently occur. The analytical framework provided by this thesis will help to structure the evaluation of learning strategies used by these residents. An assessment of learning strategies used by a case-controlled sample of successful candidates will then also permit an identification of qualitative differences in the learning strategies used by both groups. Although the "best" learning strategies are not known,

theory can be used to suggest learning strategy remediation designed specifically for particular difficulties identified. Preventive measures, through learning strategy counselling, for the most common problems, might also then be facilitated.

The second avenue of investigation suggested following this work is the development of an instrument for quantitatively assessing learning strategies used by surgical residents. In order to do correlative research (for instance, comparing two learning strategies to find out which is "better" or tracking changes in learning strategies used over the course of training) a method of quantifying learning strategy use will be required. Learning strategies reported in this study can be used to develop a core list of inventory items in the category or sub-category of interest. Although the process is involved, after a series of instrument tests and modifications an inventory can be produced which can then be used to collect quantitative data about learning strategy use in particular circumstances. Comparative studies will then be possible.

This thesis was undertaken because of the recognized pre-requisite need for a "baseline" overview and tools of investigation in this field. Hopefully, by continuing to follow this investigative pathway, interesting and important questions about optimal learning strategies used by Canadian surgical residents may be answered in the future.

References

Altheide, D. L., & Johnson, J. M. (1994). Criteria for Assessing Interpretive Validity in Qualitative Research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 485-499). Thousand Oaks, California: Sage Publications.

Anderson, R. C. (1982). Allocation of Attention during Reading. In A. Flammer & W. Kintsch (Eds.), *Discourse Processing* (8 ed., pp. 292-305). New York: North-Holland Publishing Company.

Andrassy, R. J., & Torma, M. J. (1982). Learning Styles and the Prospective Surgeon. *The American Surgeon, 48*(7), 293-296.

Arnold, L., & Feighny, K. (1995). Students' General Learning Approaches and Performances in Medical School: A Longitudinal Study. *Academic Medicine, 70*(8), 715-722.

Badger, L. W., Chesebro, M. J., & Hartman, J. A. (1987). First year residency stress: sources and mediators. *Family Practice Research Journal, 7*(2), 104-113.

Baker, J. D., III, Reines, H. D., & Wallace, C. T. (1985). Learning Style Analysis in Surgical Training. *The American Surgeon, 51*(9), 494-496.

Bereiter, C. (1992). Referent-centred and problem-centred knowledge: Elements of an educational epistemology. *Interchange, 23*(4), 337-361.

Bordage, G. (1994). Elaborated Knowledge: A Key to Successful Diagnostic Thinking. *Academic Medicine, 69*(11), 883-885.

Bordage, G., & Allen, T. (1982). The Etiology of Diagnostic Errors: Process or Content? An Exploratory Study. *Proceedings of the Twenty-First Annual Conference on Research in Medical Education of the American Association of Medical Colleges, Washington, DC*, 171-176.

Bordage, G., Grant, J., & Marsden, P. (1990). Quantitative assessment of diagnostic ability. *Medical Education, 24*, 413-425.

Bordage, G., & Zacks, R. (1984). The structure of medical knowledge in the memories of medical students and general practitioners: categories and prototypes. *Medical Education, 18*, 406-416.

Boreham, N. C. (1994). The dangerous practice of thinking. *Medical Education, 28*, 172-179.

Boshuizen, H. P. A., & Schmidt, H. G. (1990). The Developing Structure of Medical Knowledge. In Z. M. Nooman, H. G. Schmidt, & E. S. Ezzat (Eds.), *Innovation in*

Medical Education: An Evaluation of Its Present Status (pp. 218-240). New York: Springer Publishing Company.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, Remembering, and Understanding. In P. H. Mussen (Ed.), *Handbook of Child Psychology* (4th ed., Vol. 3, pp. 77-166). New York: John Wiley & Sons.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, 32-42.

Büchel, F. P. (1982). Metacognitive variables in the learning of written text. In A. Flammer & W. Kintsch (Eds.), *Discourse Processing* (pp. 352-359). Amsterdam: North-Holland Publishing Company.

Butterfield, E. C., & Belmont, J. M. (1975). Assessing and improving the executive cognitive functions of mentally retarded people. In I. Bialer & M. Sternlicht (Eds.), *Psychological issues in mentally retarded people* . Chicago: Aldine.

Butterfield, P. S. (1988). The stress of residency. A review of the literature. *Archives of Internal Medicine, 146*(8), 1428-1435.

Caffarella, R. S. (1993). Self-Directed Learning. In S. B. Merriam (Ed.), *An Update on Adult Learning Theory* (Vol. 57, pp. 25-35). San Francisco: Jossey-Bass.

Caffarella, R. S., & Barnett, B. G. (1994). Characteristics of Adult Learners and Foundations of Experiential Learning. In L. Jackson & R. S. Caffarella (Eds.), *Experiential learning: a new approach* (Vol. 62, pp. 29-42). San Francisco: Jossey-Bass.

Candy, P. (1988). On the Attainment of Subject-matter Autonomy. In D. Boud (Ed.), *Developing Student Autonomy in Learning* (pp. 59-76). New York: Nichols Publishing Company.

Cervero, R. M. (1992). Professional practice, learning, and continuing education: an integrated perspective. *International Journal of Lifelong Education, 11*(2), 91-101.

Chessell, G. (1986). Learning Styles in First Year Medical Students. *Medical Teacher, 8*(2), 125-135.

Christensen, C., Heckerling, P. S., MacKesy, M. E., Bernstein, L. M., & Elstein, A. S. (1991). Framing Bias among Expert and Novice Physicians. *Academic Medicine, 66*(9), S76-S78.

Clarke, J. R. (1989). Decision Making in Surgical Practice. *World Journal of Surgery, 13*(3), 245-251.

Coles, C. R. (1990). Elaborated learning in undergraduate medical education. *Medical Education, 24*, 14-22.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive Apprenticeship: Teaching the Crafts of Reading, Writing, and Mathematics. In L. B. Resnick (Ed.), *Knowing, Learning and Instruction. Essays in Honor of Robert Glaser.* (pp. 453-494). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Cook, L. K., & Mayer, R. E. (1983). Reading Strategies Training for Meaningful Learning from Prose. In M. Pressley & J. R. Levin (Eds.), *Cognitive Strategy Research Educational Applications* (pp. 87-131). New York: Springer-Verlag New York Inc.

Custers, E. J. F. M., Regehr, G., & Norman, G. R. (1996). Mental Representations of Medical Diagnostic Knowledge: A Review. *Academic Medicine, 71*(10), S55-S61.

Dansereau, D. F. (1985). Learning Strategy Research. In J. W. Segal, S. F. Chipman, & R. Glaser (Eds.), *Thinking and Learning Skills. Vol. 1: Relating Instruction to Research* (Vol. 1, pp. 209-239). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Dansereau, D. F., Collins, K. W., McDonald, B. A., Holley, C. D., Garland, J., Diekhoff, G., & Evans, S. H. (1979). Development and Evaluation of a Learning Strategy Training Program. *Journal of Educational Psychology, 71*(1), 64-73.

Das, J. P. (1984). Intelligence and Information Integration. In J. R. Kirby (Ed.), *Cognitive Strategies and Educational Performance* (pp. 13-31). Orlando: Academic Press, Inc.

Day, S. C., Grosso, L. J., & Norcini, J. J. (1994). Methods of preparing for certification exam in internal medicine and their efficacy. *J Gen Intern Med, 9*, 167-169.

De Volder, M. L., & De Grave, W. S. (1989). Approaches to learning in a problem-based medical programme: a developmental study. *Medical Education, 23*, 262-264.

De Volder, M. L., & de Grave, W. S. (1989). Schema Training in Problem-Based Learning. *Teaching and Learning in Medicine, 1*(1), 16-20.

Deber, R. B., & Baumann, A. O. (1992). Clinical Reasoning in Medicine and Nursing: Decision Making Versus Problem Solving. *Teaching and Learning in Medicine, 4*(3), 140-146.

Derry, S. J. (1988). Putting Learning Strategies to Work. *Educational Leadership, December*, 4 -10.

DesCôteaux, J.-G., & Leclère, H. (1995). Learning Surgical Technical Skills. *Canadian Journal of Surgery, 38*(1), 33-38.

Edmondson, K. M. (1994). Concept Maps and the Development of Cases for Problem-based Learning. *Academic Medicine, 69*(2), 108-110.

Elieson, S. W., & Papa, F. J. (1994). The Effects of Various Knowledge Formats on Diagnostic Performance. *Academic Medicine, 69*(10), S81-S83.

Elstein, A. S. (1989). Decision Analysis in Surgical Education. *World Journal of Surgery, 13*, 287-291.

Elstein, A. S. (1994). What Goes Around Comes Around: Return of the Hypothetico-Deductive Strategy. *Teaching and Learning in Medicine, 6*(2), 121-123.

Entwistle, N. (1992). Influences on the quality of student learning - implications for medical education. *SAMJ, 81*, 596-606.

Entwistle, N. J., & Ramsden, P. (1983). *Understanding Student Learning*. London, England: Croom Helm.

Ericsson, K. A., & Simon, H. A. (1980). Verbal Reports as Data. *Psychological Review, 87*(3), 215-251.

Ericsson, K. A., & Simon, H. A. (1984). *Protocol Analysis. Verbal Reports as Data*. Cambridge, Massachusetts: The MIT Press.

Farmer, J. A., Jr., Buckmaster, A., & LeGrantd, B. (1992a). Cognitive Apprenticeship: Implications for Continuing Professional Education. In H. K. M. Baskett & V. J. Marsick (Eds.), *Professionals' Ways of Knowing: New Findings on How to Improve Professional Education* (Vol. 55, pp. 41-49). San Francisco: Jossey-Bass Publishers.

Farmer, J. A., Jr., Lippert, F. G., III, & Schafer, M. F. (1992b). Making Orthopaedic Education Interactive, Problem Oriented, and on Target. In R. E. Eilert (Ed.), *Instructional Course Lectures* (Vol. 41, pp. 481-486). Park Ridge, Illinois: American Academic of Orthopaedic Surgeons.

Ferrell, B. G. (1983). A Factor Analytic Comparison of Four Learning-Styles Instruments. *Journal of Educational Psychology, 75*(1), 33-39.

Flavell, J. H., & Wellman, H. M. (1977). Metamemory. In R. V. Kail & J. W. Hagen (Eds.), *Perspectives on the Development of Memory and Cognition* (pp. 3-33). Hillsdale, N.J.: Erlbaum.

Gagné, E. (1985a). *Chapter 12 The Cognitive Psychology of School Learning*.

Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of Instructional Design*. (Fourth ed.). Orlando, Florida: Harcourt Brace Jovanovich College Publishers.

Gagné, R. M. G. (1985b). *The Conditions of Learning and Theory of Instruction.* (Fourth edition ed.). Montreal: Holt, Rinehart and Winston, Inc.

Garner, R. (1988). Verbal-Report Data on Cognitive and Metacognitive Strategies. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (pp. 63-76). San Diego, CA: Academic Press, Inc.

Geiger, M. A., & Pinto, J. K. (1991). Changes in Learning Style Preference During a Three-Year Longitudinal Study. *Psychological Reports, 69*, 755-762.

Gibbs, G., Morgan, A., & Taylor, E. (1984). The World of the Learner. In F. Marton, D. Hounsell, & N. Entwistle (Eds.), *The Experience of Learning* (pp. 165-188). Edinburgh: Scottish Academic Press.

Goldrick, B., Gruendemann, B., & Larson, E. (1993). Learning styles and teaching/learning strategy preferences: Implications for educating nurses in critical care, the operating room, and infection control. *Heart & Lung, 22*(2), 176-182.

Greep, J. M., & Siezenis, L. M. L. C. (1989). Methods of Decision Analysis: Protocols, Decision Trees, and Algorithms in Medicine. *World Journal of Surgery, 13*, 240-244.

Griffin, V. R. (1988). Holistic Learning/Teaching in Adult Education" Would you Play a One-String Guitar? In T. Barer-Stein & J. A. Draper (Eds.), *The Craft of Teaching Adults* (pp. 107-129). Toronto: Culture Concepts, Inc.

Grossman, R. S., Murata, G. H., Fincher, R.-M. E., Norcini, J. J., Kapsner, C., Layne, R. D., Seelig, C. B., Gateley, A., & al., e. (1996). Predicting Performance on the American Board of Internal Medicine Certifying Examination: The Effects of Resident Preparation and Other Factors. *Academic Medicine, 71*(10), S74-S76.

Huberman, A. M., & Miles, M. B. (1994). Data Management and Analysis Methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 428-444). Thousand Oaks, California: Sage Publications.

Janesick, V. J. (1994). The Dance of Qualitative Research Design. Metaphor, Methodolatry and Meaning. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 209-219). Thousand Oaks, California: Sage Publications.

Jones, B. F. (1988). Text Learning Strategy Instruction: Guidelines from Theory and Practice. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 233-260). San Diego, CA: Academic Press, Inc.

Kirby, J. R. (1984). Educational Roles of Cognitive Plans and Strategies. In J. R. Kirby (Ed.), *Cognitive Strategies and Educational Performance* (pp. 51-88). New York: Academic Press.

Knowles, M. S. (1978). *The Adult Learner: A Neglected Species*. (3rd ed.). Houston: Gulf Publishing Co.

Kolb, D. A. (1976). *Learning Style Inventory: technical manual*. Boston, Mass.: McBer.

Kolb, D. A., & Lewis, L. H. (1986). Facilitating Experiential Learning: Observations and Reflections. In L. H. Lewis (Ed.), *Experiential and Simulation Techniques for Teaching Adults* (Vol. 30, pp. 99-107). San Francisco: Jossey-Bass.

Kopta, J. (1971). An approach to the evaluation of operative skills. *Surgery, 70*(2), 297 - 303.

Kosower, E., & Berman, N. (1996). Comparison of Pediatric Resident and Faculty Learning Styles: Implications for Medical Education. *The American Journal of the Medical Sciences, 312*(5), 214-218.

Lawson, M. J. (1984). Being Executive about Metacognition. In J. R. Kirby (Ed.), *Cognitive Strategies and Educational Performance* (pp. 89-109). Orlando, Florida: Academic Press, Inc.

LeGrand, B. B., & Buckmaster, A. (1993). Cognitive apprenticeship approach to helping adults learn. In D. D. Flannery (Ed.), *Applying cognitive learning theory to adult learning* (Vol. 59, pp. 69-78). San Francisco: Jossey-Bass.

Leiden, L. I., Crosby, R. D., & Follmer, H. (1990a). Academic performance vs style inventories. *Academic Medicine, 65*(6), 395-401.

Leiden, L. I., Crosby, R. D., & Follmer, H. (1990b). Assessing Learning-Style Inventories and How Well They Predict Academic Performance. *Academic Medicine, 65*(6), 395-401.

Levin, R. (1988). Beyond "the men of steel". The origins and significance of house staff training stress. *General Hospital Psychiatry, 10*(2), 114-121.

Linn, B. S., & Zeppa, R. (1980). How do Surgeons Learn? *Journal of Surgical Research, 28*(6), 479-484.

Lippert, F. G., III, & Farmer, J. A. (1984). *Psychomotor Skills in Orthopaedic Surgery*. Baltimore: Williams & Wilkins.

Marton, F., & Säljö, R. (1976a). On qualitative differences in learning; I - outcome and process. *British Journal of Educational Psychology, 46*, 4-11.

Marton, F., & Säljö, R. (1976b). On qualitative differences in learning; I I - outcome as a function of the learner's conception of the task. *British Journal of Educational Psychology, 46*, 115-127.

Mayer, R. E. (1987). Instructional Variables that Influence Cognitive Processes during Reading. In B. K. Britton & S. M. Glynn (Eds.), *Executive Control Processes in Reading* (pp. 201-216). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Mayer, R. E. (1988). Learning Strategies: An Overview. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 11-22). San Diego, CA: Academic Press, Inc.

McKeachie, W. J., Pintrich, P. R., Lin, Y. G., & Smith, D. (1986). *Teaching and Learning in the College Classroom: A Review of the Research Literature*. Ann Arbor: National Center for Research to Improve Postsecondary Teaching and Learning, University of Michigan.

McNeil, B. J., Keeler, E., & Adelstein, S. J. (1975). Primer on certain elements of medical decision making. *The New England Journal of Medicine, 293*(5), 211-215.

Merriam, S. B., & Heuer, B. (1996). Meaning-making, adult learning and development; a model with implications for practice. *International Journal of Lifelong Education, 15*(4), 243-255.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis. An Expanded Sourcebook.* (2nd ed.). Thousand Oaks, California: Sage Publications.

Mitchell, R. (1994). The Development of the Cognitive Behaviour Survey to Assess Medical Student Learning. *Teaching and Learning in Medicine, 6*(3), 161-167.

Mitchell, R., & Liu, P. L. (1995). A Study of Resident Learning Behavior. *Teaching and Learning in Medicine, 7*(4), 233-240.

Moely, B. E. (1977). Organizational Factors in the Development of Memory. In R. V. Kail, Jr. & J. W. Hagen (Eds.), *Perspectives on the Development of Memory and Cognition* (pp. 203-236). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Neame, R. L. B., & Powis, D. A. (1981). Toward Independent Learning: Curricular Design for Assisting Students To Learn How to Learn. *Journal of Medical Education, 56*, 886-893.

Newble, D. I., & Entwistle, N. J. (1986). Learning styles and approaches: implications for medical education. *Medical Education, 20*, 162-175.

Newble, D. I., Entwistle, N. J., Hejka, E. J., Jolly, B. C., & Whelan, G. (1988). Towards the identification of student learning problems: the development of a diagnostic inventory. *Medical Education, 22*, 518 - 526.

Newble, D. I., & Gordon, M. I. (1985). The learning style of medical students. *Medical Education, 19*, 3-8.

Newble, D. I., & Hejka, E. J. (1991). Approaches to Learning of Medical Students and Practising Physicians: some empirical evidence and its implications for medical education. *Educational Psychology, 11*(3&4), 333-342.

Newble, D. I., Hejka, E. J., & Whelan, G. (1990). The approaches to learning of specialist physicians. *Medical Education, 24*(2), 101-109.

Newble, D. I., & Jaeger, K. (1983). The effect of assessments and examinations on the learning of medical students. *Medical Education, 17*, 165-171.

Nisbet, J., & Shucksmith, J. (1986). *Learning Strategies*. Boston, Mass.: Routledge & Kegan Paul.

Norman, G. R., Brooks, L. R., & Allen, S. W. (1989). Recall by Expert Medical Practitioners and Novices as a Record of Processing Attention. *Journal of Experimental Psychology, 15*(6), 1166-1174.

Norman, G. R., & Schmidt, H. G. (1992). The Psychological Basis of Problem-based Learning: A Review of the Evidence. *Academic Medicine, 67*(9), 557-565.

Nurcombe, B. (1987). Diagnostic Reasoning and Treatment Planning: II. Treatment. *Australian and New Zealand Journal of Psychiatry, 21*, 483-490.

Nurcombe, B., & Fitzhenry-Coor, I. (1987). Diagnostic Reasoning and Treatment Planning: I. Diagnosis. *Australian and New Zealand Journal of Psychiatry, 21*, 477-483.

Palmer, D. J., & Goetz, E. T. (1988). Selection and Use of Study Strategies: The Role of the Studier's Beliefs about Self and Strategies. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 41-61). San Diego, CA: Academic Press, Inc.

Paris, S. G. (1988). Models and Metaphors of Learning Strategies. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 299-321). San Diego, CA: Academic Press, Inc.

Paris, S. G., & Lindauer, B. K. (1977). Constructive Aspects of Children's Comprehension and Memory. In R. V. Kail & J. W. Hagen (Eds.), *Perspectives on the Development of Memory and Cognition* (pp. 35-60). Hillsdale, N.J.: Erlbaum.

Paris, S. G., Lipson, M. Y., & Wixson, K. K. (1983). Becoming a Strategic Reader. *Contemporary Educational Psychology, 8*, 293-316.

Patel, V. L., & Groen, G. J. (1986). Knowledge Based Solution Strategies in Medical Reasoning. *Cognitive Science, 10*, 910116.

Patel, V. L., Groen, G. J., & Arocha, J. F. (1990). Medical expertise as a function of task difficulty. *Memory & Cognition, 18*(4), 394-406.

Paul, S., Bojanczyk, M., & Lanphear, J. H. (1994). Learning preferences of medical students. *Medical Education, 28*, 180-186.

Perkins, D. N., & Salomon, G. (1985). Transfer and Teaching Thinking. In J. W. Segal, S. F. Chipman, & R. Glaser (Eds.), *Thinking and Learning Skills. Vol. 2: Research and open questions* (Vol. 2, pp. 285-303). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Peterkin, A. D. (1991). *Staying Human During Residency Training*. Ottawa: Canadian Medical Association.

Peterson, P. L., & Swing, S. R. (1983). Problems in Classroom Implementation of Cognitive Strategy Instruction. In M. Pressley & J. R. Levin (Eds.), *Cognitive Strategy Research Educational Applications* (pp. 267-287). New York: Springer-Verlag New York Inc.

Pintrich, P. R., & Johnson, G. R. (1990). Assessing and Improving Students' Learning Strategies. *New Directions for Teaching and Learning, 42*, 83-92.

Pintrich, P. R., McKeachie, W. J., & Smith, D. (1989). *The Motivated Strategies for Learning Questionnaire*. Ann Arbor: National Center for Research to Improve Postsecondary Teaching and Learning, University of Michigan.

Plovnick, M. S. (1975). Primary Care Career Choices and Medical Student Learning Styles. *Journal of Medical Education, 50*, 849-855.

Ramirez, J. L. J., & Velazquez, L. V. (1996). Theory and Practice in Specialized Medical Training. I. A Measuring Instrument of Learning Strategies. *La Revista de Investigacion Clinica, 48*(3), 179-184.

Ramsden, P. (1984). The Context of Learning. In F. Marton, D. Hounsell, & N. Entwistle (Eds.), *The Experience of Learning* (pp. 144-164). Edinburgh: Scottish Academic Press.

Ramsden, P., Whelan, G., & Cooper, D. (1989). Some phenomena of medical students' diagnostic problem-solving. *Medical Education, 23*, 108-117.

Razzell, P., & Weinman, J. (1977). The pre-clinical curriculum: an information processing problem. *Medical Education, 11*, 257-261.

Reese, H. W. (1977). Imagery and Associative Memory. In R. V. Kail & J. W. Hagen (Eds.), *Perspectives on the Development of Memory and Cognition* (pp. 113-175). Hillsdale, N.J.: Erlbaum.

Regehr, G., & Norman, G. R. (1996). Issues in Cognitive Psychology: Implications for Professional Education. *Academic Medicine, 71*(9), 988 - 1001.

Reynolds, R. E., & Shirey, L. L. (1988). The Role of Attention in Studying and Learning. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 77-100). San Diego, CA: Academic Press, Inc.

Riding, R., & Cheema, I. (1991). Cognitive Styles - an overview and integration. *Educational Psychology, 11*(3&4), 193-215.

Rohwer, W. D., Jr., & Dempster, F. N. (1977). Memory Development and Educational Processes. In R. V. Kail, Jr. & J. W. Hagen (Eds.), *Perspectives on the Development of Memory and Cognition* (pp. 407-435). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Sadler, G. R., Plovnick, M., & Snope, F. C. (1978). Learning Styles and Teaching Implications. *Journal of Medical Education, 53*, 847-849.

Scher, K. S., & Peoples, J. B. (1990). A study of the on-duty hours of surgical residents. *Surgery, 108*(2), 393-397.

Schmeck, R. R. (1988). Individual Differences and Learning Strategies. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 171-191). San Diego, CA: Academic Press, Inc.

Schmeck, R. R., & Grove, E. (1979). Academic Achievement and Individual Differences in Learning Processes. *Applied Psychological Measurement, 3*(1), 43 - 49.

Schmeck, R. R., Ribich, F., & Ramanaiah, N. (1977). Development of a Self-Report Inventory for Assessing Individual Differences in Learning Processes. *Applied Psychological Measurement, 1*(3), 413 - 431.

Schmidt, H. G. (1993). Foundations of problem-based learning: some explanatory notes. *Medical Education, 27*, 422-432.

Schmidt, H. G., Norman, G. R., & Boshuizen, H. P. A. (1990). A Cognitive Perspective on Medical Expertise: Theory and Implications. *Academic Medicine, 65*(10), 611-621.

Schmidt, R. A. (1975). A Schema Theory of Discrete Motor Skill Learning. *Psychological Review, 82*(4), 225-260.

Schön, D. A. (1983). *The Reflective Practitioner. How Professionals Think in Action*: Basic Books, Inc.

Schön, D. A. (1987). *Educating the Reflective Practitioner. Toward a New Design for Teaching and Learning in the Professions*. San Francisco: Jossey-Bass.

Schumacher, G. M. (1987). Executive Control in studying. In B. K. Britton & S. M. Glynn (Eds.), *Executive Control Processes in Reading* (pp. 107-144). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Shiffrin, R. M., & Schneider, W. (1984). Theoretical Note Automatic and Controlled Processing Revisited. *Psychological Review, 91*(2), 269-276.

Shirar, L. E., Vu, N. V., Colliver, J. A., & Barrows, H. S. (1992). A Survey of Study Methods, Preparation Time, Test-taking Strategies, and Perceptions of Test Validity on a Clinical Performance-based Examination. *Academic Medicine, 67*(10), S10-S12.

Slone, R. M., & Tart, R. P. (1991). Radiology Residents' Work Hours and Study Habits. *Radiology, 181*(2), 606-607.

Spiro, R. J., Vispoel, W. P., Schmitz, J. G., Samarapungavan, A., & Boerger, A. E. (1987). Knowledge acquisition for application: Cognitive Flexibility and Transfer in Complex Content Domains. In B. K. Britton & S. M. Glynn (Eds.), *Executive Control Processes in Reading* (pp. 177-199). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Sternberg, R. J. (1983). Criteria for Intellectual Skills Training. *Educational Researcher, 12*(2), 6-12.

Svensson, L. (1977). On qualitative differences in learning: III - study skill and learning. *British Journal of Educational Psychology, 47*, 233-243.

Szalay, D. (1997). Technical Skills - Lessons from Occupational and Sports Psychology. *Focus on Surgical Education, 14*(4), 12-17.

Tamir, P., Schiffmann, A., Elstein, A., Molidor, J., & Krupka, J. (1979). Development and exploratory trials of a cognitive preference inventory for medical students. *Medical Education, 13*, 401-406.

Tan, C., & Thanaraj, K. (1993). Influence of context and preferred learning environments: approaches to studying physiology. *Medical Education, 27*, 143-159.

The Royal College of Physicians and Surgeons of Canada. (1996a). *Report of the Task Force to Review Fundamental Issues in Specialty Education* . Ottawa, Ontario: The Royal College of Physicians and Surgeons of Canada.

The Royal College of Physicians and Surgeons of Canada. (1996b). *Skills for the New Millennium: Report of the Societal Needs Working Group* . Ottawa, Ontario: The Royal College of Physicians and Surgeons of Canada.

Toews, J. A., Lockyer, J. M., Dobson, D. J. G., Simpson, E., Brownell, A. K. W., Brenneis, F., MacPherson, K. M., & Cohen, G. S. (1997). Analysis of Stress Levels among Medical Students, Residents, and Graduate Students at Four Canadian Schools of Medicine. *Academic Medicine, 72*(11), 997-1002.

Tough, A. (1979). *The Adult's Learning Projects. A Fresh Approach to Theory and Practice in Adult Learning.* (2nd ed.). Toronto: The Ontario Institute for Studies in Education.

Tulving, E., & Thomson, D. M. (1973). Encoding Specificity and Retrieval Processes in Episodic Memory. *Psychological Review, 80*(5), 352-373.

Wade, T. P., & Kaminski, D. L. (1995). Comparative evaluation of educational methods in surgical resident education. *Archives of Surgery, 130*(1), 83-87.

Weber, E. U., Böckenholt, U., Hilton, D. J., & Wallace, B. (1993). Determinants of Diagnostic Hypothesis Generation: Effects of Information, Base Rates, and Experience. *Journal of Experimental Psychology: Learning, Memory and Cognition, 19*(5), 1151-1164.

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In M. Wittrock (Ed.), *Handbook of research on teaching* (pp. 315-327). New York: Macmillan.

Weinstein, C. E., & Underwood, V. L. (1985). Learning Strategies: The How of Learning. In J. Segal, S. Chipman, & R. Glaser (Eds.), *Thinking and Learning Skills* (Vol. 1, pp. 241-258). Hillsdale, N.J.: Erlbaum.

Weinstein, C. E., Zimmermann, S. A., & Palmer, D. R. (1988). Assessing Learning Strategies: The Design and Development of the LASSI. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 25-40). San Diego, CA: Academic Press, Inc.

Wentz, S., Wile, M. Z., Zyzanski, S. J., & Alemagno, S. A. (1986, October 25-30, 1986). *Change in medical student learning styles: a four year prospective study.* Paper presented at the Research in Medical Education: 1986, Proceedings of the Twenty-Fifth Annual Conference, New Orleans, Louisiana.

West, C. K., Farmer, J. A., & Wolff, P. M. (1991). *Instructional Design. Implications from Cognitive Science.* Englewood Cliffs, New Jersey: Prentice Hall.

Willson, V. L. (1988). Evaluation of Learning Strategies Research Methods and Techniques. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and Study Strategies. Issues in Assessment, Instruction, and Evaluation* (Educational Psychology Series ed., pp. 263-274). San Diego, CA: Academic Press, Inc.

Wlodkowski, R. J. (1990). Strategies to Enhance Adult Motivation to Learn. In M. W. Galbraith (Ed.), *Adult Learning Methods: A Guide for Effective Instruction* (pp. 97-118). Malabar, Florida: Krieger Publishing Company.

Zemke, R., & Zemke, S. (1995). Adult learning: What do we know for sure. *Training: The human side of business, 32*(6), 31-40.

Appendix A

Information, Consent Form and Instructions given to Resident Participants

Consent Form
PLEASE SIGN AND KEEP ONE COPY

Research Project: A classification of learning strategies used by Canadian surgical residents

Principal Investigator: Dr. Karen Joughin (thesis supervisor Dr. Jean-Gaston DesCôteaux)

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research project is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully.

1. The purpose of the proposed project is to classify and create an inventory of learning strategies used by western Canadian surgical residents.

2. Your full participation in this study will mean attendance at two sessions. This is the first session. At this session you will be asked to complete a written questionnaire describing the ways you learn. The questionnaire will be completed anonymously. It will take approximately 45 minutes to one hour of your time.

Two to three months after the first session will be the second session. If you agree to participate, you will be given a copy of the classification of surgical residents' learning strategies and you will be asked whether or not it makes sense to you and if you think anything should be changed or added. It will take about 3 minutes. *(Note: this paragraph was included in the consent, but became irrelevant as the study was changed to remove the second session from the method).*

Some information will also be obtained during the first and second sessions pertaining to your level of training and which university you are registered at. This information will be seen only by the investigator. It is necessary to assess the spectrum of responses obtained.

3. All residents from General Surgery, Orthopedic Surgery, Plastic Surgery and Neurosurgery programs at the University of Calgary and the University of Alberta are being invited to participate in the first and second sessions of this study.

4. There are no discomforts or risks involved in participating in this study. Your Program Director knows about this study. You will be freed from clinical responsibilities to attend the sessions.

5. By participating in this study you are assisting surgical educators in understanding how surgical residents learn. Ultimately, an instrument will be developed to assess approaches to learning. Further studies will be then possible to determine which learning techniques are optimal for surgical residents.

6. You may choose not to participate. Your Program Director will *not* be told who does and does not participate and you will not be penalized for not participating. Your decision not to participate will not affect your grades, in-training evaluation or final evaluation.

7. Only the study investigator and the professional assistants to the project will have access to the information collected in the course of this project. Your responses on the questionnaires will be confidential. Your name will not be recorded at all. Information about your program and year of training will be separated from response sheets and from this consent form. Only the investigator will have access to this information and it will be kept secured. Program Directors will not have access to any of this information.

8. You will be informed of the overall results of the study.

9. There will be no financial cost to you if you participate in this study.

Your signature on this form indicates that you have understood to your satisfaction the information regarding your participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time without jeopardizing your education. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions concerning matters related to this research, please contact:

Dr. Karen Joughin (403) 670-1435

If you have any questions concerning your rights as a possible participant in this research, please contact the Office of Medical Bioethics, Faculty of Medicine, The University of Calgary, at 220-7990.

_____

(name of subject)

_____

(signature of subject)

_____

(name of witness)

_____

(signature of witness)

_____

(date)

_____

(name of investigator/delegate)

_____

(signature of investigator/delegate)

_____

(date)

A copy of this consent form will be given to you. Please keep it for your records and future reference.

Thank you for participating in this study involving the classification of learning strategies used by Canadian surgical residents.

Instructions for Participating Residents
(in oral presentation preceding data collection, not provided in written form)

Read the question, then think about a *specific instance* that you were recently in the situation described. Once you have thought about what you did, read the question again and describe what you did.

Respond in point form (don't need complete sentences).

State the obvious.

Some of the questions will seem repetitious - don't be surprised. Please be patient with it and answer to the best of your ability.

Some will be wishy washy - on purpose.

Be honest! (Tell me what you do rather than what you think you should be doing).

Appendix B

Questionnaire - Learning Strategies used by
Surgical Residents

(4) University: Specialty: Program yr (R1/2/3/4/5/other):

USE POINT FORM, IF DESIRED.

Note taking

When and how often do you write notes for yourself (in seminars, after surgical cases, while you are reading, etc.)?

What do you write down?

How do you use these notes and what do you do with them?

Planning

Describe briefly your regular day-to-day/week-to-week study routine (when you study, how you apportion your time). If you don't have a specific routine, explain when you do read/study.

Surgery

What specifically do you do to prepare for an upcoming case in the operating room?

What resources do you use to prepare for a case or learn about a particular operation? How do you select which resources to use?

Please indicate your approach to acquiring the knowledge or skills you need to do an operation.

Utilization of patients in learning

Recall a valuable clinical encounter you have had recently with an interesting patient. How did you use (learn from) the encounter? What did you do (then, and later) in order to learn from it?

Diagnosis

When you are trying to learn about an unfamiliar diagnosis or disorder (example when you see a patient with a particular disorder that is new to you), how do you go about learning about it?

Do you use any specific learning "tricks" in order to remember things about the disorder? Do you use any "tricks" in order to be able to differentiate the disorder from similar disorders? (Please describe what you do).

Please indicate what resources you use in trying to learn how to make a particular diagnosis and differentiate it from a differential diagnosis. How do you select which resources to use?

Familiar vs. Unfamiliar Topics

Do you learn information differently if the topic it pertains to is very new to you or very familiar to you? (Think of a recent example of each). If so, how does your studying differ with respect to: a) how you approach the studying/learning b) what memory strategies you use (to make the information "stick") c) what resources you select to use

Exam preparation

Describe your examination study routine (when you study and how you apportion your time).

How do you decide what to study for upcoming examinations?

How do you organize and plan your studying of specific topics and specific information within broad topics?

Think about an examination you recently prepared for. When you were reading, did you cover one *topic* at a time or one *textbook* at a time or start with one item but moved to another part-way through or when you finished one section, etc.? In other words, how did you organize the reading and did you in reality follow that plan or do something else? (describe).

How do you put together information from <u>different sources</u> pertaining to one particular topic? In other words, how do you integrate the information (example: writing notes from various sources on a piece of paper / in a file dedicated to the topic, then organizing the notes on that topic to make some sense of them).

You may have a very formal approach or you may do it in your head. Tell me what you do.

What, if any, special exam-performance skills or knowledge about the exam do you think you need in order to do well in written and/or oral examinations that occur during and at the end of your residency?

Visualization & Drawing

Do you visualize patients or diagrams or procedures in your mind when you are trying to learn something? Do you ever draw while you are studying or making notes? If so, what do you use this learning technique for?

Time Management

Do you have any time management "tricks"?

Management decisions

What specific resources to you use in learning about treatment plans? How do you select which resources you are going to use?

Think of the last time you were learning about managing an ailment or a particular patient (including different treatment options. Did you organize the information to "put it together" into a clinical approach or did you use another organization scheme? How did you do this?

Checking your learning

How do you check to see if you have successfully learned what you set out to learn (for an upcoming exam or in general)? For instance, do you test yourself in some way (how?) or do you have other people test you or do you have a check system? Describe anything you do.

Reading strategies

When you are reading a textbook or journal article how do you note and "extract" pertinent information from them?

When you are reading a textbook or journal article for information, what do you do to "learn" (retain and remember later) the information provided there? In other words, what learning techniques do you use to make the information "stick"?
Don't be afraid to state the obvious as well as your own unique approaches and techniques (examples: "re-reading particular sections three or four times", "writing down important phrases, then re-writing several times without looking at the notes", writing summaries or particular types of notes, explaining the material to someone else, etc.).

While you are reading you sometimes discover questions related to the text that you want to find the answers to. When and how do you follow up on these questions?

Reinforcement

What do you specifically do, if anything, to reinforce or review things you have previously learned from reading, from observing and from direct patient encounters? *Indicate things you do that may seem obvious, such as re-reading your notes on a topic after seeing a new patient or in studying for an exam, etc.*

Please describe any other tricks or approaches to studying or clinical learning that you use that have not been addressed above!

Blueprint for Four Versions of Questionnaire (Q1, Q2, Q3, Q4):

Q1	Q2	Q3	Q4
Planning	Note taking	Checking your learning	Note taking
Exam preparation	Checking your learning	Exam preparation	Planning
Surgery	Reading strategies	Management decisions	Reading strategies
Time Management	Diagnosis	Reinforcement	Utilization of patients in learning
Reading strategies	Familiar vs. Unfamiliar Topics	Note taking	Diagnosis
Note taking	Exam preparation	Surgery	Familiar vs. Unfamiliar Topics
Checking your learning	Utilization of patients in learning	Planning	Exam preparation
Utilization of patients in learning	Surgery	Familiar vs. Unfamiliar Topics	Visualization & Drawing
Diagnosis	Visualization & Drawing	Time Management	Time Management
Reinforcement	Time Management	Diagnosis	Management decisions
Management decisions	Management decisions	Visualization & Drawing	Checking your learning
Visualization & Drawing	Reinforcement	Reading strategies	Surgery
Familiar vs. Unfamiliar Topics	Planning	Utilization of patients in learning	Reinforcement
Any other strategies?	Any other strategies?	Any other strategies?	Any other strategies?

Appendix C

Instructions for Data Analysts

Goal

The goal of this exercise is to create a classification system of learning strategies used by surgical residents.

General Method

Surgical residents from four different programs in two universities were asked what they do to study and what they do to learn in general, in the context of their surgical residency. In some cases the questions were specific and in other cases the questions were general.

On the index cards provided to you are the responses to the questions. Each response represents one or more learning strategies. Some of the responses will not represent learning strategies at all.

Three of us will be individually sorting the strategies into a grouping scheme which will become the classification system. We will then meet to discuss what we came up with individually before deciding on a "final" consensual classification system.

Your task, individually

The goal is to group and categorize the learning strategies contained in the responses. A classification system will thereby be created.

I offer you a starting point for the sorting, which you may like or you may not. You are not "stuck" with it if you do not like it. This very broad categorization of learning strategies in general, after William McKeachie's taxonomy, 1986:

1. Cognitive strategies are activities which process incoming information and allow the student to remember/recall the information later (puts it in memory, reinforces it or re-organizes it in memory).

2. Metacognitive strategies are activities in which the student plans their learning (such as setting objectives, planning what to cover/what is important) and monitors how he/she is doing (like testing). There is awareness of the learning process in metacognitive strategies.

3. Resource management strategies are activities in which the student selects what resources to use for information and how to manage time. Support of others and effort management have also been included in resource management strategies, although I chose not to directly ask about these matters.

4. Other – not included in McKeachie's taxonomy. *If* you like this general scheme and you decide to use it in your analysis, you may opt to *add* one or more to the three above, particularly if you feel that some of the strategies you encounter don't seem to fit in any of the three categories above.

The number of index cards will seem overwhelming at first, but you will find a *huge* number of duplications. In addition, you will find that some responses really provide no information at all.

I suggest you start by going through the cards, piling together responses that in concept are the same, and eliminating non-responses (bind with an elastic, label the bundle and set aside). For responses that have been duplicated, pick a best "representative" response and set aside the extras. Label the extras and bind them together with an elastic band. Use the "representative" responses in your sorting.

Go through the reduced set of cards again, identifying themes. **At this stage, try to think about the potential uses of the classification system that you are producing.** There are many ways of classifying anything! Try to judge your scheme. Does it make "sense"? Will it be "useful"?

Sort and group together cards with common themes. Continue to sort and resort within themes and within sub-themes until you are satisfied with your classification scheme.

Be prepared to identify the themes that you found and justify the inclusion of various strategies into groupings within these themes. The theme and sub-group and sub-sub-group (as far as you take it) should be written in pencil on the back of each index card sorted.

<u>How to handle "tricky" ones</u>

A. Index cards that contain more than one strategy

Responses that contain *more* than one concept or *more* than one strategy should be dealt with as follows:

a) You will be provided with some blank index cards. Please write individual strategies on separate cards, referencing the question and the ID number on the new cards.

b) Write on the back of the "original" card a note that you have done this and set the "original" aside in a separate pile ("original" not included in the rest of the sorting procedure). Bind all of the "originals" with an elastic band and label the bundle.

c) Continue to sort using your new cards.

B. Response does not seem to "qualify" as a strategy

Some of the responses will not be strategies. You have two options:

a) Identify the strategy which seems to be represented by the response and write the strategy on the bottom front of the index card. Mark the upper right corner of the card with an "*". Write on the back of the card a note to justify your decision.

b) If no strategy seems to be represented by the response, put the index card into a separate pile for a separate sort of "exceptions" later.

C. You are not sure where to put a strategy in your sorting scheme

A final decision will be made when we meet together to discuss the results of our individual efforts. In the meantime, mark the card with a " ? " on the upper right corner and place into a separate pile within your furthest-along grouping level possible. Please note on the back of the card why you are not sure, or thoughts about where it might belong. Try to make a decision if possible.

Using the computer database instead or in addition to index cards

The "Form" called "Strategies for sorting" has been designed to facilitate extracting concepts out of the data for manipulation.

You may manipulate the data in this form in any way you like, but PLEASE NEVER CHANGE THE RELATIONSHIP BETWEEN "Record #" and the "Response". The two must always be constant together. Please keep in mind when you are manipulating the data that we *will have to be able to trace* the response from which a concept has been extracted to the response that the concept came from (Response # will be the key to this).

Completely ignore the ID number, which *automatically* changes. Just tab to get to the entry boxes that you can use.

You may add new records if you want to, in order to add additional concepts or sub-groupings or whatever you want to do. I ask, though, that the "Concept *" box(es) be used to itemize themes that you extract from the responses. When there are more than four concepts than come from one response (only three boxes provided), create a new record but enter the Response # that the concept(s) came from. You may wish to copy and paste the actual Response into the Response box of the new record you are creating so that it will be easy to use.

The "sub-groupings" can be used any way you want, as can the "Category *" fields.

Keep a record of the strategies that you are unsure of, so we can compare results and discuss the more difficult ones.

Our communal task

Once each of us has completed our sorting, we will meet together to discuss the results and come up with a final version. Controversial items will be identified and discussed. A consensus will be reached.

The meeting(s) may be audiotape-recorded for future reference and analyzed for inter-rater agreement and commentary.

Thank you!!!

Appendix D

Sample Responses (Raw Data) from Learning Strategy Questionnaire and Learning Strategies Extracted

Describe briefly your regular day-to-day/week-to-week study routine.

1. "I do not have a regular routine as my clinical duties do not allow it. I study whenever I have the chance to. Usually this means leaving work at between 7 - 8 PM, returning home, eating some dinner and reading until I'm too tired and I fall asleep. This ranges from 10 minutes to 2 hours of studying."

Strategies extracted: No regular routine; Study until too tired and falls asleep

2. "Generally I will study in evenings from 6:00-9-9:30 when I am reasonably well rested (i.e. not post call with no sleep), and Sunday afternoons. Generally, my studying involves picking a topic for the day or evening and reading only about that subject until completed."

Strategies extracted: Set study schedule evenings and Sunday afternoon; Study organized by picking topic for the day.

How do you approach learning diagnoses?

1. "I will generally approach a new diagnosis in the format outlined in most texts and articles, i.e. etiology, pathophysiology, symptoms/signs, diagnostics, therapies, outcomes. Tricks I often use are mnemonics, word associations and visualizing the overall layout of a page and associating text and ideas with the visualized image."

Strategies extracted: Outline for each new diagnosis: etiology, pathophysiology, symptoms, diagnostics, therapies, outcome; mnemonics, word associations; visualizing layout of a page and associating text and ideas with image.

2. "Often use mnemonics or word associations to remember lists etc. usually silly associations that would only make sense to me and nobody else.

-Think of disease or name of disease and try to relate info or mental image that comes to mind when thinking about the name:

eg. Differential of parotid tumours - think of an Italian boy whose mom is pulling his cheeks (parotid) saying: "Please!Wait!Mama?E!
P-pleomorphic W-Warthin's M-malignant mixed A- adenoid E- epidermoid"

Strategies extracted: Mnemonics or word associations to remember lists; making mnemonics associated with visual images

Appendix E

Strategies Extracted (Independently) & Classification Systems Proposed

I. Data Reviewer #1 - Final Year Obstetrics & Gynecology Resident

For my classification scheme I have used the four stages of the learning cycle as described by Kolb (1985). This to me seemed to put structure to the learning strategies within the context of problem-solving, which is what surgical residents and physicians are faced with daily in their practice.

	Concrete Experience	Reflective Observation	Abstract Conceptualization	Active Experimentation
Descriptive	Learning from feeling Personal involvement	Learning by watching & listening Careful observation	Learning by thinking Systematic, logical	Learning by doing Risk-taking, influencing
Types of learning activities	• Clinics • Seeing patient in ER • Doing OR's • Discussing with staff, peers, seniors • Case studies • Personal case file • Experience	• Seminars • Rounds • Observe OR's of mentor • Listen to debates of others • Seek understanding of topic	• Read textbooks, papers, manuals • Note taking • Summarizing • Re-read, review • Visualization • Drawing • Files • Cue cards • Pneumonics • Discussion /study group • Memorizing • Objectives • Algorithms	• Prepare for rounds • Teaching junior residents / medical students • Experimentation • Discussion / study groups • mock exams • Old exams
Time Management	• Experience as opportunity exists	• Sets plan but not always placed into action	• Detailed outline of plan & daily schedule • Adheres to plan	• Squeezes time into everything else that is being done
Resources	• Experience • Patients • Colleagues • Staff	• Rounds • Staff • Colleagues • Patients • Video Tapes • CD ROM with video clips	• Textbooks • MedLine • Internet • Review books • Personal files • Notes / Summaries	• Textbooks • MedLine • Internet • Old exams • Clinical files

II. Data reviewer # 2 - Surgical Educator

Content Related Strategies

Strategies that are not dependent on meaning

- Mnemonic
- Empirical framework (etiology, symptoms, PE, etc)
- Textbook table of contents
- Re-read notes
- Highlight key words
- Recite
- Associate family members to specific syndromes
- Write key words in margin of text
- Use computer to keep notes
- Reading aloud
- Observe someone doing a procedure
- Memorize sequence of procedure
- Repetition of cases of same type
- Do dictation of case
- Cram
- Copy what others do
- Let it happen (passive indoctrination)
- Read previous notes on similar case
- Take down patient ID for future reference
- Visualise text page soon after reading it
- Notes on scraps of paper
- Read abstract then text of article and re-read abstract
- Read difficult sections slowly

Strategies dependent on meaningful manipulation of concepts

- Strategies while gathering information

  - Skim and identify inherent structure of text
  - Elaboration
  - Anticipate examination questions
  - Generate flow charts
  - Integrate multiple sources at the same time
  - Relate new knowledge with cases previously seen
  - Visualise
  - Draw anatomy
  - Classify information
  - Review features of current case and relate to reading

- Active mental participation while doing a case
- Review operative atlas
- Active assisting
- Focus on questions of the day
- Summarise information with diagrams
- Visualise x-rays, disease process, patients
- Summarize literature and develop own approach
- Compare complication rates of treatments
- Create a treatment algorithm
- Wing it
- Create fantasy scenarios
- Anticipate patient outcome
- Use a patient to rehearse specific aspects of examination or other
- Make mental notes of mistakes
- Organise ideas of text (write outline)
- Paraphrase text
- Self questioning before reading

• Self-monitoring strategies

- Flash cards
- Self-questioning
- Use old examinations or books of questions
- Work with peers and quiz each other
- Try to summarize the text mentally after reading it
- Switch to new topic when bored of current one
- Draw anatomy from memory
- Rehearse steps of procedure
- Teach others
- Teach patients
- Ask for feedback from attending physicians or peers
- Seek preceptors who will give feedback
- Repeat self test at different times
- Monitor your performance during seminars
- Write summary notes after reading
- Continually review even in the shower

<u>Organisation of Learning Activities</u>

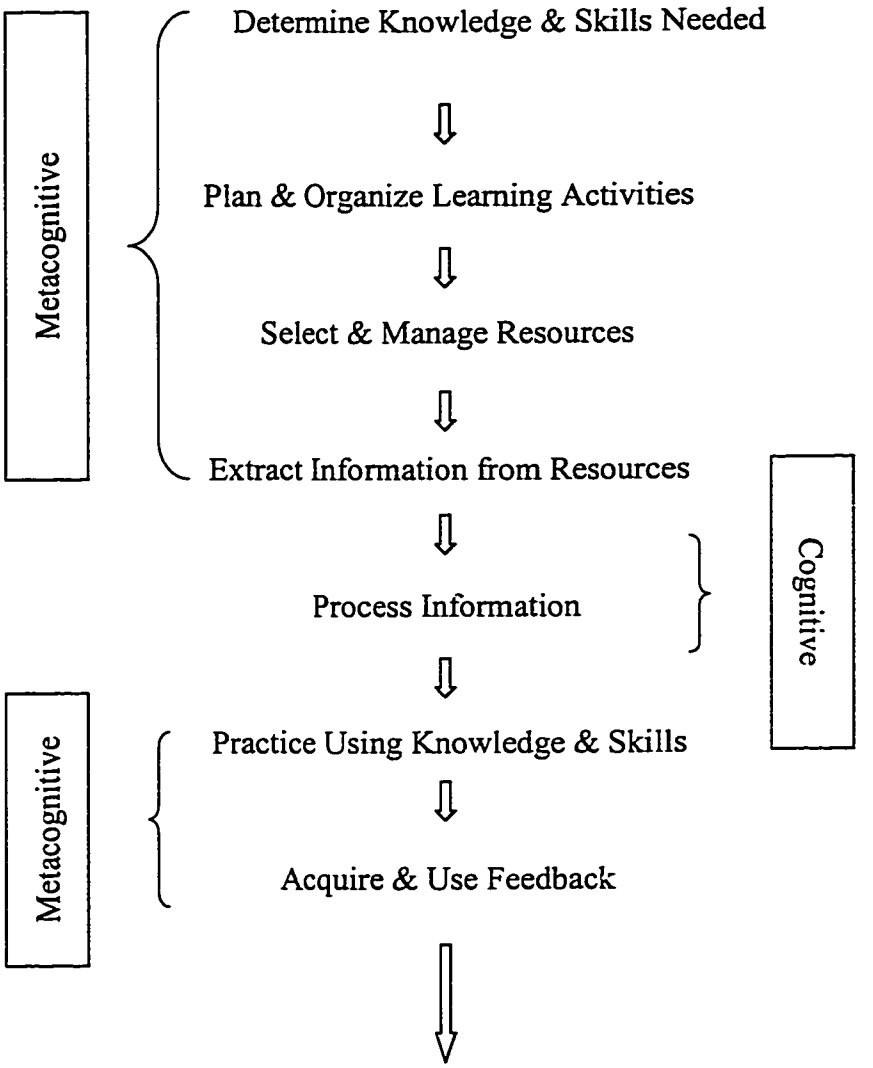
- Work with peers
- Ask questions to peers or attending physicians
- Set schedule
- Devise schedule based on self-assessed areas of weakness

- Intersperse boring with interesting topics
- Maintain diversion activities
- Identify best sources of information
- Take breaks
- Try to overshoot your goals
- Tailor learning to type of exam
- Prioritize
- Turn off the rest of your life to study
- Opportunistic studying
- Break content into small chunks
- Study more as the exam gets closer
- Save memorisation items for closer to exam
- Intimidation
- Read what seems interesting and pertinent at the time
- Rewards (break when goal reached)
- Comfortable environment
- Pick one learning issue per patient
- See lots of patients
- Ask others for direction
- Identify who will be examining you
- Review objectives
- What questions don't I want to be asked?
- Throw notes out
- Use notes for last minute review
- Taking notes forces you to identify what is important
- Review all aspects of a topic at once and use different sources
- Discuss cases with peers
- Switch textbooks frequently

III. Data Reviewer # 3 - Investigator

Models on which Classification was Based

1. Self-directed learning processes , based on (Caffarella & Barnett, 1994; Knowles, 1978; Neame & Powis, 1981; Zemke & Zemke, 1995))



Evaluated Performance (Clinical & Examination)

2. **Cognitive processes (based on (Gagné et al., 1992; Mayer, 1988))**

Learner exposed to information in environment

⇕

Learner selects & extracts information by paying attention

⇕

Learner repeats / rehearses information to retain in short term memory

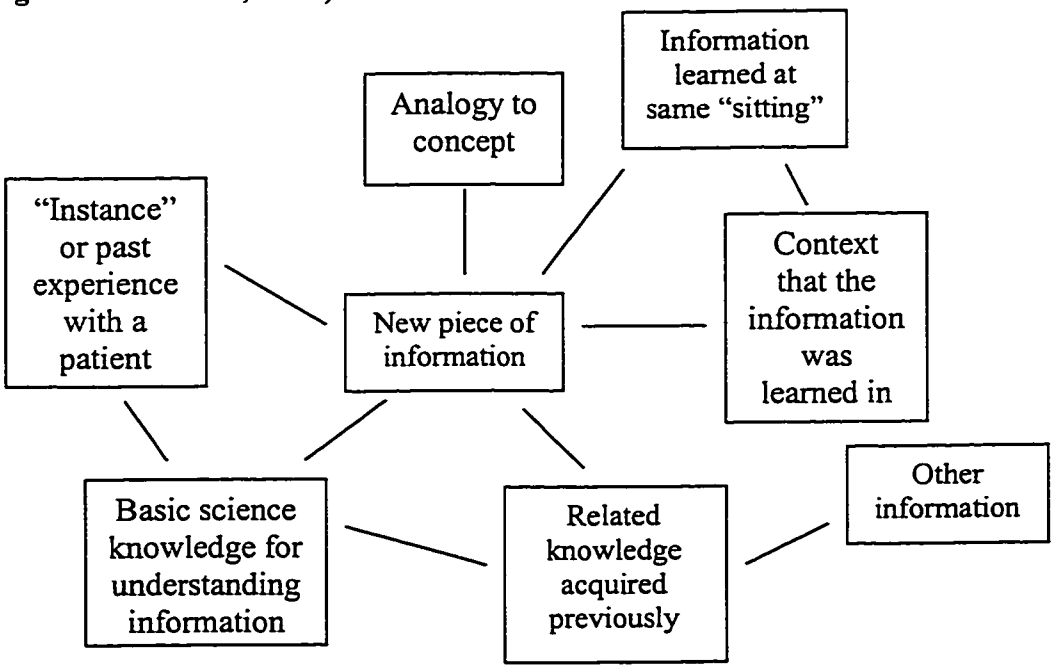
⇕

Learner encodes information (meaning attributed) into long term memory

⇕

Learner retrieves information in response to cues (practice recall)

3. **Building or re-organizing knowledge within knowledge network structure (subset of the cognitive processes), based on (Boshuizen & Schmidt, 1990; Regehr & Norman, 1996)**



Outline

Metacognitive Strategies

Strategies to determine what is needed to know
- Contact people
- Written guides
  - General outline
  - Specific details
- Own observations and perceptions

Strategies for allocating time for learning
- Organization of learning time
  - Designation of time for studying
  - Allocations of time
  - When to study
  - Prioritization

Strategies pertaining to selection and use of resources
- Resources
- Selection of resources
  - By amount of time available
  - By familiarity of "common-ness" of topic
  - By accessibility
  - By assessment of quality
  - By detail of information desired

Strategies pertaining to selection of environment for learning activities

Cognitive Strategies

Attention/Extracting information
- In clinical environment
- In study time (seminars, rounds and reading)

Strategies in providing meaning to new information
- Finding relevance in new information
- Relating new information to existing perceptions & knowledge of topic
  - Finding logic or sense based on pre-existing knowledge & understanding
  - Adding to or building the knowledge network
  - Activating prior knowledge

Linking and adding connections in memory network
- By close timing of exposure to different pieces of information

- By x stimulating y
- Environment or context at time of learning or review
- By connecting ideas and information or organizing ideas and information

Repetition/Reinforcement and Practicing Recall

- Repetition & reinforcement without "forced" recall
- Repetition & reinforcement with recall (including practicing recall)

Reduce Volume Load for Memory

- At one time
- Overall

Familiar vs. Unfamiliar Topics

Strategies for Optimizing Mental and Physical Capabilities

In Learning Activities

- Self-positive feedback
- Motivation
- Stress management
- Mental refreshment
- Physical refreshment

Impacting but not Directly Pertaining to Learning Activities

- Setting priorities in other aspects of life
- Physical Health
    - Sleep
    - Exercise
    - Diet

Time Management Outside of Residency Training

Time-saving strategies

Time-management principles

Priorities

Sequences (Need to fit in somewhere, ? where ?)

Detail

Metacognitive Strategies

Strategies to determine what is needed to know (for exams, for surgical practice)

- Contact people
    - ➢ Ask or observe what preceptors focus on
    - ➢ Study with or ask colleagues and seniors to help decide what is important
    - ➢ Ask "successful" exam takers what is required
- Written guides
    - General outline
        - ➢ Follow training objectives
        - ➢ Address standard text topics (example: use tables of contents as guide)
        - ➢ Use seminar topics as guide
        - ➢ Use old exams to set objectives
    - Specific details
        - ➢ Use lecture notes from lecturers
        - ➢ Use key review articles to guide studying of topic
- Own observations and perceptions
    - ➢ Reflect on skills and knowledge needed for practice and try to cover
    - ➢ Create objectives based on issues arising in clinical experiences
    - ➢ Write down or remember questions that arise that you want to find answers to
    - ➢ Create list of topics by each body system
    - ➢ Try to predict exam questions and study around them

Strategies for allocating time for learning

Note: learning in clinical setting largely prescribed by program and presumably thus not included in the residents' reported strategies

- Organization of learning time
    - Designation of time for studying
        - ➢ Use no time schedule, but study whenever time available
        - ➢ Study certain amount of total time daily or weekly

- ➢ Use time schedule but time not formally allocated to anything in particular
- ➢ Time schedule with specific allocations for particular things

- Allocations of time

  - ➢ Allocate time (specific time period or total amount of time) by topic
  - ➢ Allocate time (specific time period or total amount of time) by number of pages or cases to cover

- When to study

  - ➢ Study in early morning before most people awake
  - ➢ Study during day between cases, when possible
  - ➢ Have a portable resource (pocketbook) for reference/studying during day (anywhere, anytime)
  - ➢ Study in evening
  - ➢ Study very late at night when most other people asleep

- Prioritization

  - ➢ Set a daily goal
  - ➢ Set time priority for upcoming activities "with a deadline" (presentations, upcoming cases)
  - ➢ Allot time for general reading or key point reading, specifically
  - ➢ Set topic-time priorities: weak areas, topics not recently reviewed, common questions on past exams, common clinical problems, "important" areas
  - ➢ Allocate more time for unfamiliar topics than familiar topics

Strategies pertaining to selection and use of resources

- Resources

  - ➢ Written: general and specialized texts, MedLine abstracts, journal articles, O.R. reports, study guides, lecturers' notes, instrumentation manuals, Internet resources

  - ➢ People: (contexts in clinical settings, seminars, rounds, meetings) staff and guest consultants (within and outside of specialty), colleagues (peers, seniors, juniors), patients and their families, other health care workers

  - ➢ Other: video, CD-ROM,, skills lab, anatomy models, x-rays

- Selection of resources

  - By amount of time available

    - When time constraints select fewest possible resources
    - Select texts which "get to the point" (most info. in fewest words)
    - Utilize literature reviews when lots of time available

  - By familiarity or "common-ness" of topic

    - Use a greater number and variety resources when topic unfamiliar
    - Use staff or colleagues as resources more for unfamiliar topics
    - General texts and review articles when topic unfamiliar
    - Use patients more when topic familiar
    - Journal articles when topic very familiar or very new or rare

  - By accessibility

    - Selection by what is available at hand at the time (home, library)

  - By assessment of quality (own assessment or assessment of others)

    - Utilize staff and colleagues that are judged to be "good" models
    - Ask seniors, staff for advice regarding choice of resources
    - Select texts that "highlight" important things

  - By detail of information desired

    - Select general text for basic information
    - Select specialized text for detailed but general information
    - Select review articles for both detailed and general information
    - Select journal articles for fine details

  - Other

    - Select written materials that have large print
    - Utilize staff and colleagues for information, discussion, feedback, role model, advice
    - Use morbidity and mortality rounds as source of outcome information and to integrate knowledge

Strategies pertaining to selection of environment for learning activities (other than clinical)
Note: clinical environment largely imposed, not chosen

- Reading – no distraction, quiet, large table, bright light
- Read between cases (in OR lounge?)

Cognitive Strategies

Attention / Extracting Information

- In clinical environment (Pay attention to, observe, look for, note)
  - Pay attention to: a) surgery being performed by someone else
    b) instruments being used in a case
  - Observe what a preceptor focuses on
  - Look for and make notes of "salient features" of a patient seen
  - Make notes of tricks/shortcuts made by staff that are unlikely to be found written elsewhere

- In "study time" (seminars, rounds and reading)
  - Highlight
  - Underline
  - Start with a question or questions and look for the answers during the session (ref. time-saving)
  - Look for and note specific information based on an outline (ex. etiology, symptoms, lab results associated with a disease)
  - Pay attention to patient-oriented data initially
  - Skip over irrelevant information while reading and focus on "useful parts"

Strategies in providing meaning to new information

- Finding relevance in new information
  - Reflect on potential usefulness of new information to surgical practice or on a future exam (ex. could use the information to understand something)

- Relating new information to existing perceptions and knowledge of a topic
  - Finding "logic" or "sense" based on pre-existing knowledge and understanding

- Try to relate new information to something already known
- Try to "understand" or "make sense" rather than memorize:
- Ask staff, seniors and try to understand why they are using a certain technique
- Associate known pathophysiology with rationale of treatment and with outcomes
- Think about the possible reasons for observed management successes or failures
- Read, then watch, then do
- Compare disease processes and use to differentiate them
- Evaluate what you see and read (ex. "good" way of doing an operation?)
- Read before going to a lecture or seeing a patient (if hint of topic)
- Read abstract of article first and last
- Find "rules" that apply to many areas and use them as much as possible (see also reducing volume)

- Adding to or building the knowledge network

  - Start by reading a whole chapter without stopping to get the "big picture"
  - With new topic, start with overview then go back and add in particulars
  - Progressively increase clinical responsibility (example: doing more and more of operation on own)
  - See patient, read about the problem, then discuss with someone

- Activating prior knowledge

  - Sequences of approach to learning: see patient (stimulus), read about diagnosis, re-examine patient
  - Read about problem before seeing patient (if idea what it is about)
  - Read relevant old OR reports before surgery
  - Think about past experiences with a procedure before doing a case

Linking and adding connections in memory network

- By close timing of exposure to different pieces of information

  - Ask questions during a surgical procedure, related to the case
  - Read "around" a case as soon as possible before and/or after seeing the patient
  - Read related basic science and clinical science or other related topics concurrently
  - Follow up questions with answers as soon as possible (immediate, end of day, within week, etc.)
  - Allow one topic to "lead to" looking up something else in same sitting

- Before surgery, also read about the disease, other aspects of the diagnosis or treatment options

- By X stimulating Y

  - Use clinical encounters to stimulate additional learning (presentations, reading, etc.)
  - Use clinical encounter to cue recall of related information and general principles
  - When trying to recall information, visualize a patient seen previously with "classic presentation"

- Environmental (Context) at time of learning or review

  - Deliberately use "book" information in clinical setting.
  - Discuss the case (presentation, lab, management options) with staff during a surgical procedure
  - Reflection and look for new information in clinical encounters

- By connecting ideas and information or organizing ideas and information

  - Connecting written information to clinical context

    - Be stimulated to read by clinical encounters
    - "Use" patients in preparing rounds / seminars
    - Use recall of patients to stimulate recall of "factual" information
    - Associate previously seen patient with a disorder represented by the patient
    - Create patient "prototypes" to represent a disease or a management issue

  - Integrating and organizing information

    - Create filing system based on anatomic sites of diseases, "related topics", individual diseases, seminars, clinical presentation features
    - Organize notes pertaining to treatment by system or by anatomy site
    - Organize "similar" topics into an outline
    - Note (mentally or making tables on paper) differences and similarities between diseases (presentations, lab), management options
    - Look for and note differences and similarities in staff's clinical approaches, techniques
    - Look for similarities and differences in patient presentations of a disease
    - Compare management options for a disease (results, complications)
    - Create drawings (such as mind maps of related information, pictures), flow charts and algorithms (diagnoses, decision-making)

- For each diagnosis, make notes on etiology, pathophysiology, symptoms, treatment options, etc.
- Create one set of notes containing information from various sources (ex. leave spaces to add new info.)
- Mentally integrate information from various sources
- Prepare a presentation on a topic
- Return to a topic when new information found in other resources (while addressing different topic)
- Create cross-references between notes or texts on different topics
- Re-write notes into a "final set"
- Extract main points from a text, then organize them into a framework
- Organize reading or studying topic by topic (using many sources of information) (topic becomes a "unit")
- Categorize
- Create classification systems **(see also reducing volume for memory)**
- Ask preceptor for an outline, if difficulty creating one
- Discuss cases with consultants from various specialties such as radiology, pathology, etc.
- Group similar disorders in a table arranged by body parts
- Observe the flow of an operation
- Write treatment plan on history and physical form
- Discuss things (information, controversies, anything) with peers, seniors, staff (elaboration)
- Create prototype of a clinical presentation from various patients seen with condition
- Use clinical scenarios to compare disease presentations
- Reflect and anticipate what might "go wrong" in an operation or with particular treatments
- Think about the implications of the planned procedure
- Make judgments on management options such as "good" technique, "easiest", etc.
- Ask self how might recognize a disorder "next time" or how might distinguish A from B
- Consider possible causes for symptoms: infection, inflammatory, ischaemia, etc.
- Create imaginary patient scenarios while reading about diagnosis, treatments, etc.
- Visualize patient in similar and different clinical situations
- Compare a patient seen with previous similar patients
- Look for "book information" in a patient seen and try to use it
- Try to apply principles (basic science, diagnostic, management, technical) to different cases
- Associate treatment options with various complications
- Relate patient being seen with knowledge about the diseases or diagnosis represented by the patient

- When reading about diagnosis, think about patients seen in past with the condition or similar conditions
- Create an "index" or "prototype" case for a disorder (mentally or on paper)
- Create patient profiles representing different types of management
- Associate with pieces of or groups of information a mnemonic, word association, song, visual image, alphabetical order, rhymes, numbers or sounds
- Relate anatomic site to clinical presentation or vice versa
- Create lists (disease features, treatment options, etc.)
- Create hierarchical ladder of option (ex. reconstructive ladder)
- Create a visual human image of a disease with each relevant body part involved with the disease
- Mentally associate friends/family with particular disorders
- Mentally associate a disorder with something ridiculous
- Associate probabilities of outcome with other data
- Think through the most difficult part of an operation

Repetition/Reinforcement and Practicing Recall

- Repetition and reinforcement without "forced" recall

  - Alternate reading about and doing a procedure
  - Write notes during seminars, while reading, after OR cases, during rounds, etc.
  - Talk to self out loud or read out loud
  - Use different media to learn same material
  - Write notes on information in areas felt to be weak
  - Notes made in margins or on separate pages
  - Make notes of things likely to be difficult to remember, but want to remember
  - Select topics to study which are relevant to the current surgical rotation being experienced
  - Use different resources to cover same topic (different readings, read and case, etc.)
  - Read or re-read operative records
  - Read or re-read notes on a regular basis
  - Read or re-read notes when stimulated by a patient encounter or seminar
  - Practice communication skills by teaching students and getting patients' consents
  - Make an index card and carry in pocket during day to read repeatedly
  - See as many patients as possible during residency
  - Prepare a seminar on a familiar topic
  - Attend rounds and seminars
  - Keep track of patents' names and case reports

- Draw anatomy
- Draw deformities

- Repetition and reinforcement with recall (including practicing recall)

  - Try to apply recently acquired knowledge in clinical setting
  - Write "fill in the blanks" statements, then later recall and fill in the blanks
  - Reflect on the clinical presentation of a patient just seen, then re-examine patient
  - Make cue cards with questions and answer them repeatedly
  - Teach others
  - Write, re-read and re-write notes from memory
  - Repeat technical procedure in O.R. or skills lab
  - Ask to dictate operative note after surgery
  - Read the operative records that the staff dictate on cases attended
  - Visualize a procedure, step by step
  - Visualize specific or imaginary patients with a condition
  - Visualize a pathophysiologic process
  - Draw angles, mechanical drawings
  - Visualize xrays
  - Imagine "feeling" what hands will do in operating room
  - Write or draw on paper steps of a surgical procedure
  - Visualize any clinical experience observed
  - Use past patient experiences for new patient (example: to plan treatment)
  - Use past clinical examples when answering oral exam questions
  - Ask to be questioned by staff, colleagues
  - Recall information and evaluate if organized logically
  - Write a summary, then check to see if all information covered
  - Use principles in clinical scenarios
  - Visualize layout of a page of notes or of a book
  - Apply information from an old OR report to an operation in progress
  - Handle problems experienced whenever possible
  - Talk through an operation out loud
  - Do a "debriefing" after a case to review things missed or good techniques
  - When reading about surgical procedures, think about past experiences in the O.R. with the procedure

Reduce Volume Load for Memory

- At one time

  - Learn only one or two points from each case
  - Learn key features that differentiate diseases rather than all features of all diseases
  - Cover a topic generally several times instead of once in detail

- Read to answer specific questions (ref. metacognitive time-saving)

- Overall

  - Simplify complex information into widely applicable concepts
  - Try to memorize or learn exceptions to rules
  - Simplify numbers (such as statistics)
  - Progressively reduce sets of notes into themes and outlines
  - Summarize
  - Classify
  - Use a standard approach each time (when possible)

Familiar vs. Unfamiliar

- When familiar, read fast or skim
- When unfamiliar, read slowly
- Make notes when unfamiliar
- Highlight only when familiar
- Read many times when unfamiliar
- Read once when familiar
- Use mnemonics when unfamiliar
- Visualize page to recall when unfamiliar
- Condense information into few points when familiar

Strategies For Optimizing Mental And Physical Capabilities

In Learning Activities

- Self-positive Feedback

  - Check off goals as they are completed
  - Rewards when learning activities completed
  - Rewards when learning tasks accomplished

- Motivation

  - Embarrassment in front of peers used as motivator
  - Self-testing strategies used for motivation
  - Create study ultimatums (don't read certain amount, no free weekend)
  - Start with interesting material

- Stress Management
    - Set realistic goals
    - Work at small parts (so not overwhelmed)
    - Deliberate calmness prior to stressful learning activity
    - Remind self that experiences are learning experiences
- Mental Refreshment
    - Change topics when studying "when bored or tired"
    - Alternate interesting and not interesting topics
    - Take breaks
- Physical Refreshment (during Learning Activities)
    - Eat to stay awake
    - Use caffeine (coffee, other food or drink)

Impacting But Not Directly Pertaining To Learning Activities

- Setting Priorities in other aspects of life
    - Set (life) priorities
    - Always have time for family
    - Ignore family and outside life
    - Turn on or off other aspects of life
- Physical Health
    - Sleep
        - Don't sleep
        - Sleep when tired
        - Sleep certain number hours every night
    - Exercise
        - Exercise daily / regular schedule
        - Make exercise a high priority
    - Diet
        - Make eating a high priority

Time Management Outside of Residency Training

Time-saving strategies outside of residency training life

- Try to avoid doing trivial work
- Do several things at once (example: eat in car on way to work)
- Use every possible minute of day (example: read in car being driven by someone else)
- Co-ordinate activities to minimize travel time

Managing Activities other Residency Training Activities

Time-management principles

- Try to get kids to bed early

Time-saving strategies

- Try to avoid doing trivial work
- Do several things at once (example: eat in car on way to work)
- Use every possible minute of day (example: read in car being driven by someone else)
- Co-ordinate activities to minimize travel time
- Don't sleep

Priorities

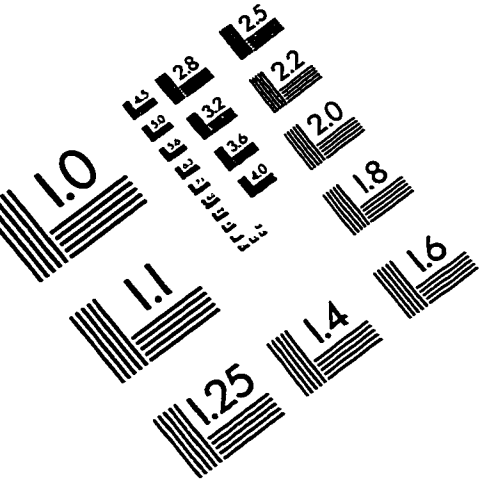
- Set priorities
- Ignore family and outside life
- Always have time for family
- Turn on or off other aspects of life

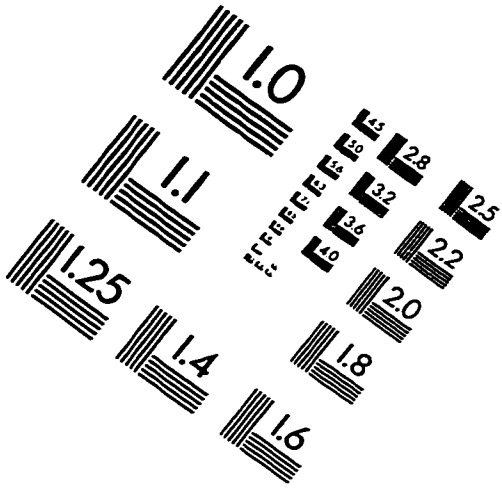
Sequences (Need to fit in somewhere, ? where ?)

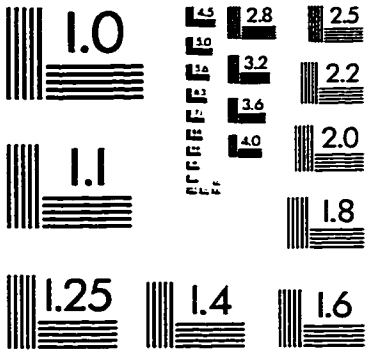
- Basic to detail
- Overview to weaker area to stronger area to overview
- Common to rare
- Read and highlight to re-read highlighted areas
- Study then self test
- Read book to read notes to do exam practice to read to follow-up
- Outline to schedule to study
- Weak first, then rest
- Follow organization of text topics

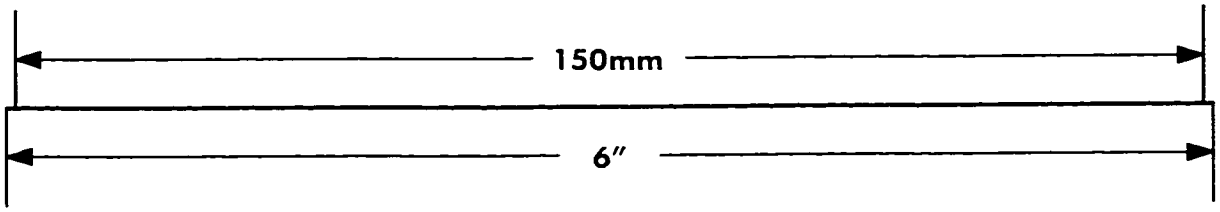
- Basic information first → detail
- Overview first → weak area → stronger area → review
- Common first → rare
- Read book first → read notes → do practice exam → follow-up
- Make outline → make schedule → study per schedule
- Follow order of a textbook
- Weak → rest
- Highlight → transfer highlighted info. into notes
- Text first → staff → literature

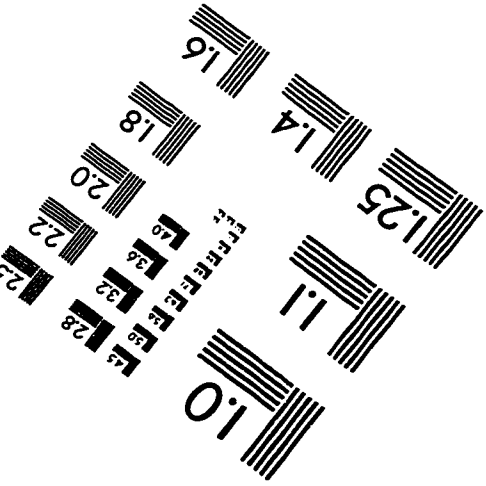
IMAGE EVALUATION
TEST TARGET (QA-3)

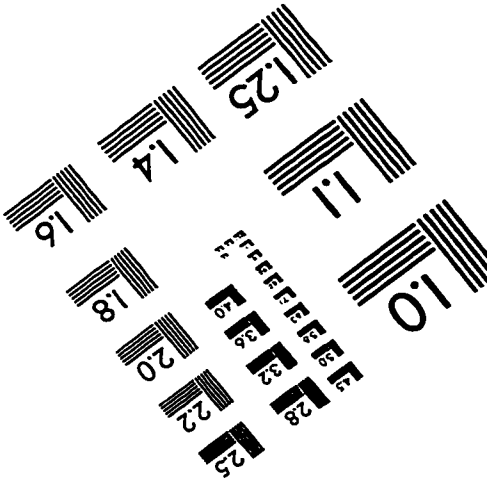












APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989