THE COGNITIVE AND METACOGNITIVE DEMANDS OF LIBRARY RESEARCH AS EXPERIENCED BY FORM ONE STUDENTS

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Abstract

In recent years educators have become increasingly aware of the necessity to support the development of higher order thinking abilities in all students. It has been suggested that, in this regard, special attention should be given to those aspects of the curriculum "which are inherently enabling of further learning" (Resnick, 1987, p44).

Library research skills tuition is one such area but traditional modes of teaching these have frequently overlooked the cognitive and metacognitive demands of tasks requiring information retrieval and use. The extent of these demands as they affect students undertaking project assignments independently was largely unknown and prompted the following study.

To access the levels of knowledge and thinking processes used by students, think aloud/concurrent interviews were conducted individually while 23 Form 1 students (mean age 11 years 8 months) attempted to gather information for a project. These interviews were videotaped and then replayed to students to provide memory cueing for retrospective interviews.

Students were found to have wide ranging metacognitive knowledge, the accuracy of which influenced their performance on the information retrieval task. However, the knowledge they made public concerning the learning task and the criteria by which their learning would be assessed was very limited. Few students voiced recognition that the criteria for evaluation would have implications for the way in which they approached the learning task itself. In contrast, they voiced considerable awareness concerning the expected features of the materials they must use, qualities of their own learning abilities and processes, and interactions between these. However, Form 1 students often lacked an accurate understanding of the relationships within the library system and between access structures in individual books.

Overall they had insufficient general and tactical knowledge to facilitate the use of alternative action paths when a favoured approach failed. However, both able and less able students were found to engage in some form of executive control processing. Two case studies are presented which illustrate differences in the quality of students' executive control processes. In particular, students varied in the degree to which monitoring events triggered associated planning and regulation/revision episodes.

The findings are discussed in terms of their implications for providing a learning environment that supports the development of higher order thinking and increased information retrieval success.

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CHAPTER ONE

INTRODUCTION

An essential part of educative endeavour has always been the evaluation of student performance. In recent years the proliferation in America and Britain of high level government reports on aspects of that performance for wide populations of students has given impetus to international conferences, workshops and the development of training programmes of many kinds. These are frequently intended to address the problems of modifying student performance to meet the expectations of educators, employers, politicians and parents, not to mention those of the students themselves.

These expectations in their turn are influenced by technological and social changes. For example, the much vaunted "information explosion" has resulted in a situation where much of the information imparted to 11 year olds will be obsolete by the time they leave school (Irving, 1985). To counter this, people from several disciplines are in favour of "learning to learn", that is, of fostering conceptual skills which will allow students to process information from a wide variety of sources and to learn independently (e.g. Liesener, 1985; Irving, 1985; Sternberg, 1987). This implies a prominent role for higher order thinking skills such as those associated with analysis, evaluation, inference, interpretation and problem-solving. The strategies underlying these skills must be monitored, regulated and deliberately brought into service, thus metacognitive knowledge and executive control must also be a focus of education. The question is, to what extent are these abilities fostered in education at present? The short answer seems to be that while educators talk about learning to learn the skills involved are often only poorly supported in schools. An examination of the study skills literature serves to illustrate the problem.

Although high technology is appearing in classrooms, Guthrie (1982) points out that students are still expected to cope with at least 32000 textbook pages during elementary and high school years and Jones (1988) suggests that 70 to 90% of instruction in schools is based on the use of textual materials. Thus one might expect that critical reading and study skills would feature prominently in any catalogue of student abilities. However, Baker and Brown (1984a) state that "all too few college students today are critical readers and this is a barrier to the development of an adequate repertoire of study skills" (p372).

In general, the literature shows that in recent years there has been a decline in literacy achievements at secondary schools and it appears that many British and American students leave high school with few or no reading or study skills (Reynolds & Shirey, 1988; Rudduck & Hopkins, 1984). This situation is reflected in the number of universities and colleges finding it necessary to offer extensive remedial courses for students. This in itself is not a new development - McKeachie (1988) notes that Wellesley College in America offered a course in study strategies as early as 1894. In addition, reading and study skills courses were offered in abundance during the 1930s. However, despite ninety years of research concerning study skills, there is still a gap between theory and practice in that the theory itself has some serious limitations (McKeachie, 1988) and study skills courses "have often remained surprisingly isolated from findings obtained in training studies" (Schallert, Alexander & Goetz, 1988, p195). Consequently, there is a wide variation in the effectiveness of study skill programmes.

Schallert et al (1988) indicate that even the most effective special learning strategy courses have only limited impact since they reach a relatively small proportion of students. Further, they say that the instruction students receive within such courses is likely to be decontextualized and, if skill transfer does occur, it may be "incomplete, inappropriate and short lived" (p195).

This view prompted Schallert and her colleagues to explore how learning strategies are delivered to the majority of students. They found that teachers at college level rarely give explicit suggestions of how to go about reading a text but that students may be told which sections of content are important. Schallert et al's findings were in accord with McKeachie's (1988) comment that students are seldom taught to develop study strategies, instead "they stumble upon effective strategies only when, by chance, they vary their approach and find that one method works better than others" (p5).

Reynolds and Shirey (1988) say that the role played by study techniques in determining which information will be retained is still poorly understood. They suggest that achievement of such understanding is dependent upon thoroughly researching and comprehending the processes underlying studying. They point out that techniques such as note-taking, underlining, summarizing, outlining and graphically relating concepts are necessary to the integration and understanding of information but that these can only take place after processes which select and focus attention on important information. Thus Reynolds and Shirey identify a deficit in ability to select important information as one of several possible causes for differences between study skills theory and practice. Comprehension monitoring processes are also implicated in that they must be applied both during and after the identification of important information. These processes have only recently begun to be understood but would seem to shed further light on the processes of studying. Clearly, to address the processes underlying studying one must investigate cognition and higher order thinking skills.

Developments within cognitive research have provided both conceptual frameworks which can be used to gain an understanding of the processes at work, and methodologies for accessing the thinking abilities of students. Indeed, with regard to these, Baron and Sternberg (1987) observe that American government-sponsored reports of recent years suggest that children's thinking skills have reached an abysmally low level. It appears that students are generally able to read for literal meaning but that their performance is significantly poorer when asked to make inferences from, integrate and evaluate information. This statement is in accord with that of other researchers such as Wilson (1988) who concludes that a large number of students "falter in their ability to achieve", because they lack high level organisational and information processing skills (p323). He found this lack of skills to be most evident when students move into senior high school and are faced with a dramatic increase in the amount of information to be comprehended and retained. The net result of many similar findings, and an awareness of the necessity of being able to process increasingly vast amounts of information, is a call for the inclusion of thinking skills and study skills courses in curricula for all students.

This may seem an unrealistic demand, given that the higher order thinking skills implied have for a long time been considered to be the preserve of particularly able students. However, Resnick (1987) assures us that recent research on the nature of thinking clearly indicates that higher order thinking skills are actually essential ingredients of learning at even elementary levels. Previously held notions that such thinking skills must be preceded by acquisition of a set of more basic skills are giving way to the idea that we use higher order skills in relation to growing expertise and knowledge. We do not merely impose them on knowledge as an after thought, rather, they are critical to learning at all levels. Sadly, Resnick claims that activities, such as written composition, which were once used to engage these skills have all but disappeared from the American school curriculum.

In discussing what is meant by the term "higher order thinking skills", Resnick questions whether critical thinking, metacognition, cognitive strategies and study skills (all generally subsumed by the term) actually refer to the same kinds of capabilities. It is suggested here that critical thinking and study skills together with problem-solving, writing and researching, all make use of cognitive strategies and metacognitive abilities. These terms imply the existence of a range of strategies amongst which the individual can choose appropriately and that range of skills is certainly essential to the level of literacy required to cope with the information explosion. Indeed, Weinstein and Mayer (1986) note that an increasingly important goal in education is that of "helping students develop effective ways to handle the barrage of information coming from the environment, as well as their own thinking processes" (p315).

At present, students are rarely expected to use their own spontaneously generated strategies to facilitate learning. Teachers employ pre-tests, behavioural objectives, overviews and advance organisers and generally provide students with a framework within which to carry out activities (Reynolds & Shirey, 1988). The opportunity is there for students to generate their own learning strategies but seldom is any explicit attention given to helping them become aware that they can set up such aids for themselves, or that they can choose among a range of learning strategies (McKeachie, 1988). This awareness is necessary if students are to be encouraged to learn independently.

In sum, there is a great need for students to be taught strategic study skills and related thinking skills in order that they be able to cope in a world that is changing rapidly on both social and technological levels. Although past attempts to achieve this have not been entirely successful, change is evident in current methods. For example, developments within cognitive psychology indicate that strategy training efforts are more likely to be effective when tuition is combined with attention to the skills necessary to selecting, monitoring and regulating strategy use appropriately (Belmont, Butterfield & Ferretti, 1982). This involves both metacognitive knowledge and executive control processes.

Metacognitive knowledge is that concerning an individual's knowledge of his or her own abilities and the constraints imposed on these by the characteristics of learning activities, materials and criterial tasks. Executive control processes are concerned with the use of this knowledge in planning, monitoring and regulating cognitive action (Brown, Bransford, Ferrara & Campione, 1983). At this stage in the development of metacognitive theory, much of what is known is merely descriptive (Yussen, Matthews Hiebert, 1982) with the early research focusing on memory and comprehension monitoring. These aspects are particularly germane to learning in an information rich environment.

Although metacognitive processes are still poorly defined and understood, it appears that research has identified a "psychological space in which educationally powerful effects seem to occur" (Resnick, 1987). The parameters of the metacognitive concept and its application to theories of reading and study skills and information retrieval and use will be discussed in detail later.

Suffice it to say that metacognitive research, especially that of Brown et al (1983), highlights the need to consider interactional models of learning. Briefly, Brown et al (enlarging on a model originally put forward by Jenkins, 1978) suggest that the complexities of learning situations can be reduced by considering four sets of interactive variables. These are the characteristics of the learner, those of the learning activities, the nature of the instructional materials and of the task used to assess the learning outcome. Metacognitive functioning demands that the learner consider the nature of these variables, their interactions and their effect on individual performance. This information must then be used to direct strategy selection and use. Brown et al suggest that it is because knowledge has dramatically increased concerning each of these sets of variables in relative isolation that we can now begin to consider the complexity of interactive models of learning. Thus we may be able to explore a broader context for learning to learn than has previously been possible.

In terms of this tetrahedral model, the study skills literature has thus far tended to focus on some of the learner's characteristics, relatively simple learning activities and instructional materials that are teacher-provided (containing only such anomalies as the researcher introduces by way of experimental manipulation). The students' end use of the information studied has usually been limited to a test relating to this same material. In addition, the study of reading processes basic to this task has often been secondary to researchers' other interests.

Studying seems to have been researched in terms of learning a small amount of especially provided material for a test. Consequently, students' abilities to integrate material from multiple sources while studying a topic have not received attention (Venezky, 1984). However, as Resnick (1989) points out, learning is a process of knowledge construction. In the context of independent learning, studying frequently involves the location and use of multiple and often fragmentary information sources, the contents of which must be re-organised and structured into a coherent whole. The information explosion dictates that we discover the difficulties that students experience in this situation so that teachers are better able to help them learn independently. Furthermore, technological and social changes rule that we move rapidly, as Irving (1985) puts it "we need tomorrow's education today" (p1).

In the past, library and study skills have quite logically been "lumped" together and teaching attempts have emphasized library organisation and contents, with hardly any attempts to assess students' information needs or uses. Irving (1985) suggests that "... equating the use of library materials with teaching about catalogues and classification schemes, is like learning cookery by acquiring a knowledge of where to find the ingredients on the supermarket shelves" (p3). This approach to teaching library skills is often followed by repeated exercises in the "project method" which, Marland (1978) notes, have been assumed to somehow equip a child to approach the study of topics independently, even when guidance and specific instruction have been lacking. This assumption has also been challenged by Liesener (1985), who cites recent American studies showing that such methods result in students unwilling and unable to use tertiary level libraries effectively.

In summarizing a hundred years or so of library-based instruction, Irving (1985) points out that lessons have generally been divorced from the rest of the curriculum. Where the curriculum has been taken into account, Beswick (1977) states that library skills exercises have often been quiz-based, relying on "aimless trots through the catalogue and reference books by pupils carrying work cards which set them questions, the answers to which nobody but a desperate teacher-librarian would ever think to ask".

Moreover, not only does library skills instruction frequently lack academic relevance, Irving argues that commonly published lists of library skills omit all reference to actually thinking! She criticises the terms "library skills" and "study skills" in that the former has failed to relate thinking and communicating to the activity of retrieving information from a library and the latter emphasizes reading and writing to the detriment of thinking, asking questions or seeking information in libraries (p22). The similarity between these criticisms and those levelled at study skills research and tuition (e.g. McKeachie, 1988; Schallert, Alexander & Goetz, 1988 and Reynolds & Shirey, 1988) is most striking. It is suggested here that information retrieval and use is an important aspect of studying, in the broad sense of independent learning, which has been neglected in the study skills literature. Further, lack of explicit attention to the cognitive skills underlying the information retrieval process and subsequent information use may be a barrier to students' development and use of higher order thinking skills. Integration of theory and research findings from the fields discussed above, and application of them to the literature surrounding information retrieval and use, i.e. library related issues, should foster a deeper understanding of students' information use and of ways in which they can be encouraged to learn independently in all subject areas. However, the library and information research field provides little understanding of how people select and retrieve information.

Until recently evaluation of retrieval systems was largely limited to counting the number of documents retrieved, regardless of their value to the information user. However, there is growing awareness that the user's satisfaction with, and the final use of the material found, should be taken into account when evaluating systems (Beal, 1980; Lancaster, 1986). Beal suggests that the user's information search strategy should also be considered and, from the cognitive psychologist's view, it is clear that differences in strategy use have a marked effect on final outcomes.

According to Beal, the existing studies concerning information users do not address issues such as the problems of using the indexes and catalogues which are central to the use of information services. In addition, the majority of studies have focused upon adult library users. Virtually nothing is known of the problems besetting children as information seekers yet teachers often set resource-based learning tasks which demand considerable skill in information retrieval and use.

Irving (1985) points out that future generations will certainly need the skills to handle information, both as creators of new information and as recipients of that previously generated. If educators are to address these issues, a clear description of the necessary skills and library research processes is essential. Further, to promote effective teaching, the task of information retrieval needs to be explored from the student's viewpoint. At this stage there appear to be few available descriptions of the cognition underlying library research, yet this task is a common component of all levels of education.

The foregoing discussion has served to raise several questions concerning education in an information age. It has stressed the importance of information skills for social and economic survival and indicated that these include higher order thinking and information processing abilities. Effective teaching in this area must be grounded in an understanding of what is involved in retrieval of information from large systems, use of that information, together with an understanding of the factors which contribute to success or failure in such tasks.

Such understanding requires a clear description of the thinking skills underlying the processes implied. While this can be partially generated by drawing on relevant literature and adult experience, the experiences of students themselves are essential to the completion of the picture. For example, an earlier attempt to address some of these issues (Moore, 1988) uncovered some basic student perceptions which hinder information location and use. It was found that young students (11 years old) have difficulty interpreting aspects of the library's organizational system and in relating these to the books on the shelves. The books themselves were found to be highly variable in quality and assumptions about the ease of locating information within them were strongly challenged. The students participating in that study were not very aware of the parameters of the learning task and the cognitive demands underlying information retrieval but most of them were still able to present a written report of their findings on the search topic.

The present study aims to generate a description of the cognition and metacognition underlying information retrieval processes as experienced by Form 1 students. Reviews of the literature reveal little that is directly applicable to this task, thus the following two chapters serve to draw together relevant threads from library and information research, and educational psychology. Given that these two areas of endeavour are rarely considered in tandem, the nature of information retrieval and the current role of school libraries in teaching learning skills will be discussed first. Attention will then turn to a theoretical discussion of metacognitive concepts and their application in the context of information retrieval. Relevant empirical studies from both fields will be reviewed in Chapter 4 which outlines the present study in detail.

CHAPTER TWO

SCHOOL LIBRARIES AND LEARNING TO LEARN

Although educational institutions are generally expected to contribute to meeting challenges posed by today's social and technological changes, Liesener (1985) comments that the level of resource allocation and the priority and status accorded education in American society do not reflect this. The case appears similar in New Zealand. Funding remained at substantially the same level for the years 1977 to 1987 (Royal Commission on Social Policy, 1988) and since then reforms and upheavals in the education system have made it difficult to assess the effect of actual changes in the allocation of resources. It is clear, however, that development of expertise in the area of teaching library and information skills has been affected by fluctuating support during this period. Indeed, Lealand (1990) says that it has "faced a prolonged threat of extinction" (p89).

For many years school libraries in New Zealand have been run by teachers with normal classroom responsibilities and little, if any, training in information matters or, more rarely, by professional librarians lacking teaching skills. Voluntary help from parents has not only been highly valued in this situation, it has often been essential. Recommendations from the Foley Report (1978) prompted the *NZEI and other teachers' and library organisations to work towards improving efforts to provide information services in schools (Gawith, 1986a). In 1986 a specific course was initiated to combine the knowledge and skills developed by teaching and library professionals. It ran successfully for three years before government cutbacks brought it to a standstill. The course produced 55 trained teacher-librarians, of whom 35 are still employed in that role (Griffiths, personal communication, February, 1992). Many are now highly valued within their schools but some have

*NZEI stands for the New Zealand Educational Institute had to deal with non-comprehension of their role by teaching colleagues and disappointments associated with lack of finance to build up resources as well as a lack of adequate ancillary support (Lealand, 1990).

Lealand's report suggests that these trained teacher-librarians have had very positive effects on student learning and on enhancing the information and teaching skills of their colleagues. This success, combined with intense lobbying, has resulted in reinstatement of the teacher-librarianship course in a form which will permit a greater number of teachers to take part. However, continued support for the teacher-librarianship role is not certain. After 1993 schools cannot be assured of government funding for the positions and will therefore have to rely on the generosity of Boards of Trustees. Given the emphasis, in the draft National Curriculum (1991), on the essential nature of information skills, one hopes that government support will cease to fluctuate.

Lealand quotes one principal as saying the introduction of a teacher-librarian in his school was "the most cost effective innovation I have witnessed in 38 years of teaching" (p21). However, not all principals view the role as positively. So what is the role of teacher-librarians and how does it differ from that of other teachers or professional librarians running school libraries?

The key difference lies in perceptions of library functions within a school. For librarians, issues have traditionally centred on managing and organizing a collection of resources. Many teachers having library responsibility would agree that resource management is the primary goal of time spent in the library, and given the limitations of time available, it may be unrealistic to expect them to achieve anything more. While resource management is also a concern for teacher-librarians, their primary concern is to facilitate the end use of information in a manner appropriate to the students' level of cognitive development. This requires an emphasis on teaching about the processes of learning in an information rich environment, and hinges on perception of library functions in terms of the educational needs of the users, be they teachers or students. The learning and research processes involved are said to be the same whether a research task is set at the primary school or tertiary education level, that is, whether it is for a brief project or a PhD thesis (Irving, 1985). The major differences between these tasks concern the sophistication and depth of inquiry required.

In designing the teacher-librarian course, Gawith (1986a) aimed to extend the skills of the participating teachers to include "approaches and strategies far wider than those traditionally needed and used by the classroom teacher" (p171). Indeed, the object was, and is, to produce "teachers whose subject is learning itself" (p171). Thus on one hand librarians and many teachers having library responsibility have traditionally focused on management of library resources and systems, while on the other, teacher-librarians are primarily concerned with the needs of the information user and supporting attempts to learn how to learn. Within this role teacher-librarians also have the task of revealing hidden aspects of library research to their colleagues in order to improve the support given to students embarking on all manner of resource-based learning tasks. This requires that they draw on knowledge gained by information specialists.

While more information professionals are becoming aware of the need to look at information users' satisfaction with and final use of material found, few studies provide understanding of how people actually select and retrieve information. Further, Streatfield (1983) cautions that such studies are likely to use the term "information user" in an idiosyncratic manner, one in which "the information user as one who makes use of information (i.e. all of us, much of the time) is displaced in favour of that relatively abnormal creature, the regular user of the information systems and services under review at a given time and place" (p226). These "abnormal creatures" are likely to make systematic and rational use of the available retrieval tools but

Streatfield quotes Brittain' s (1982) findings that users generally do not like bibliographic tools for information and document retrieval and do not use them rationally and systematically. Nowhere is this more likely to be true than in schools where students are novices in the task. Indeed, Liesener (1985) suggests that teachers themselves have "incredibly low levels of both awareness and skills" in this area (p13), despite the fact that they probably have a greater diversity of information needs than many other people. While agreeing with Liesener's assessment, Beswick (1983) suggests also that librarians' descriptions of what is involved in information use are often very naive.

Given the diversity of information retrieval tasks and the naivety of current views of their demands, the teacher-librarian is unable to provide colleagues with a single, simple formula for teaching students. Rather, the emphasis must be on collaboration between teachers and teacher-librarians as curriculum units are planned, taught and evaluated. Lealand's (1990) review of the effect of appointing teacher-librarians to schools found that collaboration was indeed the most important aspect of their work, yet the appointees themselves found it to be the most difficult. Collaboration is necessary to the exploitation of the potential of the current curriculum to foster information and high order thinking skills. It could be used to counter the past unsuccessful tendency to teach library and study skills in isolation of the curriculum and students' information needs. It would also answer the call, made by Irving (1985) and other information skills lobbyists, for new thinking and teaching strategies to be incorporated into the existing practices of all teachers. Beeby (cited by Beswick, 1977) is one of many who suggests that this is essential "if the new generation is not to be intellectually smothered beneath a mountain of facts". However, it is the view of Liesener (1985) that the challenge to teach higher order cognitive and problem-solving skills more effectively will also demand a much more sophisticated view of information use and users.

The rhetoric surrounding the potential of library programmes to promote thinking skills is persuasive but in reality the contribution of library media programmes to meeting this challenge is limited by attitudes that pervade schools regarding the purpose of a library. Beswick (1983) states that school libraries are assumed to be admirable and essential but are rarely shown to be so. He says it is not clear how the presence of a school library can foster the development of informed and skilled reading, nor has it been shown if, how and why the relationship between reading at length and in depth, and thinking and understanding, is important. Some of the answers lie, he thinks, in gaining a "proper understanding" of reading. Other commentators, notably Avann (1985), suggest that library research tasks at their best provide students with opportunities to acquire and practise the skills of gathering and evaluating information from a variety of sources. They can also lead to critical use of resource materials and greater skills in reading and writing. However, these claims have not been fully substantiated and merely providing opportunities does not ensure that they are taken (Perkins, 1985). To make matters worse, Beswick contends that many teachers and parents do not see the importance of information skills and would give them lower priority than acquisition of subject knowledge. In accord with this, Avann observes that the product of library research tasks, or project work, has often been treated as more important than the process by which the information was obtained. A recent discussion the writer had with senior teachers revealed that they saw work beginning in the classroom **after** a visit to the library to get information, thus the knowledge and thinking involved in collection of data went completely unrecognised. Lack of perception that these contribute to the solution of information problems is a barrier to the realisation of the potential of library media programmes (Irving, 1985; Liesener, 1985). As yet that potential is unproven but there is wide agreement that it exists. That it is severely limited by perceptions of the roles of staff and functions of libraries is illustrated by a quote from Smith (1987). A school library media specialist (American terminology) informed her that "I am not responsible for teaching thinking skills. I teach library skills." Many researchers would join with Smith in questioning whether the two can in fact be separated (Kuhlthau, 1987; Breivik, 1987; Mancall, Aaron & Walker, 1986; Irving, 1985; Gawith, 1986) and one is sharply reminded of Irving's (1985) criticism that commonly published lists of library skills omit all reference to actually thinking!

In sum, one can see that uncertainty exists among educators concerning the roles of school library programmes and those running them, be they school librarians, teachers with library responsibility or trained teacher-librarians. Liesener (1985) and Beswick (1983) call for greater clarity of vision of the raison d'être for school library programmes in order that their potential can be realised. Beswick (1983) notes librarians' naivety about information use while Liesener (1985) (supported by Irving, 1985) comments on teachers' low level of information skills. One must hasten to note that these deficiencies are hardly ones for which the teachers and librarians should be blamed. In the previous chapter the inadequacy of a hundred years of attempts to learn and teach about library and study skills was clearly outlined. Today's information explosion is merely exposing the gaps in the education of the previous generation. The library, as a focus of learning about learning, demands that teachers and librarians apply skills that may not have been included in their own training.

Smith (1987) suggests that failure to recognise that library skills training necessarily involves teaching thinking skills is the result of a poor understanding of what is involved in higher order intellectual activity. While this may be true, it is suggested here that another factor is a lack of understanding of the cognitive demands of information retrieval and use. Much of the confusion about the place of school library media programmes might be dissipated by gaining some empirical data regarding the cognitive and problem-solving demands of children's project work, especially from the viewpoint of the students themselves. Irving says that "few researchers really get underneath the problems children face when using resources or collections. Without such detail, we'll never understand what goes wrong or why." (Irving, 1989, personal communication).

INFORMATION SKILLS

The omission of reference to the role of thinking in both study and library skills tuition has led Irving (1985) to prefer the term information skills, but what are these skills? In general terms Irving (1985) holds that differences in information skills application may account for differences between good and poor students. Definitions of the skills implied vary in specificity from Henri's (1987) statement that they underpin self-directed learning and information literacy (as distinct from, but related to, text and computer literacy) to that of Avann (1985) linking information skills to the acquisition of knowledge from a variety of sources and the ability to assess and apply the information gained. Lists of specific skills involved in this process differ in format but there is agreement in essence that the following elements are important:

1) identifying a need for information and being able to articulate that need
2) framing appropriate questions
3) finding information sources
4) evaluating those sources
5) extracting relevant information
6) processing and if necessary presenting the information to others. (Avann, 1985)

Each item above implies a complex combination of practical and thinking skills, for example, most of what are usually referred to as study skills are packed into item 6.

Often such lists are accompanied by curriculum guides detailing information skills acquisition at various levels of schooling and suggestions for their introduction. These tend to be characterized by the adult's view of skills and knowledge to be gained rather than approaching the problem from the view of the child (e.g. Walisser, 1985; Haycock, 1985). Irving (1985) states that this difference, while subtle, is very significant.

While the role of cognition in information skills is somewhat understated in the above list, the relationship between the two is now being made clearer with writers such as Irving (1981) stating that "the central activity in all information searching is concept formation" (p14) and Cleaver (1987) noting that information skills are concerned with "sense making". Some lists of information skills also include an implied metacognitive element in that the learner is encouraged to evaluate what has been learned. Moreover, explicit acknowledgement of the role of metacognition in information handling is a feature a growing number of recent articles (e.g. Mancall, Aaron & Walker, 1986; Bertland, 1986; Sheingold, 1987).

These perspectives have lately been reflected in a shift of attention among information specialists from the traditional focus on document storage and organization to one more closely allied with that of educators. Approaches to teaching information skills are currently being developed which consider the cognitive environment of the information user, that is, "the whole framework they use in acquiring knowledge" (Irving, 1983; cited by Kuhlthau, 1987). Thus there is greater acknowledgement of the role of prior subject knowledge and awareness of library information retrieval processes, together with critical reading and problem-solving skills. Previous lack of attention to cognitive aspects of information retrieval and use are now generally held to be partially responsible for the failure of study and library skills tuition to enable students to meet their information needs.

In addition to explicit attention to cognitive issues, the acquisition of effective information skills may also require a conceptual awareness of the nature of information and its diversity (Cleaver, 1986). Dervin and Dewdney (1986) suggest that information itself is a construct of the user and that "information seeking and information using occur when individuals find themselves unable to progress through a particular situation without forming some kind of 'new sense' about something". This context extends consideration of the concept of information well beyond the confines of library walls. The affinity between information seeking in general and concept formation is evident in that the shaping of a topic through the re-structuring of available information is emphasized rather than simple location of the right answer to a specific question. Kulleseid (1986) takes this a step further in her discussion of comprehension processes and the contribution schema theory can make to understanding the cognitive basis of information skills. This leads her to outline how metacognitive skills are called upon during reading for meaning and remembering, an issue which will be explored in the following chapter.

In sum, the literature emanating from information specialists reflects a growing awareness of the cognitive and metacognitive demands of information seeking and use. Information is the resource from which knowledge is constructed. The flexibility with which that knowledge can be applied would appear to depend on the nature of the information skills used in its acquisition. It is apparent from cognitive research that these skills are fundamental to all academic work and much non-academic work undertaken in schools. They also play critical roles in many aspects of tasks common to daily life such as vocational choice, home-finding, domestic problem-solving and the pursuit of leisure and recreation (Irving, 1985, p14-15).

The potential to meet the challenge of fostering higher order thinking skills in all curriculum areas is inherent in the nature of information skills and as such provides an educationally sound raison d'être for school library media programmes. However, Sheingold (1987) notes that while schools are capable of doing a reasonable job of teaching routine, basic skills, they do not know enough to teach the more complex skills described above. Moreover, although the contribution of cognition and metacognition to the solution of information problems has been recognised, we have yet to discover the learning demands imposed by various types of assignments and the ways in which students meet them (Irving, 1985). The level to which any one aspect of information skills needs to be developed varies with the context of its use but often the degree of skill development needed for completion of an assignment is hidden from both student and teacher until the point of assessment (Irving, 1985). Consequently, Irving calls for teachers to gain greater awareness of the skills involved in studying his or her subject in order that both content and process skills can be developed through appropriate learning tasks.

In the past it was assumed that, to some extent, process skills would develop in the course of repeated experiences of independent project work, even in the absence of specific instruction (Marland, 1978). Although project work has been tried and found to be wanting, there is ample evidence that it is widely used throughout elementary and secondary schools. Writing in 1987, Marland commented that projects are set in abundance for students aged 7 to 17 "with no noticeable increase in skill apart from the cover pages which are rather more carefully done by the 17 year olds" (p9). Consideration of the foregoing discussion suggests that this type of resource-based learning carries with it a potential for self-directed, individualized learning that looks tremendous but Marland (1981) suggests that "it is fair to guess that the pupils who attempted those assignments found them both more difficult and less educative than they should have been; it is also fair to guess that the teachers were at least somewhat disappointed in the results".

It has been noted previously that the product of project work has often been regarded as more important than the process by which information was collected and that the demands of such tasks are often hidden from teachers. Avann (1986) voices an increasingly common opinion that project work should be undertaken with the idea that the skills gained in the process of completing it are at least as important as the content area. Indeed, Irving (1981) states that "learning about a subject is less valuable in the long term than learning how to learn... Knowledge changes and increases but the skills for finding and using information are of life-long value" (p9). However, changes in philosophy promoted by theorists are often slow to filter down to those working directly with students and teachers' expectations of the learning involved in project work are as varied as definitions of resource-based learning in general. Beswick (1977) says that all its variants assume that the student will learn from direct experience of resource materials and related activities rather than from conventional exposition of these by the teacher. For some, resource-based learning involves closely sequenced, teacher directed programming, for others it means setting activities based on inquiry and discovery techniques with more direction provided by the students themselves. Others again interpret the theory by assuming that such work is to be carried out with the minimum of guidance (R. Gagne, 1977).

In discussing the nature of inquiry, Sheingold (1987) contrasts typical school research tasks with those aimed at producing understanding of something, answers to a question or a solution to a problem. She says that the former frequently centre on a person, place or event and request the child to "do a piece of research on ....". Topics such as Switzerland and, that perennial, Ancient Egypt are merely broad categories which can be itemized according to subcategories (people, religion, geography etc). In Sheingold's experience such assignments result in the student using as few resources as possible, relying heavily on an encyclopaedia and a tending to copy (even photocopy) the pages required. The student knows when the exercise is complete because the required number of resources has been consulted, the required number of pages written and an attractive cover has been made. Moreover, Sheingold complains that all too often evaluation of the work depends on these factors rather than those more central to the intellectual task. Further, the level of topic comprehension students gain by meeting these goals may limit their ability to use the knowledge and result instead in "knowledge telling". This is characterized by unstructured, goalless writing in which students often write anything they know about the topic with little regard to the question they are answering or the audience for whom it is intended.

Where inquiry activities are motivated by questions whose purpose, meaning, or relation to the real world are apparent to the student, task demands are more likely to focus on abilities to restructure the information found to demonstrate understanding of the topic. Irving (1985) holds that if students were given opportunities to impose their own order and structure on material, many more would be able to demonstrate their true ability. However, this requires a flexibility on the part of the teacher to appreciate that not all students will match the topic structure he or she envisaged. Markuson (1986) suggests too, that a focus on higher order thinking skills will produce students who are less inclined to take things at face value and who may equal, if not surpass, teachers in their level of information skills. This may produce some unexpected challenges for teachers, perhaps equivalent to those concomitant with the introduction of computers to classrooms.

Although some teachers put much thought into the design of project work, Irving (1985) notes that broad assignments implying a life-time's research are still frequently set. Further, she says that "far too many pupils are given information tasks by teachers who have no idea whether or not suitable resources are available" (p127). Marland (1987) sees information skills as "illuminating all other activities" (p10) but in many schools the curriculum is fragmented into specialist areas and these important skills are either ignored completely or merely added-on as a separate subject rather than being shown to be an inherent part of science, history, technology etc. Instructional materials which follow the newer approach to information skills are appearing (see Irving, 1981 for a bibliography), but given the small number of trained teacher-librarians here and the fact that about 75% of secondary schools in Britain have allocated library responsibilities to staff with no special qualifications or expertise (Irving, 1985), it is not surprising that old style assignments are still much in evidence.

Successful exercises in resource-based learning place heavy demands on both teachers and students in their search for information and Callison (1986) notes that such exercises require a great deal of advanced planning and trial, in some cases taking several weeks, if not months, of teacher preparation. Issues to be considered include the depth of inquiry required of students, the variety of experiences needed to cater for different abilities, clear learning objectives and criteria for assessment and provision of appropriate resource materials. If thinking skills are to be addressed explicitly in this context, one must also consider how best to use the potential inherent in different phases of the task. Not surprisingly, Lealand (1990) reports that some teachers baulk at the planning effort required but the effects of collaboration with teacher-librarians result in better understanding of their role and greater satisfaction with student outcomes.

Students' information needs are just as complex and specialized as those encountered in public and specialist libraries and positive experiences of learning in an information rich environment require the development of a wide array of information skills. Development of adequate support for their endeavours relies on assessment of the task demands and students' present abilities to meet them. A cognitive view of some of those demands is presented below. Although cognition and metacognition are interdependent, metacognitive skills are not made explicit within that description. Metacognitive research using information seeking as a vehicle for studying thinking is in its infancy. It is therefore more appropriate to devote an entire chapter to drawing together the threads of existing metacognitive research that can be applied in this field. Current empirical research illustrating students' actual experiences with various aspects of information seeking will be discussed in Chapter 4, thus helping focus attention on ways in which the present study aims to extend understanding of the cognitive and metacognitive demands of information retrieval.

The information retrieval process

The earlier listing of components in the information retrieval process (see page 18) is reviewed here in terms of the prior knowledge and some of the process skills assumed necessary for task completion. In any textual presentation of this material it is easy to assume that because items appear in series, the process itself is similarly serial in nature. It is generally agreed, however, that the information retrieval process is replete with loops and iterations (Sheingold, 1987; Irving, 1985; Avann 1986).

Identifying and articulating a need for information

As Sheingold (1987) pointed out, inquiry is driven by questions but frequently the information tasks set by teachers only represent broad categories. Thus the first task the student faces is one of narrowing down or selecting the topic and identifying the information to be sought - rather a difficult task if the parameters of the topic and/or the teacher's evaluation criteria are unknown. Belkin (1980) describes this process in terms of movement from "anomalous states of knowledge" towards specificity.

In other words, initially a person may not be able to detail what information is missing, but knows that more is needed. As information is gathered, the nature of specific gaps in knowledge becomes more focused, concepts are partially formed and it is easier to specify what information is still needed. As Irving (1985) puts it, "unless we know clearly what we are looking for, the exercise of 'finding out' becomes impossible" (p42). While PhD students are likely to receive help in refining an information problem, the sophistication of the task is often overlooked in the classroom.

The student's prior knowledge of the topic is highly influential at this point. It determines whether the terms the teacher uses to discuss the topic are understood, whether alternative terms can be generated and relationships can be elaborated. The extent of that prior knowledge must be evaluated so that the information needed can be identified and questions asked (Irving, 1981).

Framing appropriate questions

It is often assumed that students beginning project work will spontaneously mobilize prior knowledge to generate questions on a little known subject. However, it is common for students to know something, but to be unable to use that knowledge (Sheingold, 1987), perhaps because its relevance to the unknown topic is not self-evident. In addition, the quality of the questions generated is an issue. They must be appropriate, but to what? The topic alone? A specific audience? The system that is about to be interrogated? Miyake and Norman (1979) found that adult experts on a given topic are able to generate significantly more questions on that topic than are novices. No doubt they are also better able to judge the appropriateness or relevance of the questions. It has been noted by Marland (1987) that the usual reason given for failure to complete a Phd is exactly the same as that given by 15 year olds when they fail to complete a research paper - "they find that the question they set out to investigate is too vague to pin down, or impossible to research" (p10).

Cognitive theory endorses Irving's (1985) comment that it is difficult for new knowledge to be absorbed into and linked with existing knowledge if its purpose is unclear or unknown. Thus it is essential that students understand the relationship of the research assignment to their existing knowledge and the manner in which it is expected to add to it. Clearly those able to brain-storm and elaborate the given information to related areas will stand a greater chance of activating prior knowledge and generating relevant questions but many students require help in changing the width of focus of their initial response to assignment topics.

Finding and selecting information sources

Before one can find information sources, one must have some idea of which sources are available and which are most appropriate. (It may be that parts of the problem cannot be solved by information resources at all and Beswick (1977) suggests that a key task for teacher-librarians or other advisers is to help identify these.) Sources include various library materials; books, journals, vertical files, microfiche; people, places, objects and radio, television or video. The older student may also turn to national resources and archives.

To become an independent information user, the student needs to develop an ability to assess which of these sources is the most appropriate to a given problem. Irving (1981) and Cleaver (1987) suggest this demands awareness of the concept of information, its generation and the forms of its storage. The need for flexible use of prior knowledge specific to these issues is evident. Having knowledge about the library system, the collection it houses and ways other systems can be accessed through it, is insufficient for information retrieval success. One must also know exactly where and how to look for specific materials.

The key to discovering where to look is the catalogue, be it computer or index card driven. Catalogue use is often assumed to be unproblematic for casual users (Beal, 1980) but one must remember that indexes have been constructed by information workers whose view of the world is likely to be somewhat rigid since it is influenced by universal classification schemes such as the Dewey Decimal System and Library of Congress. Streatfield (1983) states that "there is a distressing tendency to assume that these arbitrary schemes bear something more than a passing or accidental relation to the reality experienced by people working in various disciplines.... Unfortunately it is only a short step from here to assuming that all fields of knowledge can be consistently viewed in a particular way and are inherently related to other fields" (p227).

To use an index the student must bring his or her language in to line with that used within the classification system (Lancaster, 1972) but a study at Loughborough University found that the majority of tertiary students are unaccustomed to thinking of their information needs in such terms (Beal, 1980). Successful information retrieval depends in part on the user's ability to generate search terms appropriate to both the question driving the information search and the demands of the classification system.

Thus far some of the cognitive problems underlying location of information have been sketched, but what of actually searching text for information? This process is, according to Irving (1981) much neglected. She notes that searching individual books includes cognitive skills such as advanced reading strategies, scanning a page for facts, skim reading for meaning, reviewing one's understanding of what has been read and knowing what should be noted. (Differences in the cognition underlying reading for different purposes will be explored in the following chapter.) It also demands an understanding of organizational aids within books and skills varying in complexity from alphabetization to distinguishing fact from fiction or opinion.

Evaluation of information sources

Evaluation is said to be the most difficult part of information handling for people of all ages (Irving, 1981). Relevance and accuracy of textual material may be assessed through consideration of publication dates or the author's qualifications to write on the topic but much more is implied. The reader must also assess the material in terms of relevance to his or her question, whether it adds to or conflicts with previously acquired knowledge and common sense and must consider consequences for further information searching. As Irving explains, evaluation includes the student's "subjective judgement - what he thinks about the information...[it is] possibly the most crucial element in the process of handling information because it conditions the application and use of any new knowledge" (p12). (Again, metacognitive research, particularly that by Baker (1985) elucidates these issues and will be discussed in the following chapter.)

Extracting relevant information

This phase of information retrieval demands that the reader direct attention to relevant material to identify important points and supporting detail as itemized by Reynolds and Shirey (1988). As Beswick (1981) suggests, a "proper understanding" of reading would illuminate the cognitive demands of this particular task. Moreover, students are often told to make notes but to make sense of this task they must consider the definition of the topic questions, the purpose of the assignment and the audience for whom the finished work is intended (Irving, 1981). Often students are told to make notes in their own words but this may not be possible where the subject is largely unknown and an expert author has already distilled the information to its simplest form. Knowing when to use a verbatim quote implies sophisticated knowledge and critical appreciation of excellent writing (Irving, 1985) but disapproval of any form of copying may discourage its expression by young students.

Processing and presenting information

That information retrieval and use is not serial in character is amply illustrated with respect to processing information. Processing is the last item in Avann's (1986) list but the work actually begins as soon as some relevant material is found. A small section of text may be read, comprehended and evaluated in terms of the research question, what is already known and how the search task must be modified in response to new information. This processing may be fairly superficial but it is bound to add to concept formation. Indeed, Kulleseid (1986), writing from the library perspective, uses schema theory to describe information processing at this point. New text information is said to activate memory schemata (networks of concepts that form prior knowledge), usually through a word or contextual association. The schema most closely allied to the new information may be expanded or modified, or the information may be rejected, perhaps because it has not been understood.

When notes are taken, the information will be subjected to further processing and may be transformed in terms of the student's own language. At the point of processing for writing and presenting information to others, the information user can re-order the material, integrate that from other sources and impose a structure of their own choosing on the subject. Here the emphasis is on making a coherent whole of information fragments and one suspects that at this point that new relationships are recognized and further elaborations made.

The task of presenting a final report requires that the student applies existing knowledge and that gained during information retrieval to the solution of the information problem which initiated the activity (Irving, 1981). This demands the activities that are central to studying yet, as noted earlier, Venezky (1984) says that students' abilities to integrate information from multiple sources have not received research attention. It is outside the scope of this thesis to examine the cognition underlying writing reports but the quality of such reports must depend to some extent on the information skills used in gathering data. To fully understand the nature of information retrieval and use, the entire process must be explored - information itself may provide building materials for knowledge construction but it is what is done with the material that determines the structure and flexibility of the final educational edifice.

SUMMARY

Social and technological changes are underlining the need for all students to acquire sophisticated information handling and higher order thinking skills. While it is generally held that library programmes can contribute to skill acquisition in both of these areas, progress towards that goal is limited by uncertainty about the educational role of school libraries and their staff. Several authors (Liesener, 1985; Beswick, 1983 and Marland, 1987) have called for greater clarity of purpose and imply that the cognitive demands of information retrieval and use can provide a context within which attention can focus on higher order thinking skills. However, the nature of those cognitive demands is as yet poorly understood and Sheingold (1987) holds that while educators do a reasonable job of teaching basic skills, they do not know enough about higher order thinking skills. In addition, teachers' information skills abilities and librarians' understanding of information use have been called into question (Liesener, 1985; Beswick, 1983). While in both Britain and New Zealand many teachers responsible for libraries are far from being information specialists, in the latter steps have been taken to mell expertise from teaching and library professions to create teachers whose subject is learning itself (Gawith, 1986).

The number of these teachers is currently small and they have the task of establishing a role for themselves amongst colleagues who may have little appreciation of their aims until collaborative teaching and consequent student outcomes have been experienced (Lealand, 1990). Although many teachers are aware of the need to focus on processes of learning, the importance of information skills and their inherent emphasis on learning to learn may be given lower priority than acquisition of subject knowledge (Beswick, 1983). The potential of the project method to provide a context in which these two aspects of learning converge will remain unrecognized while its own demands are hidden. It can no longer be assumed that information skills will be developed to a high degree as a by-product of project work experiences (Marland, 1978; Sheingold, 1987) but although the cognitive demands of such assignments are becoming evident, empirical observation from the students' viewpoint is necessary to uncover difficulties which cannot be predicted by adults theorizing from their larger knowledge-base.

However, while such observations may expose the approaches used by students and the circumstances in which they meet with success, something more is needed for the development of adequate information skills training. In the past, study and library skills training have paid scant attention to cognition and even less to the learner's ability to select and monitor strategy use. Metacognitive research literature focuses explicitly on these abilities and training attempts incorporating them have shown much promise in improving student performance, even when used in the normal classroom. Thus it is suggested here that exploration of the metacognitive demands of information retrieval and use will enhance the development of future information skills tuition. The following chapter discusses the concept of metacognition and reviews literature applicable to this task.

CHAPTER THREE

METACOGNITION AND LIBRARY INFORMATION RETRIEVAL

METACOGNITION

Metacognitive theory has a relatively short and some what controversial history. Many researchers distrust concepts which demand awareness of internal processes for their verification and measurement (Siegler, 1983) and in addition, the concepts involved in metacognition suffer from a lack of uniform operational definition (Paris & Lindauer, 1985). That the definitional boundaries of metacognition are often unclear is said to be testimony to the variety of research perspectives currently directing study of the topic. Yussen (1985) gives an overview of the questions arising from each perspective, but those arising from the developmental and cognitive information processing frames of reference dominate the literature and supply the basis of the following discussion.

The developmental view of metacognition is founded upon research by Flavell (1979). Flavell used the term "metacognition" to refer to knowledge of and thinking about cognitive phenomena. He developed a model of cognitive monitoring which illustrates interactions among four components of cognition, the components of which are as follows:

a) metacognitive knowledge - knowledge or beliefs about which variables act and interact in which ways to affect the course and outcome of cognitive undertakings

b) metacognitive experiences - any conscious cognitive or affective experiences associated with thinking (e.g. the feeling of being confused or having solved a problem)

c) goals or tasks - the objectives of cognition and

d) actions or strategies - the cognitions or other behaviours employed to achieve the goals.

Flavell suggests that metacognitive knowledge itself has three elements. He classified these as person, task and strategy variables. For example, one has beliefs about one's own abilities to complete a task. Knowledge about the task itself concerns such things as the familiarity of the material, its organization and its interest value and what these variables imply for management of the task. The third element of metacognitive knowledge focuses on knowledge of strategies and their appropriate application. Flavell (1981) noted also that knowledge can be acquired about interactions between these sets of variables. At a later date (1987) he commented that "this taxonomy is not very satisfactory, but at least it helps in thinking about the domain" (p21).

He also stated that there is no reason to think that metacognitive knowledge is qualitatively different from other kinds of knowledge. It increases gradually with time and experience of particular cognitive domains and can be incomplete or flawed. It also has both declarative and procedural components, that is, elements of knowing **that** something is the case and those of knowing **how** to do something.

Metacognitive experiences and metacognitive knowledge form a partially overlapping set in Flavell's (1981) cognitive monitoring model. Some metacognitive experiences have metacognitive knowledge as their content, others are the result of cognitive outcomes. Many metacognitive experiences are concerned with progress being made on a task and may activate further actions or strategies aimed at cognitive or metacognitive goals. This of course raises the question of distinguishing between cognitive and metacognitive aspects of behaviour. Flavell (1981) classified them on the basis that cognitive strategies are invoked to make cognitive progress, while metacognitive strategies are invoked to monitor that progress (p53). Such a distinction is not always easy to make since the same strategy may be used for cognitive or metacognitive purposes. Further, although the notion of strategies is central to discussion of learning and metacognition, Brown et al (1983) point out that the literature is not particularly clear as to what is strategic and what is not. This issue is of importance to the present study and will be pursued later. At this stage suffice it to say that there is evidence that metacognitive experiences, such as feelings of confusion or puzzlement, do not necessarily lead to application of metacognitive knowledge or strategy regulation. For example Flavell, Speer, Green and August (1981) found that young children sometimes looked puzzled when they heard an ambiguous instruction but did not seem to recognize that this was a signal that a problem existed and action must be taken to solve it. Thus it appears that effective cognitive monitoring depends upon metacognitive experiences being interpreted correctly and used to direct subsequent action.

Although Flavell's distinction between strategies to make and monitor cognitive progress does touch on the self-regulatory processes that are likely to result from the interaction between metacognitive knowledge and metacognitive experiences, his work has emphasised the knowledge about cognition that learners bring to any task. The orchestration of such knowledge components by learners forms the second major focus within the metacognitive research literature.

Psychologists adopting an information processing perspective have termed this undertaking "executive control". There is some agreement that "in the domain of deliberate learning and [in] problem solving situations, conscious executive control of the routines available to the system is the essence of intelligent activity" (Brown, 1977). However, the exact nature of executive control is still in dispute as illustrated by the following quotation from Wagner and Sternberg (1987, p2).

> "There is as yet little, if any, consensus about what executive control is, or even what it is not... Frankly, it is grossly premature to worry about such issues of definition."

Definitions aside, researchers are willing to list the sorts of activities comprising executive control processes. Baker and Brown (1984a) suggest that they include checking the outcome of any attempt to solve problems, planning the next move, monitoring the effectiveness of any attempted action, and testing, revising and evaluating the strategies of learning. Sternberg (1984) suggests that they also involve:

a) deciding on the nature of the problem
b) deciding which performance components are relevant for completing tasks
c) selecting a mental representation for information
d) allocating resources for problem solution, and
e) being sensitive to external feedback.

Brown et al (1983) note that the notion of executive control processes assumes the existence of a repertoire of heuristic routines amongst which the learner can choose. Further, they place emphasis on the dynamic, responsive nature of the control process.

Within this executive system, Brown et al suggest that both automatic and controlled processes exist. The former are fast, not limited by short term memory capacity and require little cognitive effort, whereas the latter are comparatively slow and are limited by short term memory. They are also serial in nature and require a great deal of effort. With increasing age and expertise many effortful controlled processes become automatic. In the event of a cognitive failure and effective metacognitive activity, the learner switches from automatic to controlled processing and allocates extra processing resources to the problem areas (Garner, 1987).

The views expressed above describe expected attributes of executive control processes, but are obviously far from providing a precise definition. Lack of definitional clarity is compounded as the research literature has, in the past, tended to use the term metacognition to refer to both the knowledge and control elements of metacognition, often leaving it to the reader to sort out which is which.

Cavenaugh and Perlmutter (1982) argued that although the two aspects are logically distinct, they are mutually influential. Currently, differentiation between metacognitive knowledge and executive control is seen in the literature as necessary to ensure that similarities and unique features of metacognition are fully appreciated (Garner, 1987). However, it is felt that attempts to discuss the concepts in isolation of each other would lead to over simplification and would deny their close interdependence (Brown et al 1983). Since the study to be reported here investigated aspects of both metacognitive knowledge and executive control processes, these terms will be used quite specifically. The term metacognition will be used to refer to the two elements in combination.

While it is difficult to define the exact nature of the interaction between metacognitive knowledge and executive control processes, qualitative similarities between metacognitive knowledge and other forms of knowledge have been acknowledged (Flavell, 1985). This suggests that consideration of Gagne's (1985) view of the mental representation of knowledge may provide some inkling of how metacognitive knowledge and executive control might be constructed, activated and in turn interact with each other and general world knowledge.

Gagne takes the view that mental representation of knowledge assumes the form of a network, consisting of declarative knowledge units (propositions involving knowing that something is the case) with procedural knowledge (productions involving knowing how to do something) embedded at appropriate places in the network. She says that "one of the most important characteristics of any given unit of information is its relationship to other units" (1985, p40). With regard to metacognition, Flavell (1981) states that metacognitive knowledge also has both declarative and procedural components and Paris and Lindauer (1977) suggest that relationships are at the heart of metacognition since it depends upon the perception of similarities and differences, not only between objects and events, but between mental states.

Gagne also suggests that procedural knowledge is mentally represented as a set of **if-then** conditions and actions. Control is said to pass from one production to the next as the action of the first produces the conditions which prompt the second. Rather than matching exactly, it is suggested here that conditions resulting from one production may be appropriate to a range of alternative productions. Thus executive control processes come in to play to monitor the conditions and predict which of the available productions is likely to be the most economical in terms of cognitive resources, yet the most likely to result in positive achievement. This suggestion is in accord with the view of Spiro, Vispoel, Schmitz, Samarapungavan and Boerger (1987) who reject the rigidly compartmentalized conceptions of knowledge representation often common in schema theory. In contrast, they favour a more flexible representation in which fragments of knowledge are mobilized and assembled to fit the demands of a given context of application.

According to Gagne (1985), use of procedural knowledge is faster than that of declarative knowledge, as the latter requires memory search whereas the former requires pattern recognition and points to related sequences of action. Gagne states that declarative knowledge is relatively static but that when procedural knowledge is activated, information is not merely recalled, it is transformed. Thus, there is a parallel between the way in which procedural knowledge is used to operate on declarative knowledge, or information, and the manner in which executive control processes are assumed to operate on metacognitive knowledge.

As mentioned in Chapter 2, the relevance of schema theory and metacognition to reading and library based learning have been discussed by Kulleseid (1986). They seem doubly relevant in light of the fact (discussed later in this chapter) that information retrieval depends on ability to organize and give coherence to fragments of information as they are found.

Metacognitive abilities

Much of our knowledge about metacognition describes what subjects of given ages know about certain tasks (Yussen, Matthews & Hiebert, 1982). However, Resnick (1989) says that a substantial amount of research now suggests that actual regulation of thinking processes is probably more important to learning than self-knowledge about those processes.

In general terms, there is considerable agreement that metacognition is a function of expertise, experience and socio-cultural milieu (Paris & Lindauer, 1982). The skills involved are said to be late developing (with even college students having difficulty estimating the state of their knowledge under some conditions) but Brown et al (1983) acknowledge that research on early cognition is somewhat limited and tends to focus on what young children cannot do rather than on their positive achievements. In contrast Pressley, Borkowski and Schneider (1987) comment that children are known to monitor and modify strategies well in some situations. They hypothesize that children monitor most effectively given very familiar tasks and settings. Perhaps these are the settings for which declarative and procedural knowledge are more highly organized and perception of relationships amongst these elements is in some way easier. The literature referring to differences between novice and expert performances would seem to bear this out. Indeed, Baker and Brown (1984a) suggest that learners of any age are more likely to take active control of their cognitive endeavours when faced with tasks of only intermediate difficulty, that is, where some appropriate knowledge and ability already exist.

While many studies demonstrate the inefficiencies of children's metacognition, many others show that this can be improved with brief instruction. However, with regard to executive control processes, children in general are said to fail to consider their behaviour against sensible criteria, to follow instructions blindly and to be deficient in the self-questioning skills that would alleviate these inadequacies (Brown, 1980). The extent of their difficulties is described in the literature with reference to differences between good and poor strategy users. Poor strategy use is clearly associated with lower levels of academic performance (Pressley et al, 1987). So what characteristics are generally associated with good strategy use?

Pressley and his colleagues (1987) say there is evidence that the efficiency of working memory is a factor in determining who is likely to be a good strategy user. In particular, they cite the influence of differences in attentional capacity and ability to allocate attentional resources. There is strong agreement that other conditions necessary to good strategy use include having a range of strategies available, having conditional knowledge relating to how, where and when to use each one and having a base of non-strategic world knowledge. In addition to these, Pressley et al consider it essential that the learner understands that good performance is the result of effort, application of appropriate strategies and inhibition of competing behaviours. Whether or not such activities will be brought to bear on a task is said to be dependent upon children's conceptions of what is involved in learning and the role of student motives in determining which strategies will be used (Biggs & Telfer, 1987).

However, it was noted earlier that there is little consensus on just what is strategic (Brown et al, 1983). In accord with the previous discussion of Gagne's (1985) view of knowledge representation, Alexander and Judy (1988) state that strategies are a variety of procedural knowledge that can vary in degree of generality or separation from a specific content area. An earlier view held that cognitive strategies were essentially content free (R. Gagne, 1977) but Alexander and Judy's position is currently supported by researchers such as Brown et al (1983), Dansereau (1985) and others. In terms of education, effective learning strategies are described by Dansereau as sets of processes or steps which facilitate acquisition, storage and/or utilization of information. Flavell (1981) would no doubt add that they can serve cognitive or metacognitive purposes and their goal-directedness is certainly well acknowledged in the literature. For further clarity, Pressley, Forrest-Pressley, Elliott-Faust and Miller (1985) point out that most observers would agree that strategies are operations over and above those that are natural consequences of a task, for example, word seeking and page turning when reading cannot be considered to be strategies but scanning or skim reading can be.

The attributes of strategy employment are the major focus of disagreement amongst researchers. The critical question seems to be whether or not deliberate use should feature in the definition of strategies. Deliberate use implies appreciation of the effects of strategies, yet recent studies have shown that children's use of strategies is not always tied to such understanding (Pressley et al, 1985). In addition, Pressley et al question whether the conscious employment of a strategy by a novice in a field should be considered more strategic than the automatic use of the same strategy by an expert. They hold that it is becoming generally recognized that "strategy functioning at its very best has a mindless, reflexive character to it" (p3). Thus some researchers argue that deliberate conscious use is not a defining feature of strategies. However, there is agreement that strategies are almost always potentially conscious and controllable, with automatic processing reverting to the conscious level when suggested by metacognitive outcomes (Brown et al, 1983). In addition, Garner (1988) claims that to be considered strategic, action must be selected by the learner from a range of alternative activities intended to attain a goal. The emphasis she places on this point implies that conditional knowledge of when to use a given strategy is an integral part of strategy use, thus supporting the notion of deliberate application as a defining feature and including in that a metacognitive element.

Garner (1987) defines strategies as sequences of activities, rather than single events, noting that these depend upon acquisition of component processes and a routine for organising them into strategic wholes. This view echoes that of Bruner, Goodnow and Austin (1967) who state that "a strategy refers to a pattern of decisions in the acquisition, retention and utilization of information that serves to meet certain objectives, i.e. to insure certain forms of outcome and to insure against certain others" (p54). Garner takes this one step further by commenting that when strategies have been learned to the point of automaticity, they are better labelled as skills.

Consideration of the development of procedural knowledge as discussed by Gagne (1985) and its later organization into strategies as implied by Bruner et al (1967) suggests that metacognition must be involved in strategy formation rather than being applied only after the event, if at all. Differences in the degree and quality of metacognition brought to bear on action sequences would perhaps account for differences in ability to devise strategies independently of instruction. Garner (1988) makes the comment that defining strategies in unitary terms results in observations of users and non-users. This denies access to the information necessary to fostering development of strategies and combinations of strategies. Seeking information about the role of metacognition in the development of strategies as well as their later application would thus seem to be fruitful.

It should be noted that Brown et al (1983) say recent reviews have "justly criticised the literature for encouraging the dubbing of any strategic action as metacognitive" (p107). These authors imply that strategies can exist without a metacognitive component. Consideration of the foregoing discussion reveals a picture in which strategies are necessarily metacognitive but metacognition does not necessarily require complete strategies upon which to operate. Systematic activities are often referred to as strategies according to Brown et al but definitions which emphasize planning and constant monitoring of these suggest that the glue that holds the components together may well depend on metacognition and the perception of relationships between objects, events and mental states.

In arguing for the exclusion of deliberate use from the definition of strategies it was affirmed that children have been observed to apply "strategies" with little understanding of their outcome (Pressley et al, 1985). To account for such events Snowman's distinction between tactics and strategies will be adopted here (cited by Biggs & Telfer, 1987). Snowman defines tactics as short term manoeuvres during learning that are really orders to be followed whether or not they are understood. Thus the same behaviour can be strategic or tactical, depending upon the learner's metacognitive activity.

As illustrated above, the literature concerning strategy use is often confusing. Not only is the definition of strategies in dispute but a quick perusal of the literature reveals a bewildering array of competing category labels for strategies, many of which are just as poorly defined. For example, Dansereau (1985) uses the terms primary and support strategies, Weinstein and Mayer (1986) discuss eight categories of learning strategies related to acquisition, organization and monitoring activities. Pressley et al (1987) prefer goal specific, monitoring and higher order sequencing strategies. There are similarities in the usage of many of these terms but their proliferation serves most to illustrate the fuzzy nature of the concepts being dealt with. Certainly, strategies differ in function but there is as yet no consensus on describing those differences. If one accepts Flavell's (1981) classification of cognitive and metacognitive strategies (to make and monitor progress on tasks) one point becomes clearer. As Pressley et al (1987) note, good strategy users rarely apply goal specific strategies in isolation, rather they combine these with strategies serving metacognitive goals to plan and monitor effective execution of complex sequences of action, that is, cognitive and metacognitive strategies go hand in hand. For example, Belmont, Butterfield and Ferretti (1982) detail seven studies demonstrating that important transfer can be achieved only when aspects of metacognition (i.e. strategy planning and self-monitoring) are explicitly included in the training attempt. In terms of the foregoing discussion, training attempts omitting metacognition have focused on encouraging the use of tactics, not strategies.

In sum, metacognition was used by Flavell (1979) to refer to knowledge of and thinking about cognitive phenomena. The notion of executive control processes being essential components of metacognition was developed from the cognitive information processing perspective. The terms still lack uniform operational definition but allow reference to knowledge and abilities which have far reaching implications for education. Tuition which gives explicit attention to the metacognitive aspects of learning has had dramatic effects on performance in a wide range of situations and holds much promise for guiding attempts to enhance teaching methods.

The dispute over deliberation and conscious use as features of strategic action is put in perspective when one considers the role of metacognition in developing procedural knowledge and recognizing patterns of decisions. The relationship between decisions made and subsequent outcomes is metacognitive in nature. Thus the routine Garner (1987) refers to as organizing single events into strategic wholes is heavily dependent upon metacognition. Recognition of the conditions appropriate to a given strategy sets off a chain reaction which proceeds smoothly and easily until an unexpected condition arises. Cognition slows down as the implications of that condition are weighed and consequently strategy use can be regulated.

The emphasis on strategy use throughout the literature could result in the assumption that because able students differ from less able ones in strategy application, success is entirely due to that use (McKeachie, 1988). Drawing attention to the wider context of learning and interactive nature of learning variables, McKeachie suggests that able students may use different strategies because they have a good grasp of the material and are therefore better able to use more sophisticated strategies. This takes us back to the conditions seen as necessary for metacognitive activity - expertise, experience and socio-cultural setting. Socio-cultural setting provides a climate conducive to reflection and experience will presumably allow acquisition of the declarative and procedural knowledge that provide the basis for strategy development. Expertise is characterized by the degree of knowledge organization achieved by the individual and this is well illustrated in studies of novice and expert performance (for example Chi, 1981).

The independent project work to be considered in the present study requires knowledge of the information retrieval process and of the content area selected for learning. In most cases the aim of such tasks centres on increasing student knowledge of content, thus the learners are unlikely to have a "good grasp" of the material initially and perhaps good strategy use is not possible for this reason alone. However, the students have probably been subjected to library skills tuition, which will at least have provided them with a range of tactics and their own inventions, even if fully developed strategies are not available. The demands of managing the complex problem solving necessary to library information retrieval are largely unknown. In the absence of an existing description of those demands, one must look to research in related fields and try to specify the ways in which information retrieval differs or is similar.

At the very least library information retrieval and use demands that skills associated with reading comprehension and studying be combined. Both of these areas have received considerable attention from those investigating metacognition and it is to these that we now turn.

The demands of reading

At one time, text was assumed to be understood when the reader could pronounce words correctly and naturally (Venezky, 1984). More recently, reading has come to be seen as a constructive process, success in which depends largely on the reader's ability to organize, interpret and integrate information. This contributes to the conception that reading is an extremely interactive phenomenon, with text-based aspects being processed simultaneously with those of prior knowledge and context. Moreover, Garner (1987) points out that acceptance of the notion that information from sensory, syntactic, semantic and pragmatic sources is available simultaneously rather than serially, allows one to assume that a process at any level can compensate for deficiencies at any other level.

Spiro and Myers (1984) hold that reading can be shown to involve the full range of cognitive activities from visual perception and verbal memory to logical reasoning and highly heuristic and judgemental problem-solving. Readers process information as a function of the purposes for which they read, the demands of those reading tasks, the type of text, its structural characteristics and the relative familiarity of the content. Individual differences in reading ability can be described in terms of:

a) text-based processing
b) knowledge and context-based processing,
c) interactions between (a) and (b)
d) the control processes that manage the system (Spiro Myers, 1984).

Wagner and Sternberg (1987) state that the most important facet of the executive control of reading is the "ability to determine how and where to apply one's reading resources in order to maximally reach one's comprehension goals in a given situation" (p2). More specifically, Yekovich and Walker (1987) include in their list of executive control responsibilities the coordination of component reading processes, coordination and allocation of cognitive resources, and selection and use of knowledge to fill gaps in the text. It should be noted that even well-written texts only reveal part of the author's mental representation of the content and reader's efforts are directed towards constructing a plausible representation of this for him or herself (Resnick, 1987).

Referring to the purposes for which people read, Anderson and Armbruster (1982) say that although children may appreciate the constraints associated with various reading tasks, they know much less about the strategies necessary to fulfilling different reading goals. Guthrie and Hall (1984) acknowledge that children's conception of reading and its purposes has a vast effect on their learning. This is illustrated by Garner and Anderson's (1982) statement that younger and poorer readers, compared with older and better readers, are more likely to miss the meaning-getting purpose of reading and to fail to demand informational coherence and consistency from text. Such children tend not to engage in comprehension monitoring activities but while this is associated with poor comprehension, it cannot be assumed to be the sole cause of it. Baker and Brown (1984b) speculate that poor comprehension may itself reduce monitoring ability or a third factor such as impoverished background may be responsible for both problems. Further implications of overlooking the goal of understanding text are highlighted by Resnick (1987) who observes that the habit of meaning imposition, that is a tendency to elaborate and seek relationships, has emerged as a major candidate for explaining why good learners in one area tend to be equally good in other areas of learning.

Comprehension itself is a complex phenomenon. Lunzer, Waite and Dolan (1979) broadly define it as penetration beyond verbal forms of text to the underlying ideas, comparison of these with what one already knows and also with one another, abstraction of essential and new information and finally, revision of one's previous conceptions. In terms of meaning imposition, Resnick (1987) holds that it requires linguistic and topic or content knowledge, knowledge of rules of inference and of conventional rhetorical structures, all of which must be coordinated and monitored. Prior knowledge is highly influential in comprehension processes in that the schemata a person holds are considered to be the principal determinants of what will be learned from text (Garner 1987). Although the nature of schema activation is not completely understood, Anderson and Pearson (1984) cite evidence that schema selection is often based on rules of inference and this influences the amount and nature of later information recall.

While acknowledging the role of inference in comprehension tasks in general, Samuels and Kamil (1984) make a distinction between forms of comprehension requiring different degrees of inference. In the case of literal comprehension all the information to be retrieved is provided in the text but in what Samuels and Kamil term inferential comprehension, the reader must go beyond the information provided. Some support for this distinction comes from Cole (1979) who says "...experience tells us that pupils can often complete the written work which they are required to do without understanding the passage they have been asked to read, simply by scanning for the 'answer' somewhere in the text" (p151). The children apparently have comprehended enough to be able to recognise the 'answer' but the level of understanding is superficial. This is in accord with Baron and Sternberg's (1987) observation that students are generally able to read for literal meaning but that their performance is significantly poorer when asked to infer, integrate and evaluate information.

Inference has a role in comprehension monitoring also. Baker and Brown (1984b) point out that less experienced and less successful readers tend not to engage in cognitive monitoring activities and in the case of comprehension, Pressley et al (1987) conclude that many monitoring errors are due to incomplete text processing. In agreement with Brown (1977) they say that children fail to use the inferential, constructive processing techniques commonly used by adults. Empirical support for this is cited by Anderson and Pearson (1984) to the effect that younger children are "simply not predisposed to draw inferences spontaneously". Brown (1977) observes that children's difficulties are compounded by the fact that their knowledge is often inconsistent, incomplete and more poorly organised than that of adults. This factor, rather than memory capacity or control mechanisms, has been implicated in accounting for differences in the quality of inferences drawn by five and eight year olds (Anderson & Pearson, 1984).

The basis of three major types of comprehension failure is described by Baker and Brown (1984a) and reflects the foregoing discussion:

a) The reader may not have appropriate schemata available, that is, he or she lacks the knowledge to impose an interpretation on the text
b) the reader has appropriate schemata available but the author has not provided enough clues to suggest them
c) the reader creates a consistent interpretation of the text, but not the one the author had in mind.

This may result in the reader being completely unaware that comprehension failure has occurred.

Baker and Brown observe that when critical reading is the purpose of the task a fourth type of comprehension failure may occur. The reader may match the author's intended interpretation of the text but may fail to consider other interpretations. A more detailed, but highly similar, account of knowledge-based processing failures is provided by Spiro and Myers (1984).

Another important factor in comprehension concerns the actual information presented in a text. As noted earlier, the structure of text and its familiarity to the reader do influence comprehension. Indeed, Hartley (1987) has examined the influence of typographical layout and errors on reading processes. He argues that layout can facilitate the reader's more global and conscious decision making. For example, spatial and typographic cues are used to group relatively large chunks of text and to sequence them appropriately. He says there has been very little research on typographic setting of features such as headings, summaries, contents pages and boxed material etc but these can cause confusion for children. He concludes that children need instruction in the typographical conventions that adults take for granted. Certainly Brown, Armbruster and Baker (1984) agree that expert learners use such features to help them concentrate on essential information and say that even college students sometimes need specific training to enhance their use of text structure as a learning aid. Hartley points out that designers of texts are asked to provide a single solution to serve multiple reading goals and differences between individual readers. However, he concludes that publishers and designers have remained "peculiarly resistant" to the notion of individual differences in readers (p59).

While one's understanding of instructions can be tested by mentally or physically carrying them out, comprehension monitoring is more difficult as the criteria for successful monitoring are not as explicit. Most researchers treat comprehension monitoring as a unitary concept although they acknowledge that comprehension itself has several dimensions. In contrast Baker (1985) argues that the reader independently selects from among three basic standards to evaluate comprehension. These are lexical, which centres on individual words in isolation of the text; syntactic, which is concerned with grammatical constraints such as word order; and semantic, which centres on meaning of sentences and text as a whole. She notes that semantic and syntactic standards are inter-related since syntactic errors result in semantic ambiguity. The lexical standard is seen to be necessary but insufficient to comprehension and Baker notes that failure to meet a lexical criterion for understanding does not always result in the need for regulatory action. The efficient reader has metacognitive knowledge relating to which words are central to a point and which can be safely ignored if unknown, for example unknown adjectives may be ignored but nouns cannot.

One difficulty children experience with text concerns its coherence and consistency. Brown, Armbruster and Baker (1984) consider children's failure to think about such issues to be a common short-coming of their comprehension monitoring and say that even college students have difficulty with these aspects of reading. Although primary school children may be able to evaluate their understanding of single sentences, they need to develop skills to integrate and evaluate larger portions of text. Indeed, a study by Garner and Taylor (1982) demonstrates the difficulty of this task. The researchers even underlined two conflicting sentences and told students that they did not make sense but high school students were still unable to explain what was wrong! In discussing the basis of this type of processing failure, Spiro and Myers (1984) suggest that integration of information across segments of text requires activation of the correct schemata for a longer period than is required for understanding a single sentence.

Children's difficulties in integrating information across sentences are also reflected in Baker's (1985) identification of five types of semantic evaluation for comprehension monitoring. The types and what they involve are as follows:

a) propositional cohesiveness - checking that neighbouring propositions can be successfully integrated
b) structural cohesiveness - checking that ideas are thematically compatible
c) external cohesiveness - checking that ideas are consistent with existing knowledge
d) internal consistency - checking that ideas are consistent with one another, and
e) informational clarity and completeness - checking that the text states all of the information

necessary to achieve a specific goal (Baker, 1985; p156).

This highlights the major role that prior knowledge plays in reading processes. Further, it may seem unreasonable to expect young readers to use such sophisticated standards for evaluation of comprehension but although they are rarely told what criteria they should use and rarely receive explicit feedback about their efforts, Baker (1985) reported that children across a wide age range can effectively evaluate their understanding using multiple standards. Her examination of which standards are used is most interesting. Using expository material, she found that "many more younger and poorer readers never used the internal consistency standard" (p198). Moreover, many 4th and 6th graders relied exclusively on the lexical standards and never identified problems other than those at the individual word level. This finding supports the earlier comment that many children miss the meaning getting purpose of reading and this in turn must influence critical reading abilities.

Looking at an older group, Baker found that for college students the frequency of application of specific standards was influenced by the type of instructions given before the reading task rather than by their level of verbal ability. General instructions most frequently elicited use of the lexical and structural cohesiveness standards with the informational completeness standard being used less often. The semantic standards concerned with propositional and external cohesiveness and internal consistency were rarely used at all. In fact, college students' use of an external consistency standard was lower than that of the younger students! Baker speculates that this may indicate a negative correlation between years of school attendance and a tendency to challenge the truth of what one is reading. She bills this as "an unfortunate by-product of the 'answer is in the book' school of instruction" (p198) and it is seen here to be one which influences the outcome of attempts to find and use information.

Baker (1985) also observes that both adults and children tend to use a smaller range of standards of evaluation when they are not given specific instructions about which to use. She concludes that "children are not typically taught how to evaluate and regulate their own comprehension; hence they do so ineffectively if at all. They are not encouraged to critically evaluate what they read, hence they accept text as given" (p198).

An essential element of critical reading is that it involves going beyond the information given and being aware that authors write for different purposes (Baker & Brown, 1984a), that is, it demands inferential comprehension. While most elementary school curricula include units in critical reading, instruction is often, in the opinion of Lunzer and Gardner (1979), inadequate and limited to a specific class period, thus limiting generalization. In addition, Baker and Brown comment that such instruction is sometimes postponed until the children are fluent readers, by which time they may already have learned to accept the printed word as truth.

The above discussion of comprehension monitoring can be summarized in accord with the activities described by Baker and Brown (1984b) as being essential to good comprehension. One must first establish the purposes for reading then modify reading rates and strategies in light of that purpose. Important elements in each paragraph must be identified and prior knowledge used to interpret new information. One should capitalize upon the logical structure inherent in the material and must show sensitivity to contextual constraints. Appropriate standards for evaluation of understanding must be selected and comprehension failures must be dealt with. Naturally, this assumes that the reader has a range of strategies or heuristic routines available to cope with comprehension failure as well as those appropriate to executive control.

Brown, Armbruster and Baker (1984) imply that expository and narrative text are equally predictable in structure but Garner (1987) argues that the structure of expository text is not inherent, rather it varies with the communicative intention of the author. Thus, the reader must extract the specific content carried by a proposition (microstructure) and then derive the overall gist (macrostructure). However, selection of the main points for inclusion in the macrostructure presents difficulties when people read loosely structured texts with no clear goals in mind. One might expect school materials to be clearly structured but it has been suggested that this is not the case. Anderson and Armbruster (1982) say that school texts are often "inconsiderate" in that authors frequently fail to provide adequately structured, coherent and information appropriate text. Baker and Brown (1984b) agree, adding that "sensitivity to such problems is an important component of comprehension and critical reading" (p27). Moreover, Beck and McKeown (1989) point out that where prerequisite knowledge is lacking, the degree to which the language used makes the nature of ideas and their relationships apparent, and the degree to which the sequencing of those ideas makes sense, becomes extremely important. Even at basal reader level, expository texts "frequently call for significant amounts of prerequisite knowledge" and in their opinion, the brevity of the expository sections often fails to support the development of the schemata necessary to comprehension of the content.

The above has discussed ways in which purposes of reading, the demands of the task and the nature of the text itself influence comprehension. When comprehension is proceeding smoothly few conscious metacognitive experiences will occur but a lack of prior knowledge with which to interpret the text, the provision of illogical information in the text or provision of insufficient information can all trigger more controlled comprehension monitoring. For example, if remedial action is necessary the reader may choose to re-read, look ahead or store the confusion in memory until the author provides clarification. On the other hand, the reader may seek alternative external sources of clarification (other books, people etc) (Baker and Brown, 1984b).

In general however, children seem to lack some of the metacognitive knowledge and executive control skills necessary to reading comprehension. Their executive skill deficiencies are summarized by Anderson and Armbruster (1982) as being associated with comprehension monitoring, prediction of task difficulty, recognition of changing levels of difficulty and, in relation to learning from the text, prediction of test performance and study time apportionment. Similar difficulties extend to selection of important points from text, to prediction of strategy appropriateness and evaluation of strategy use. This summary of deficiencies reflects the overall negative emphasis of the research literature with regard to children's metacognitive abilities and is not particularly encouraging. That their abilities in these areas can be improved is apparent from recent literature on self-questioning instructional research. It is outside the scope of this review to detail that research but Wong (1985) provides an excellent review which clearly indicates that, under certain conditions, attention to self-questioning aimed at activating prior knowledge and encouraging metacognition has a positive effect on prose processing.

Although reading is necessary to library information retrieval and use, something more is required. At the very least it also demands skills akin to those used in studying. In turn, according to Baker and Brown (1984a) studying requires more than reading for meaning. It demands that the learner make a definite effort to render the material memorable as well as comprehensible. The implications of this additional task demand will now be discussed briefly.

The demands of studying

It appears to be widely accepted that studying is a major factor in educational success (Schumacher, 1987) yet Schallert, Alexander and Goetz (1988) found that although students may be told what they should study, they are rarely told how they might do so. Further, according to Spiro and Myers (1984), children often experience difficulties moving from narratives to expository text material and this may be the result of their never discovering what is meant by the vague instruction to "learn about x". Studying usually implies that resultant learning (or lack thereof) will be tested in some way and it is this that sets reading for study purposes apart from reading for meaning (Anderson and Armbruster, 1984).

The ways in which text is processed to make it memorable have been the focus of the bulk of research on studying. However, Anderson and Armbruster claim that empirical studies of students' techniques have failed to confirm the benefits of most popular strategies. They suggest that this is because within research designs the need to match learning activities to criterial task demands has been largely ignored. Furthermore, they say that as the learner's knowledge of the criterial task demands decrease so too does the effectiveness of studying techniques. The corollary of this is that "almost any study technique can be effective, if its use is accompanied by focused attention and encoding in a form and manner appropriate to the criterion task" (Anderson and Armbruster, 1984, p 236). Baker and Brown (1984a) support this view with comments to the effect that if a child is unaware of what is needed to perform effectively, it is unrealistic to expect him or her to take steps to meet the demands of the learning situation adequately. The difficulty is compounded if the child is also unaware of his or her limitations as a learner. This of course, highlights the role of metacognition in studying and one suspects that paucity of attention to this aspect of learning is another contributor to the lack of confirmation of the benefits of popular study techniques. In light of the earlier discussion, it appears likely that much of the training literature refers to study tactics rather than study strategies which include metacognition and conditional knowledge of use.

Reading for meaning and efforts to make the material memorable to facilitate performance on a later learning task are key aspects of studying but several other characteristics deserve consideration. In the typical research task the delay between studying and a subsequent test of learning is relatively short and the material to be studied is usually novel. In school or college, however, studying is frequently characterized by:

a) the relatively large quantity of material to be processed
b) the fact that much of the material may have been processed once already
c) variations in the quality of earlier processing and the degree of integration achieved across topics
d) the passage of a considerable period of time since the initial reading, and
e) having encountered considerable new information since the initial reading (Spiro and Myers, 1984).

Whether the material is novel or being revised, the metacognitive demands of studying include the ability to concentrate on the main ideas, to apply strategies to aid learning and to monitor their effectiveness as well as progress on the task according to some internally generated criteria, since explicit external criteria are rarely available (Baker & Brown, 1984a; Spiro & Myers, 1984).

The ability to sort important points from trivia features in several of the accounts of studying referred to previously. This is small wonder when one considers that a single expository text page may contain more than 50 ideas that can be interrelated in a variety of ways. The task of studying a single chapter in light of this could easily appear overwhelming (Anderson & Armbruster, 1984).

To aid learners in their bid to determine the main points of text, Baker and Brown (1984a) suggest that one should capitalize on the inherent structure of the text. However, they note that children have difficulty detecting even flagrant violations of logical structure. In addition, as previously discussed, the structure may not be obvious to the learner and Spiro and Myers (1984) maintain that any conceptual domain is bound to be ill-structured until one has sufficient knowledge of it to recognize which organizing principles should be applied. Anderson and Armbruster (1984) have summarized research findings which suggest that despite this difficulty, students "naturally spend more time on text segments that are relevant to learning goals" (p225). It appears that some students process the entire text in a general "reading to comprehend" mode but that when a sentence is encountered which is relevant to the criterion task, they increase cognitive effort and inspection time for that segment. In support of this, Reynolds and Shirey (1988) argue that text elements become important when they relate to the instructions or objectives stated before studying begins, when they are relevant to the student's perspective or are interesting to the reader. Importance also rises when authors provide explicit cues and when text elements represent conceptual or relational links between several text elements and ideas. Finally, Reynolds and Shirey agree with Baker and Brown (1984a) that text structure also conveys importance. However, Winograd and Bridge (1986) have commented that researchers still do not really understand how fluent readers identify important points from text.

Summarizing developmental differences in metacognition underlying reading and studying, Brown, Armbruster and Baker (1984) have found that novice readers have difficulty distinguishing between easy and difficult texts, identifying contextual constraints on meaning and identifying the structure of text. They also have difficulty identifying anomalies and confusions in texts and in sorting important points from trivia. Further, even college students do not find identification of the main points of text easy, yet school children are commonly asked to concentrate on just these points when reading and studying. Baker and Brown (1984a) maintain that lack of critical reading skills is a barrier to the development of such study skills.

The types of activities frequently undertaken to make text information memorable include underlining, note taking, summarizing, student questioning, outlining, elaboration and diagrammatic representation. Anderson and Armbruster (1984) conclude that of these, techniques which force the student to identify or impose relationships which convey meaning of the text have a greater potential for effectiveness. In contrast, Mayer (1988) observes that while learning strategies such as underlining aim to focus attention on certain kinds of information, they may also serve to limit attention and reduce the potential for noting relationships and forming connections between information units. One could imagine that this would be especially true where the learner is unable to identify main and subsidiary points accurately.

Whilst children's abilities to apply study strategies, both spontaneously and following training, are of importance to the overall outcome of information retrieval and use, the present study focuses only upon the skills needed for the first part of this process, that is, assembling the material upon which these strategies will be used. Therefore, it is inappropriate to discuss study strategies in detail. Suffice it to say that readers capable of high levels of comprehension, compared with those achieving lower levels, have been found to identify significantly more main ideas from text and to process them in a manner which aids recall. However, both groups were found to be equally able to identify the necessary techniques and strategies, although they did not always use them as claimed (Phifer & Glover, 1983). With regard to strategy effectiveness, Nolan, Meece and Blumenfeld (1986) found that students at all ability levels could recognize effective strategies but that only the better students could distinguish differing levels of effectiveness. They conclude that students' perception of the utility value of given strategies is dependent upon their level of achievement, self-competence, motivation and perception of the learning situation and its demands.

Evidence of developmental differences in the application of learning strategies leads Reynolds and Shirey (1988) to conclude that even good readers at high school level are not able to make use of the same types of study strategies used by college level readers. They agree with Baker and Brown (1984a) that immature learners do not make effective use of attention allocation, and indeed can hardly be expected to do so since they have difficulty determining which points are important. These younger children tend to reread text in order to learn it, while older children will underline or take notes (Baker and Brown, 1984a). However, one must remember that the nature of the text itself also exerts an influence on strategy use. Amongst high school students, strategy use decreases for good and poorer readers as text difficulty increases (Olshavsky, 1976-77, cited by Baker and Brown, 1984a).

The above discussion deals with the reading task underlying studying and alludes to the learning strategies used to make material more memorable. When reading for meaning, the metacognitively active individual constantly evaluates his or her level of understanding, sometimes by posing self-questions. In the case of studying, this self-interrogation must be extended to identification of the main points (i.e. getting the gist of the text), to selection of strategies appropriate to the task used to assess learning and to checking readiness for that test. In brief, strategies must be activated to serve the following functions:

a) clarification of the purposes of reading, i.e. explicit and implicit task demands should be understood
b) activation of relevant background knowledge
c) allocation of attention to major points, not trivia
d) critical evaluation of text content for internal and external consistency
e) monitoring of on-going comprehension, and

f) inference testing to allow interpretation, prediction and forming conclusions (Brown, Palincsar and Armbruster, 1984)

It is evident that some students have difficulty with particular items in this list and no doubt find integration of the full range of strategies is far from easy. However, information retrieval for independent project work adds yet another level of difficulty.

The demands of information retrieval

So little is known about the actual demands children face when retrieving information from library systems that much of what follows must be speculative. Clearly, they face all the demands associated with reading for meaning but the reading task itself is complicated by the nature of information retrieval. Firstly, the materials encountered during classroom reading tasks are likely to have been selected with careful regard for the children's reading abilities. Those found independently may challenge even the best readers. Secondly, classroom materials may have been chosen to build on the level of prior knowledge known to exist in students. In the library the students may pick relevant texts that assume a far higher level of prior knowledge, thus reducing their ability to impose meaning. Thirdly, in class, reading tends to be in short bursts of about 15 seconds, yet to find information for a project the student must read and reflect upon substantial pieces of text (Lunzer and Gardner, 1979). Dolan, Harrison and Gardner (1979) found that the greatest incidences of continuous reading in class actually occurred when children were reading between class activities. Further, they found that "experience of meaningful reading" across the curriculum becomes stabilized or even regresses during the first year of secondary schooling (equivalent to Form 1 in New Zealand) and is of low priority throughout the pre-examination years (p135). Added to this, reading speeds tend to be far slower than adults expect and of course, the students have to weave their way through the library organization system to find the books in the first place. Thus, where teachers are unaware of these complications, time allowed for library work may be insufficient to produce much information. For example, one teacher was heard by the author to complain when, after a mere five minutes, Form 1 students had failed to find anything about ancient Egypt!

Not only must the learner read for comprehension but information gathering for later use dictates that additional short term reading goals be met. Lunzer (1979) describes four styles of reading which embody these. In his description receptive reading equates to reading for meaning and involves immediate on-going interpretation, much like listening behaviours but in absence of the socially provided cues which aid comprehension monitoring. Reflective reading is characterized by application of critical reading skills with frequent pauses for reflection. To establish an overview of the text the reader may skim read rapidly and finally he or she may just scan the pages for specific words or information units. Children embarking on independent project work may be told to skim or scan but there is little evidence that they understand what is in involved in these. For example, Myers and Paris (1978, cited by Baker & Brown, 1984b) found that 6th grade students assumed skimming to involve reading informative words, whereas 2nd grade students focused only on easy words when skimming. The situation is further complicated in that the efficient information seeker must switch between these reading styles rapidly as dictated by the content of the text and its relevance to the question being researched.

This relationship implies another major role for metacognition in that the relevance of the information encountered is continually changing, both as a function of the learner getting a better idea of the importance of various aspects and as assessment of the growing knowledge base points to explicit information gaps. Indeed, Brown et al (1983) suggest that shifting attention as a response to increments in learning can be used as a non-verbal reflection of on-line monitoring. As in studying, it implies a need for information on the current state of knowledge (i.e. aspects known and not known), knowledge of the task demands of gist recall, knowledge of ordering text elements with regard to their varying importance, and metacognitive knowledge that allows strategies to be marshalled in response to changing demands. The student who is gathering information for subsequent use immediately uses the gist of what is found to direct further information seeking. The sophistication implied is incredible, yet many children face this task with little support.

As previously stated, reading for meaning is a major element in information retrieval and use. How then, is this task likely to be modified in the context of information seeking? Baker and Brown (1984b) state that an essential activity for good comprehension is to determine the purpose of reading. The purposes essential to information retrieval and use include comprehension that leads to concept building and learning such that the knowledge gained can be used immediately to direct further information retrieval as well as providing an overview ofthe topic to aid more extensive processing later. However, Lunzer and Gardner (1979) have found that reading for learning purposes does not figure prominently in students' minds in the early secondary school years. Comprehension itself depends in part upon linguistic and topic knowledge (Resnick, 1987), yet the students are likely to have little of the latter and may be unable to predict which areas of prior knowledge are relevant to the new topic. They have to assess their understanding on the basis of incomplete information. For this reason alone, comprehension monitoring may be impeded and students are likely to find themselves in the position of indulging in "cognitive bootstrapping" (Resnick, 1989), that is, lacking firmly established prior knowledge but having to behave as if it existed.

The kinds of comprehension failure to be monitored are also modified by the task of information seeking. In particular, even where an author has provided sufficient cues to activate relevant schemata and these are actually available to the student, comprehension may fail because reading for information retrieval is highly selective. The university student may select articles and complete chapters to read but the younger student may seek much smaller units of information - relevant paragraphs or even single sentences. Thus although an author may have written a superbly structured and clear text, the Form 1 student is probably not about to read it from beginning to end. Instead, he or she generates some questions then scans the headings, reads a paragraph here and an illustration caption there before passing on, thus maybe missing information essential to concept construction. This pessimistic view may well characterize the child who approaches the task with the aim of "finding the answer" rather than of constructing one.

The interaction between getting enough of the gist of text to aid information gathering and reading to learn about the topic is likely to be complex and indeed, one suspects that often students will be unable to assess the adequacy of the information found until they read it in full and try to use it for report writing. In the situation where a student is asked to "learn about x" Spiro and Myers (1984) suggest that the best approach may be to "tentatively encode as much information as possible in as many ways as possible" until such time that the learner has sufficient data to guide construction of more uniform representation and processing modes. These authors discuss at length the differences between well-structured knowledge domains and entangled domains. They hold that any domain will be represented in memory in an entangled manner prior to learning the principles by which organization is possible. Although Spiro and Myers' encoding instruction is somewhat vague, it seems appropriate to information seeking since the selective nature of this task is likely to increase the extent of domain entanglement. As far as concept building goes, it appears that the selective nature of information seeking could be in conflict with reading to understand relationships between information units.

Problems associated with comprehension monitoring in the face of incomplete knowledge have been noted above. These difficulties extend throughout the range of semantic evaluation standards discussed by Baker (1985). For example, standards of consistency must be constructed that deal with multiple information sources. Detection of inconsistencies within and between texts is an important cue to check sources more thoroughly, yet Baker (1985) found that younger and poorer readers never used an internal consistency standard on a single piece of text. How then, will they cope with two separate books, or even two chapters within a single volume? Critical reading skills are absolutely essential to information gathering but it appears that independent project work may be set considerably in advance of any tuition in those skills.

In sum, reading for comprehension is a complex process which demands coordination of many cognitive and metacognitive strategies. The student reading for information retrieval must some how read for comprehension, allocating more attention to segments of text relevant to his or her research purposes (somewhat akin to studying), but must do so in the absence of an overall view of the topic which would help distinguish between important and trivial points. Lunzer and Gardner (1979) suggest that, when reading for learning, the reader must carry on a conversation with the text, continually asking questions, finding answers and commenting. During information seeking the reader must extend this questioning to consider whether the material encountered is relevant, not only to the question that is driving information seeking, but in light of what has been found to date. However, this is only possible if the information found during the search is remembered in spite of the large amount of additional, and maybe conflicting, information continually being fed into the system. This would suggest that encoding specificity and depth of processing have very important effects on library research outcomes. In addition, the student must assess the implications of information found for further searching. Clearly, this puts a heavy burden on memory and steps to make relevant material memorable will help. At some stage, students usually engage in traditional study techniques such as note-taking and begin to draw together essential information. However, this task must to some extent be tackled mentally during the information gathering stage.

It is apparent that the comprehension purposes of reading in the context of information seeking are circumscribed by the students' lack of topic knowledge, a possible inability to predict which areas of prior knowledge are relevant to it, and the selective nature of the task which may negate structural aids inherent in texts. Guthrie (1982) concludes that basic research on the cognitive processes underlying learning from expository materials has shown that the goals of readers and the structures of texts mediate what is comprehended. In contrast to the limiting factors expressed above, these same materials provide cues which can be used to activate prior knowledge. Whether children engaged in information seeking use titles, contents pages, side headings and indexes in this manner is not known but it would appear that such use would help them identify elements of prior knowledge previously difficult to activate in isolation.

SUMMARY

The foregoing literature review has examined the parameters of metacognitive concepts and focused on the cognitive and metacognitive demands of learning from text, suggesting ways in which these are modified for information retrieval. However, information retrieval demands that students also cope with the vagaries of library systems. The role of metacognition in the library information retrieval process itself was sketched in Chapter 2 but insufficient literature exists to allow discussion in more depth. It is clear, though, that information retrieval puts a double loading on metacognitive abilities. The students must constantly monitor progress on the information location task at the library systems level while also monitoring comprehension and an ever changing knowledge base. Progress in one task determines what will be found in the other and what is found has implications for the future process of information seeking. Where little is known of the topic and the information retrieval process itself, it is unrealistic to expect efficient information seeking. However, children do complete project assignments, if inefficiently.

It has been said that "tasks requiring transfer and coordination of discernible elemental skills" will probably prove most revealing in assessing metacognition (Meichenbaum, Burland, Gruson & Cameron, 1985). The task of information retrieval in the context of school libraries demands that a large array of skills be integrated and therefore it appears to be an excellent vehicle for the exploration of metacognitive functioning.

One recalls Liesener's (1985) comment about the futility of trying to improve the teaching of higher order cognitive and problem-solving skills with a naive view of information use and users. The present study aims to illuminate information retrieval and use through the examination of students' thinking processes. The following chapter reviews relevant studies and demonstrates how information retrieval tasks can be conceptualized for the purposes of metacognitive research.

CHAPTER FOUR

THE PRESENT STUDY

The previous chapters have drawn on literature from information science and cognitive psychology in order to characterize the cognitive and metacognitive demands of information seeking and the context within which they occur. The view that emerges is one of complexity; a myriad of interactive variables which influence not only what information is found, but also what can be learned.

It is hardly surprising, therefore, that as a learning activity, information seeking is best described in terms of a model that recognises the contribution that each variable makes to learning outcomes and emphasises the significance of interactions between variables. As discussed briefly in Chapter 1 (p6) Brown, Bransford, Ferrara and Campione (1983) suggest that the complexities of learning situations can be reduced by considering four interactive sets of variables, the specifics of which change with the particular learning activities of interest. Figure 1 (see below) shows their model as modified in light of tasks demanding information retrieval from library collections and subsquent use of that material.

The model is applicable at two levels. Firstly, it can be used to organise the observational activities of researchers, allowing examination of particular aspects of the learning situation without totally losing sight of their context. Secondly, Brown et al suggest it describes what individuals can come to know about themselves as a learners, that is, to describe the contents of their metacognitive knowledge and the interactions which fuel executive control processes. For example, a learner may believe him or herself to have considerable topic knowledge and high reading ability and on the basis of this metacognitive knowledge can assess the difficulty level of a given book. The result of this assessment may then be used in allocation of reading time and study activities appropriate to the type of test he or she expects to be given.

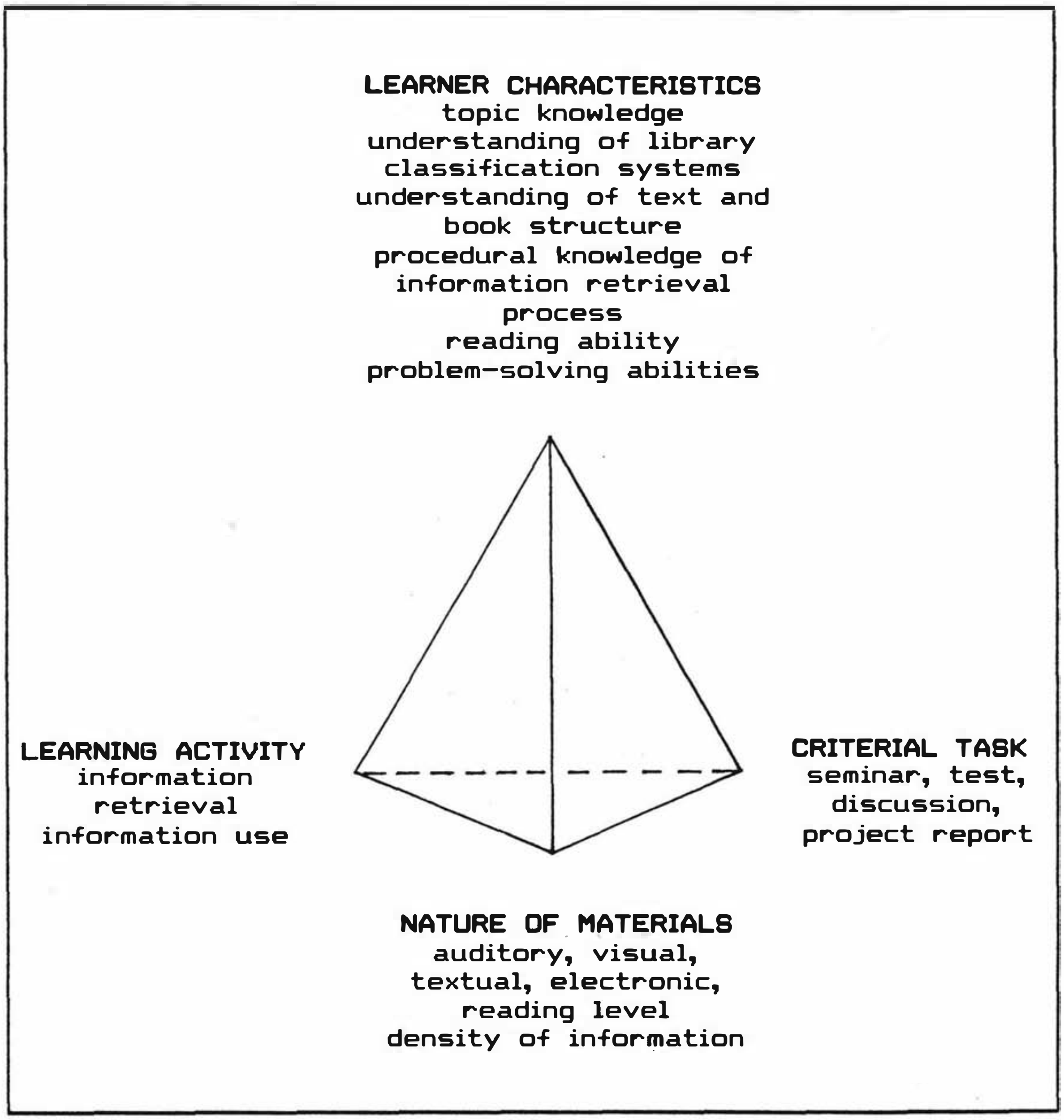

Figure 1: Learning situation variables for the context of information retrieval (After Brown, Bransford, Ferrara and Campione, 1983)

Brown et al's use of the model in conceptualizing metacognition was instrumental in prompting the present study. It was seen to provide a structure and a set of categories through which a learner's self-knowledge and subsequent actions could be analyzed, that is, it provided a possible window on metacognitive knowledge and executive control processes.

A major assumption here was that children would be willing and able to share their thinking. Perusal of the literature uncovered studies such as that by Scardamalia and Bereiter (1983) which demonstrated that children can do so when they are involved as co-investigators of their own mental processes. A small study comparing methods of accessing children's thought processes (Moore, 1987a) subsequently led to the conclusion that think aloud concurrent interviews, conducted in the manner of those by Scardamalia and Bereiter, could be usefully supplemented by retrospective interviews where visual cueing was used to enhance recall.

The verbal data generated by such an approach may be regarded with some caution, as the reliability with which they reflect actual thought processes varies with the nature of the context of data collection. This issue is addressed by Ericcson and Simon (1980) who detail the conditions under which verbal data and thought process are likely to be in accord. The methodological problems associated with data collection and analysis are discussed in detail in the following chapter.

The choice of an on-going task suited to assessment of metacognitive activity also demanded careful consideration. The skills to be assessed have been described by Resnick (1987) as highly complex and demanding the application of many (sometimes conflicting) criteria. They also involve nuanced judgement and interpretation, and yield multiple solutions of differing values. She suggests that tasks selected for metacognitive assessment should call for application of higher order thinking skills in some socially valued endeavour, such that the subject's level of knowledge allows optimum demonstration of those skills. Further, Meichenbaum, Burland, Gruson and Cameron (1985) suggest that tasks requiring learning transfer and involving "co-ordination of discernible elemental skills" will probably be most revealing in assessing metacognition.

Again, a previous research exercise helped to focus attention on an appropriate task. A study exploring the sorts of words children use to access information through the Dewey Decimal System (Moore, 1987b) suggested that information retrieval tasks meet many of the above criteria and that the children's behaviour in this context lends itself to observation. For example, it is easy to see which parts of books are used to access information and whether the student is familiar with tables of contents and indexes.

The final catalyst for the present study arose from experiences as a parent guiding children through project assignments that were poorly defined and supported by teaching staff. That these experiences were far from unique became evident as other parents quickly voiced frustration if an opportunity was offered.

Thus an interest in the assessment of metacognition and experience of the difficulties children have in accessing information for independent project work raised many questions about the cognitive and metacognitive underpinnings of information retrieval and led to the present study.

While the previous chapters attempt to discuss the processes involved from a theoretical viewpoint, they do not draw on observational studies of children's actual attempts to retrieve and use information. Such studies are rare and those that do exist tend to take an adult view of the task, not that of the students themselves. Further, despite an extensive literature search, no studies have been located which track the information retrieval process from identification of an information need through to final satisfaction of that need and presentation of findings. Admittedly, such an undertaking would be enormous and is outside the scope of the present study. Instead, this study aims to explore the information retrieval phases of defining the search area and finding relevant material.

Reference will be made to students' final use of that material but the report writing process itself will not be examined in detail at this stage. It is suggested here that consideration of the information handling process, even in this limited form, will shed light on both the nature of information retrieval and use and the ways in which the task demands could be used to foster higher order thinking abilities among students.

What then, is known about children as information seekers and users? The following review draws together findings relating to the phases of the information retrieval process previously outlined (see page 18) and leads to discussion of the specific aims of the present study.

Identifying and articulating a need for information

The initial phase of information retrieval demands awareness that one has insufficient information for understanding or for completion of a task. Any assessment of the ease with which students identify an information need is usually associated with questioning behaviours. For instance, in the context of reading a report supposedly written by a child, Kobasigawa (1983) found that only 25% of 9 year olds, compared with 80% of 13 year olds, realised that relevant information was missing. Moreover, in a wider context, Project INQUIRE (a full scale investigation into the development of inquiry skills among American children) found that while children in school are encouraged to ask questions to clarify their own understanding, they rarely use their own questions to guide intellectual activities such as research (Sheingold, 1987). This is illustrated by an earlier study by Robinson and Rackshaw (1977) who found that, having been given some information, more than 20% of 9 year olds were unable to generate questions that called for additional information. Sheingold attributes this sort of finding to children's conceptions of legitimate classroom activities rather than some innate inability and reports that once questioning for the purpose of directing inquiry is seen as legitimate, children cope well with the task.

However, Sheingold later comments that even when inquiry is undertaken on a regular basis, defining the right questions is very difficult. She quotes an expert researcher's opinion that "it is the worst and the best part of research, long term, that you end up with the questions you wish you'd started with" (p83). Thus one must consider the quality of the questions that arise from an information need.

Framing appropriate questions

Not only must students identify a need for information, they must generate questions that will allow them to demonstrate the abilities to be tested in the tasks used to assess learning. In a study similar to that of Robinson and Rackshaw, Kobasigawa (1983) gave 9 and 13 year olds some information about China and requested that they generate questions for related project work. Of the 9 year olds, 50% did not formulate any research questions but all of the older students did. Questions produced by the 9 year olds could mostly be answered by re-reading the text provided or by finding a single fact elsewhere. Seventy-five percent of questions from older children were open-ended, demanding the integration of information from several sources. The younger students' questions were not appropriate to the criteria by which project assignments are frequently assessed.

Studies assessing children's ability to formulate questions rarely seem to look at where the questions lead. Moore (1988) noted that although all the 11 year olds she observed were able to generate questions for a project assignment, some students had considerably more difficulty than others. In addition, only 48% of questions generated by students were answered in their final reports. The problem seemed to lie both in the general nature of many of the questions and in actually finding and selecting information to answer them.

Finding and selecting information sources

As part of a project aimed at finding out how far children could successfully cope with tasks involving reading, Cole and Gardner (1979) observed students' location of information resources. They say that searching often appeared to be a random sampling of books from the shelf rather than a purposeful inquiry. This was despite the fact that most students could explain the theory of using a library system. Rudduck and Hopkins (1984) made similar comments about sixth form students and Moore (1988) observed the same gap between theory and practice among 11 year olds.

The project work set for the Cole and Gardner study was extremely well supported, to the extent that students had many discussion sessions and a booklet of questions to help guide their work. Teaching staff had also written text for them with the aim of leading them to library resources, and had even selected a shelf of relevant books. Cole and Gardner found that in this context few students actually searched the library for information. They went straight to the "project shelf" but used very few of the resources. They clearly preferred the more concise teacher-written materials but these failed in their purpose of prompting further information seeking.

The students in Moore's (1988) study frequently expressed a preference for using a shelf of encyclopaedias containing concise information rather than searching the main collection. Since in this case they were denied access to encyclopaedias, they had to search the shelves. It was found that their interpretations of subject index cards and lack of understanding of shelving conventions frequently hindered location of books. For example, a third of the students were unaware that books are shelved top to bottom on adjacent units, not along one continuous shelf after another. Many students consequently had difficulty knowing where to look when they reached the end of a shelf. In addition, mis-interpretation of Dewey numbers restricted some students' field of search, for instance, some thought that 598.2 meant there were just two books on the shelf!

With regard to selecting individual books, Moore found that children relied heavily on titles and cover illustrations. In a few cases books were totally rejected if their titles did not contain a keyword from the student's question. Kobasigawa (1983) found that 70% of 9 year olds and 50% of 13 year olds selected materials on a similar basis.

Phases of the information retrieval process overlap and selection of information sources cannot be done without reference to some sort of evaluation of their content. It is to this topic that we now turn.

Evaluation of information sources

As discussed in the previous chapter, evaluation in the context of comprehension occurs on many levels (Baker, 1985). While those levels are critical to information retrieval and use, that of greatest concern here is evaluation of resource relevance to the question driving information seeking. Irving (1981) has said that this part of information retrieval is the most difficult for people of all ages but there do not seem to be any studies exclusively concerned with how children fare on the task or even how they approach it. One must piece together fragments of studies to get an overview.

For example, Moore's (1987b) study found that some 10 year olds were willing to evaluate books on the basis of the cover alone. In a task demanding classification of books by subject, 25% of the students opened no books at all, while a further 25% did so only after striking a difficulty and being questioned as to what they could do to learn more about a particular book. Looking inside books was little help to these and some of the remaining children. One student flicked through the pages so fast they could not be read while another looked at every page slowly and deliberately without reading anything other than a list of illustrations, and others clearly lacked purpose in their perusal of texts. In contrast, six of the 25 children observed seemed to have developed efficient strategies for accessing information for subject evaluation. They used cover notes, contents pages, indexes, pictures and sampled text before making an evaluation. It appears from this that the stuctures designed to give access to information are also used in evaluating content and presumably the relevance of a text to student inquiry. However, Cole and Gardner (1979) observed that students rarely use these aids in the course of project assignments. Further, they report that in general "the first book which contained something that could be noted served the pupils' need" (p174). They suspect that students were actively searching for anything they could use, rather than for a solution to their particular information problem. In contrast, only one 11 year old in Moore's (1988) study failed to use the available access structures to assess book content, although evaluation of texts was not necessarily more successful as a result.

Use of book access structures is not as easy as it appears in theory. Heather (1984) examined the difficulties inherent in their use, only to find that many students do not know the difference between tables of contents and indexes and do not understand the relationship of dictionary and encyclopaedia guidewords to the text on the page. Moreover, Miller (1980) came to the conclusion that it could not be stressed too strongly that using an index is a laborious task for many children, partly because indexes in children's books tend to be of a low standard with many omissions and errors. To make matters worse, some non-fiction volumes do not have indexes, others lack contents pages and still others do not have page numbers (Moore, 1988)! The nature of the text further complicates matters in that it is often loosely structured and headings are not always consistent with the content of the text that follows (Anderson & Armbruster; 1982). Thus the nature of the materials contributes to the difficulty of evaluating information sources. A further problem centres on the finding that children are often distracted by illustrations or an item of personal interest and lose sight of the information problem they are trying to solve (Lunzer & Gardner, 1979).

In the majority of investigations of studying and project work, the texts have been pre-selected but many teachers do not support independent project work in this way and Rudduck and Hopkins (1984) note that sixth form students are often expected to find materials for themselves in several curriculum areas. Within a given subject Rudduck and Hopkins found that these students may evaluate books in terms of size alone because "you carry them around with you in your bag and they don't weigh you down" (p35)!

With regard to the wider context of resource evaluation, cognitive research suggests that children lack the executive control abilities to predict task difficulties and to recognise changing levels of difficulty (Anderson Armbruster, 1982). This has serious implications for their ability to select books matching their reading ability and assuming an appropriate level of prior knowledge. Indeed, Brown, Armbruster and Baker (1984) state quite clearly that novice readers have trouble distinguishing between easy and difficult texts.

In the course of trying to evaluate materials for relevance to their research question, students are bound to begin processing information in terms of concept formation and getting an overview of the topic. Part of this task is carried out covertly but at a later stage the process becomes more overt with note-taking, outlining and other study techniques being applied. Evaluation and extraction of relevant information may occur simultaneously and will be considered together in the following section.

Extracting relevant information

As outlined earlier, this phase of information retrieval demands that the student direct attention to important points and supporting detail relevant to the question to be answered (Reynolds & Shirey, 1988). Cole and Gardner (1979) found that for many children talking in a group was essential to this process and at later stages was a substitute for reading as well as prompting memory, gaining text suggestions and providing the opportunity to rehearse written prose. Thus the presence of a group may affect information retrieval and use and consequently the use of books by a group of students may differ from that of individuals.

In the context of working alone, Kobasigawa (1983) studied children's use of tables of contents and indexes to narrow the field of search within a book. Asked to provide keywords and to identify chapters relevant to a given question, it was evident that many 9 year olds did not use their general knowledge to limit the search. However, this could be prompted by handing the children the book opened to the table of contents. When explicitly asked in this situation to identify three relevant chapters younger students performed as well as 13 year olds. The implication being that more direction and structure is needed to enable 9 year olds to identify which parts of a book are worth searching for relevant information.

It is also worth recalling Kobasigawa, Lacasse and MacDonald's (1988) findings that searching is straight forward only when the questions driving information retrieval indicate what specific sections of a book should be searched. They found that the percentage of students spontaneously using headings to aid information searching increased from 42% of 9 year olds to 75% of 13 year olds. However, efficient use of headings declines when text and questions do not have keywords in common.

Overt extraction of relevant information often takes the form of taking notes or engaging in other study techniques. Detailed examination of these is outside the scope of the present study but brief mention will be made in order to keep the entire information retrieval and use process in view. Note-taking depends on student ability to identify important points, yet it seems to be generally agreed that where complex prose is the subject of study, children have difficulty recognising these and require help in focusing attention on relevant information (Baker & Brown, 1984b). Further, although most college students can select important points for a summary, they fail to include all the points judged important by researchers (Garner, 1988).

In the wider context of information retrieval, Sheingold (1987) reports on one study of note-taking in which it was found that the information noted by students bore little relation to the problem they were asked to solve and similarly, the solutions they offered were only indirectly related to the notes taken. There appeared to be insufficient overall plan coordination and monitoring. Further, Lunzer and Gardner (1979) noted that 10 to 15 year old students often transferred information directly from the textbook to their notebooks, using strategies that maximized short term memory and by-passed the need for reflection. Indeed, they state that reference books were often treated as "treasure troves of sentences and paragraphs that could be stolen and marketed again in another setting".

This finding is indirectly supported by results from Brown and Day's (1983) study of summarization. Here it was found that 10 year olds could accurately delete trivial and redundant material from a text passage but almost never invented a topic sentence capturing the gist of a text. Even 15 year olds failed to invent topic sentences in many cases and college students only did so for half the occasions it would be appropriate. Brown and Day state that invention of topic sentences is a skill used with facility by experts but is most difficult for novices. It seems to rest on abilities to identify and integrate important points but Winograd and Bridge (1986) have observed that researchers still do not really understand how fluent readers achieve this.

Having gathered information and partially processed it, the student must now process it more thoroughly and begin to structure the topic in ways appropriate to the criterial task set by the teacher. Lofland (1971, cited in the context of qualitative research methods by Miles & Huberman, 1984) offers the opinion that it is not until one attempts to complete this task that one truly begins to think.

Processing and presenting information

Bereiter and Scardamalia (1987) say that children have a major problem in getting access to and establishing order for the knowledge that they have acquired. Their control over relevant content seems to be unstable. For example, when asked to state which items of subject knowledge they would not include in an essay, 9 year olds could not imagine knowing something and excluding it on the grounds that it did not fit some overall plan. The essay plans that they produced tended to be lists of content items simply arranged in the order that they had come to mind. In addition, Kobasigawa (1983) found that while 9 and 13 year olds were able to assess the adequacy of a report, they noticed lack of important information, not inclusion of irrelevant material. These findings are in accord with those reported by Sheingold (1987) with respect to the tenuous relationship between a question, notes taken and resulting solutions produced by students.

Given the difficulties of finding and extracting important information from texts and the added problems of putting it into one's own words, it is not surprising that project assignments result in students copying tracts of text. However, copying should not be taken as a sign that understanding is totally lacking. Cole and Gardner (1979) noted that although written work was largely copied, students demonstrated their ability to restructure material in the course of oral presentations and discussions. Perhaps this is due to what Avann (1985) calls "a sense of audience". She and Irving (1985) agree that having a clear idea of with whom one is communicating may make the task of "putting it in one's own words" easier for children.

Indeed, the effects of "live" communication were obliquely mentioned by Rudduck and Hopkins (1984) who found that library rules of silence hindered sixth form students in their study attempts. The conflict here is that while one has to be able to concentrate, talking and interacting with an audience often advances knowledge.

Project assignments

While there is clear evidence that teachers are often disappointed with the final product of project assignments, it must be acknowledged that students frequently enjoy the work and, despite the inefficient study methods used, they learn a great deal (Cole & Gardner, 1979). However, Lunzer and Gardner (1979) point out that interest and enthusiasm for project assignments apparently does not lead to reflection on reading and associated higher order thinking abilities. The potential for their engagement certainly exists and past failure to achieve that has been attributed to the way in which library and study skills have been conceptualized and taught (Irving, 1985). The literature implies agreement that reconceptualization in terms of broad, integrated information skills is necessary. However, empirical research is largely lacking and this alone supports Liesener's (1985) observation that we are somewhat naive in our understanding of what is actually involved in information retrieval and use. This severely limits the ability of educators to provide students of all ages with adequate instruction.

Aims of the present study

In order to reduce that naivity and provide a sound educational basis for modifying the teaching of library and study skills, the present study aims to describe the difficulties students experience in retrieving and using multiple information sources, to generate a description of the necessary cognitive skills and to explore the students' metacognitive knowledge concerning information retrieval. In particular, questions guiding the research include:

1) What is the content of Form 1 students' knowledge concerning:
   a) themselves as learners and information seekers
   b) the learning activity of information retrieval
   c) the materials used in the activity, i.e. the library system and books
   d) the criteria by which project reports are assessed
   e) awareness of interactions among these variables
2) With regard to executive control processes:
   a) what happens when barriers to information retrieval are encountered
   b) are students more able to regulate behaviours in some phases of the information retrieval process than in others
3) What factors contribute to successful information retrieval by Form 1 students

The task chosen for the focus of the study is that of project completion in the absence of "good" teacher support as this demands coordination of many skills and should thus expose executive control processes and metacognitive knowledge. Although much of the discussion will focus on the implications of findings for fostering higher order thinking abilities in the context of information retrieval, broad implications for teaching and learning will also be discussed.

ADDENDUM

STUDENT CHARACTERISTICS
PROGRESSIVE ACHIEVEMENT TEST PERCENTILES

	RANGE	MEDIAN
READING VOCABULARY	4 - 89	63
READING COMPREHENSION	2 - 98	64
STUDY SKILLS, knowledge and use of reference materials	10 - 99+	62

CHAPTER FIVE

METHODOLOGY

SUBJECTS

The participants in this study were 23 Form 1 students at a suburban intermediate school. Ages ranged from 10 years 9 months to 12 years 6 months (mean 11 years 8 months). There were 12 girls and 11 boys.

While no distinction was made on the basis of academic ability, given the role of language in information seeking, it was thought preferable that all students have English as their first language. However, one student was included for whom English was a second language. He had previously demonstrated English language skills of a very high order and was not considered to be disadvantaged by the language requirements of the research task.

The children's socio-economic backgrounds were diverse, thus their experiences of and familiarity with library systems were likely to vary greatly. While these differences compound the problems inherent in the analysis of qualitative data, the focus of the study was on the range of cognitive and metacognitive approaches currently used by Form 1 students. Selection of a sample on the basis of academic ability or background was thus deemed inappropriate.

This particular group of students was selected because their class teacher had expressed interest in the research and was willing to tolerate minor disruptions to daily routine. The teacher concerned had a well-developed and systematic approach to supporting students during independent topic work. She had, prior to the study, guided them through two projects using a contract form (see Appendix 1) and a teaching programme based on questions to aid student monitoring of the research process (see Appendix 2). Thus the students had some familiarity with project assignments but were not expected to be proficient in carrying them out independently. For this study the teacher did not engage in any of the conferencing activities she considers necessary to supporting independent project work.

PROCEDURE

Overview

The first contact made with students took the form of a class discussion about the aims of the research. Students were encouraged to see themselves as experts and were invited to share with the researcher their thinking and methods of approaching project assignments. The method of research data collection was discussed and all student questions were answered candidly. The non-evaluative nature of the task was emphasized and anonymity and confidentiality were assured.

Students were then given a letter detailing the same information for their parents' benefit and including a permission slip to be returned to the school (see Appendix 3). Only those students for whom signed permission slips were received were included in the study. In the event, five students were excluded as permission was not received and a further four were absent. The students themselves were asked to sign consent forms allowing the communication of results to interested parties, given that individuals' anonymity would be respected.

Data Collection

The subject BIRDS was selected as a focus for information gathering following consultation between the classroom teacher, teacher-librarian and researcher concerning the availability of resources and students' familiarity with the topic. Then, some weeks prior to the study, the classroom teacher asked students to write down something of what they knew about birds, explaining that she wished to plan a unit on the topic. This written material was collected and set aside until the data analysis phase of the study. It was hoped that it would provide the researcher with a rough notion of the students' prior knowledge. No student mentioned this episode at any time during the study, perhaps because school holidays intervened between it and the actual research project.

As detailed earlier, the researcher then met with the students to discuss the study. Following this, the main phase of data collection took place over a period of five weeks. Individual students were interviewed in the school library, the order of interviews being organised by the students themselves. The researcher had no idea of any particular student's ability prior to the interview session.

In order to ensure a degree of privacy and uninterrupted access to resources for interviewees, library access for the rest of the school was denied for one day a week during the data collection period (five weeks). To minimize this disruption, the associated learning resource centre, which houses encyclopaedias and other reference materials, remained open and was not used by participating students. The setting within which interviews took place is discussed in detail later.

Each interview and attempt to find information was video-taped by a research assistant who endeavoured not to intrude between the student, the resources and the researcher. Additional retrospective interviews, carried out while students viewed their own videos, were recorded using a cassette tape machine. In both cases the recorded data were supplemented with notes taken by the researcher. The interview procedure lasted approximately 40 minutes. It is discussed in further detail later in this chapter.

To ensure that initial planning and thinking associated with the project assignment was "captured" during the interviews, students were asked not to talk about the project topic with those still to be interviewed. Students appreciated the problem and appeared to enjoy this "secrecy agreement". The last students to be interviewed seemed genuinely surprised when told of the topic they must research.

Students were given a week in which to return to the library to complete their assignment and hand it to their teacher. Insistence that they complete the work in the library instead of taking books out ensured that resources for the remaining interviewees did not dwindle. Copies of completed assignments were retained for data analysis.

On completion of the data collection phase, the researcher met again with all students to share impressions of the study and to express thanks for their contribution.

Task setting and equipment

The school library used in this study was well established. A comprehensive catalogue existed for both fiction and non-fiction, with the latter being organised according to the Dewey Decimal System. Attached to the main library was a learning resource centre which housed the library's collection of encyclopaedias and other additional materials. It must be emphasized, however, that the bulk of the non-fiction collection was in the main library.

The library was staffed by a trained teacher-librarian, a teacher's aide who was previously a professional librarian, and a rostered group of students who received on-going training.

For the topic in question the main library had on its shelves 35 books on various aspects of BIRDS, thus it seemed likely that individual interests would be satisfied. These books were positioned on the top shelf to the right of the non-fiction catalogue. However, the first student interviewed found a few mis-shelved volumes on the bottom shelf to the left of the catalogue. Consequently, the shelves were checked to ensure that some BIRD books were at this location for every interview.

The battery-operated video camera used during the study was mounted on a tripod facing the children when they were seated at a table and was hand-held while following them to the shelving. Sound recording relied on the camera's built-in microphone thus reducing the presence of trailing wires which might get tangled in furniture and feet as the children moved around the library. The audio-cassette recorder used for retrospective interviews was hand-held and also had a built-in microphone. This machine was quite unobtrusive and its presence was thus easily forgotten. It was hoped that any student made nervous by the video camera would talk more freely in the retrospective interview. In fact only one student maintained an obvious awareness of the camera throughout much of the think aloud/concurrent interview.

Interview procedure

In general, metacognitive studies share a heavy reliance on verbal reports from subjects. This reliance has been criticized in that the veracity of verbal reports is sometimes suspect and some of the information sought by researchers may not actually be available to the subjects. Rather than entirely rejecting verbal data on these grounds, Ericcson and Simon (1980) have discussed factors influencing the reliability of verbal reports and several researchers have expressed opinions concerning the nature of appropriate tasks and supplementary data collection that could reduce methodological problems (Baker & Brown, 1984; Meichenbaum, Burland, Gruson & Cameron, 1985; Scardamalia & Bereiter, 1983). In light of their recommendations a dual think aloud/concurrent interview was immediately followed by a retrospective interview, using the video-tape of the former to provide memory cues for the latter.

Participating students were seated at a table and the task of thinking aloud was explained. To give them some time to become accustomed to both the researcher and the presence of a camera person, they then tried thinking aloud while solving an amusing puzzle. A previous comparison of think aloud and retrospective interviewing techniques had revealed that Form 1 students sometimes give a running commentary on physical movements rather than on thinking processes (Moore, 1987a). This exercise was therefore used to reinforce students' comments about thinking processes. Completion of the puzzle was not an object and this point was used to emphasise that the whole interview was not about "getting things right or wrong".

When students seemed relaxed and had shown some ability to think aloud they were given the following information:

"I know you've done projects with your teacher before and I'd like you to tackle this one in the way she's shown you. While you're thinking about the questions you'd like to answer on the topic and while you're looking for some books to help you, I'd like you to think aloud. I'll ask you questions to help you share what you're thinking."

They were then given the familiar contract form drawn up by their teacher (see Appendix 1) and reminded that they had a week in which to complete the work. At this point a further request was made:

"I'll ask you not to tell the others what the topic is, as that will spoil their chances of sharing all their thinking with me."

Once any questions concerning the interview procedure had been answered, recording began as the students were told that the topic for the project was BIRDS. They then spent some time thinking of questions they would like to research. When they felt they had formulated sufficient questions, the students were asked how they intended to locate the necessary information. This question served to obtain a statement of declarative knowledge about the library system and to ready the camera person for moving about the library.

In line with Scardamalia and Bereiter's (1984) recommendations, the researcher followed giving students practice in thinking aloud with much encouragement and prompting during the actual research task. It was expected that verbalizations would cease when difficulties were encountered and when talking was incompatible with the activity of the moment, for example, reading. The type of questioning used at such points is critical to the quality of the data obtained and care must be taken that questioning itself does not become disruptive to performance (Moore, 1987a). While there has been little research on the best ways to interview children about performances, there is some agreement that questions asking for direct report rather than inference are preferable (Meichenbaum et al, 1985; Scardamalia & Bereiter, 1984). To gain clarification of points, interviewers have successfully used the technique of recounting an event in a puzzled tone of voice to emphasize that it is the researcher who is failing to understand. These research experiences were considered when designing the present study and were used in the production of a question guide for the interviewer (see Table 1 below).

During the 20 minutes or so of the think aloud/concurrent interview, the researcher made notes of points to be explored in retrospective interviews and recorded the questions students formulated for information seeking for her own reference. Notes were also made concerning behaviours that might not be evident from the video-tape, for example, the exact use of index cards was not always visible from the camera's vantage point. However, note-taking was kept to a minimum by the sheer speed of events.

Pressures of time resulted in the retrospective interviews themselves being limited to picking up particular points rather than viewing the entire video. During this phase the interviewer endeavoured to verbally cue points at which video and audio tape matched by describing the student's actions (e.g. When you were looking at Meet the birds....). This action was taken to ensure that the original context of students' comments was retained for the purposes of analysis.

Although questions of interest had been listed to guide the researcher during both segments of the interview and to provide some comparability across the sample, the actual content of each interview was open-ended, depending on the student's actual performance. The interview procedure took a total of 40 minutes for each student.

Table 1 General guide for interviewer questioning

Think aloud/concurrent interview
Have you looked up anything about birds before?
How will you choose the books?
What word are you looking for? Did you find it?
Would another word help?
What are you thinking about now?
Was there anything there that suggested where to look next?
Does that add to what you already know?
Can you point to where you are reading?
What made you put that book back? What made you keep that book?
Are you looking for something different now?
Pay special attention to difficulties - get the children to explain the problem if possible.
Retrospective interview
How did you come up with the questions?
Is it difficult to think of them?
Were you interested in the subject already?
What did you know that helped you decide where to look?
What were you reading then? Do you have a way of reading fast?
What helps you decide to take books out?
When you don't find what you want in the catalogue or index, what do you do?
Have you got enough books to answer your questions?
What will you do if you haven't? Will you look in the same way or change something?
Pick out silences or indecisions that were not explored in the think aloud interview - what were you thinking here?

DATA ANALYSIS

From the above it can be seen that the data collected contained verbal, visual and written material, rich in detail and clearly qualitative in nature. The analysis of qualitative data does present some difficulties and is still somewhat controversial because it relies heavily on interpretation of ambiguous symbols (words), and is therefore subject to possible researcher bias (Miles & Huberman, 1984). Indeed, Guthrie and Hall (1984) point out that while most reading researchers may talk about ethnographic approaches (involving techniques such as those of the present study), "they really take a dim view of such "soft" research" (p91). Yet descriptive studies can be invaluable in the exploration of new research areas in that they may result in the identification of important variables underlying complex behaviour.

With regard to the problem of reliability, Miles and Huberman (1984) emphasise the provision of clear descriptions of methods and data analysis procedures to facilitate replication of qualitative studies. Further, to address the problems of bias in interpretation of the data, they suggest the use of data displays which allow independent verification by other analysts. The creation and use of such displays is part of the data reduction and analysis process, thus the evolution of data displays for the present study is detailed below.

Data preparation

On completion of the interviews, the researcher made transcripts of all video and associated audio records. To ensure that the referents of verbalisations were clear, observer comments were included, for example, "OC: Points to non-fiction catalogue". The transcripts were randomly sampled and five of the 23 were independently transcribed by an assistant who had not been present during the actual interviews. A word by word comparison of the original and independent transcriptions was carried out. A tally was kept of the number of occasions on which there was agreement that a word had occurred and that it was correctly transcribed. On this level there was 97.5% agreement that the transcription was accurate. Incorrect transcription of words had occurred on 0.6% of occasions and on 1.9% of occasions the interviewer and assistant disagreed that words had occurred at all. The majority of these disagreements concerned words repeated by students, for example, the number of times "no" appeared in the following was disputed: "No, no, most of them do have indexes."

During the initial inspection of the data library systems and the books themselves were unexpectedly found to present barriers to children's information retrieval attempts. The nature of these barriers was such that it was necessary to discuss and summarize them before beginning analysis of the thinking processes underlying information retrieval. Given this fact, and the sheer volume of data, it was decided that the study should be analysed in two sections. Thus Moore's M.A. thesis (1988) analysed the data with respect to information retrieval and the difficulties inherent in libraries and books, while the present analysis was, as originally intended, to deal in depth with the cognition and metacognition underlying information retrieval tasks. All results reported here are based upon the following data preparation which differs from that used in 1988.

The transcripts themselves were prepared in a format suitable for use as coding forms, with columns reserved for coding at the cognitive and metacognitive levels. A further column was provided for notes about converging evidence together with subjective opinions of the coder. The source of each entry in this column was clearly identified. This particular format allowed the codes, their contexts and the basis of inferences to be kept together for later inspection. Very little data reduction occurred during this phase of data preparation since the only criterion for exclusion was that the actions or words recorded in the transcripts were totally unrelated to the task at hand (for example, the researcher on one occasion requested that people in the adjacent learning resource centre be quieter!). Appendix 4 includes two complete, coded transcripts.

According to Miles and Huberman (1984), data display formats are dependent upon expression of research questions and coding categories in operational terms, thus identifying the relationships of major interest and allowing their nature to be examined. The formulation of criteria which defined coding categories is discussed below.

Coding categories

The parameters of metacognitive concepts have been shown in Chapter 3 to be complex and lacking in an agreed operational definition. As described in Chapter 4, the present study used Brown et al's (1983) model to identify categories by which metacognition might be assessed.

To reiterate, these authors consider that the individual's knowledge about four sets of variables and the implications of their interactions for effective learning contribute to metacognitive knowledge. Executive control processes coordinate elements of this knowledge in order to monitor, evaluate, plan and regulate cognitive activity. While the degree of self knowledge of executive processes is of interest, according to Resnick (1989), actual use of the processes is probably more important to learning ability.

Consideration of Brown et al's model and the role of executive control processes gave rise to several broad categories for coding metacognitive events as follows:

1. Metacognitive knowledge:
    - a) characteristics of the learner
    - b) learning activities
    - c) nature of materials
    - d) criterial tasks
    - e) knowledge of interactions among these
2. Executive control processes
    - a) monitoring activities

b) checking monitoring objectives

c) planning activities

d) regulation/revision of strategies

An additional focus of the present study was to illuminate aspects of the information retrieval process in terms of cognition. Thus phases of the information retrieval process itself (detailed on p18) provided a set of codes at the cognitive level.

Figure 2 illustrates the relationship between these sets of codes. The criteria for inclusion of data in each category are discussed below.

Cognition: information retrieval and use

Cognitive and metacognitive aspects of students' behaviour are interdependent but the nature of the cognition necessary to information retrieval tasks is often more salient to the observer than is the nature of metacognition. Thus it was considered that initial coding of the data at the cognitive level would provide a description of the procedural knowledge students bring to bear on information retrieval tasks and help to focus later attention on metacognitive functioning.

Coding at this level required identification of cognitive goals in terms of a relevant phase of the information retrieval process, together with a description of component behaviours. The coding task was complicated by the fact that the students were engaged in two tasks simultaneously: the primary one was to retrieve information while the secondary one was to answer the researcher's questions. Where the goal of action was clearly related to answering questions about side issues, the data were excluded from information retrieval process coding. However, where such activity appeared to change the next event in information retrieval, the code for that event was prefixed "prompted".

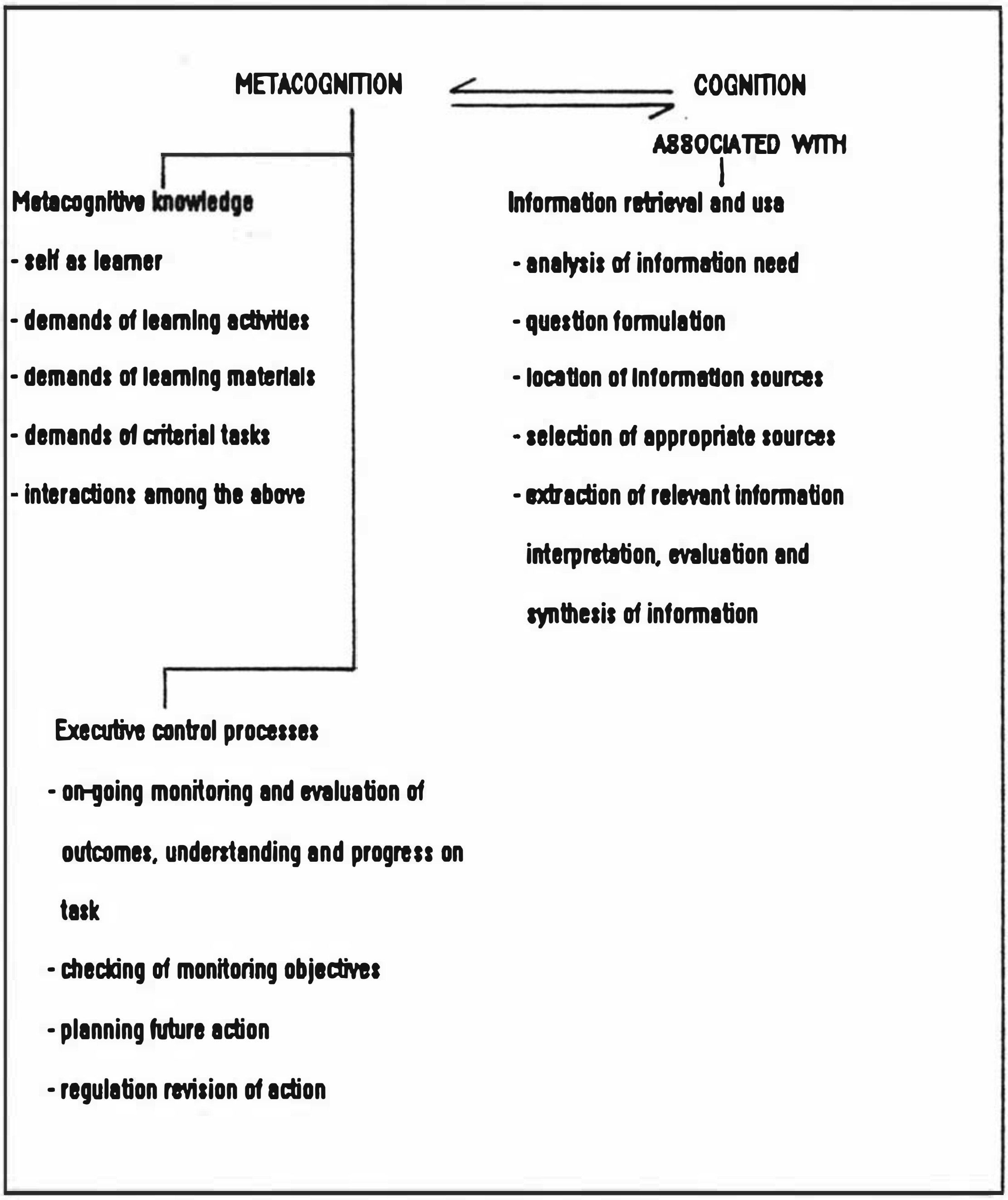

FIGURE 2: The relationships between the sets of broad coding categories used

Phases of the information retrieval process were labelled in accord with descriptions provided by Avann (1985) and Irving (1985). The broad categories and overall goals of action are listed below.

a) **Analysis of information need:** student explores task to find out what information is needed. Two kinds of information were included here, one concerning the external task demands (what have I got to do to meet evaluation criteria?) and one concerning a review of prior knowledge and its implications for defining the information needed (what do I know and what must I find out?).

b) **Formulation of questions:** student defines and refines questions which will direct information seeking, e.g student focuses attention on a particular area of information need.

c) **Location of information sources:** student uses knowledge of the library system to find relevant resources, e.g. the student searches shelves randomly or uses the catalogue to identify an appropriate Dewey number before searching shelving.

d) **Selection of information sources:** student identifies individual resources and evaluates their usefulness, selecting some for closer examination, e.g. student reads titles and other aids to determine which books are likely to contain appropriate information. Some information may be absorbed incidentally if text is read during this phase but processing tends to be superficial (e.g. little elaboration takes place).

e) **Extraction of relevant information:** student locates a unit of information within resources and uses it to direct further information seeking or records or rehearses it to aid future use, e.g. student looks for keyword in the index, reads relevant entry and uses a keyword from that to access more information or relates information just read to that already held. The overall goal of this phase is the extraction of appropriate information fragments and to gain a general understanding of the necessary concepts.

f) **Information processing, interpretation, evaluation and synthesis:** student attempts to "makes sense" of information gathered and assess its sufficiency to answer the questions asked. This refers to a more global processing than **e)** above, e.g. student combines information from different sources, seeks relationships, organises and structures information to form more detailed concepts. A higher level of reflection is required and the constraints of the criterial task are brought into focus. (Actual production of a finished report was not, however, a focus of the present study.)

As has been emphasized earlier, the process of information retrieval is not linear and the boundaries between the above phases are somewhat artificial. In practice it was found that analysis of information need and the formulation of questions could not be usefully separated as the latter depends heavily upon the former. The two phases were therefore combined when coding the goals of information retrieval activity.

Metacognition: Executive control processes

Data in this category included the students' direct statements and indirect comments or actions from which it could be inferred that executive control processing was taking place. In making such inferences it was essential to consider the context of the coded events, which varied in size from a single clause to an entire paragraph. Where possible, inferences were supported by converging evidence from retrospective interviews, observational notes and non-verbal behaviour. Where overt behaviours indicated that executive control processing was taking place but the nature of that processing could not be determined, data were excluded from coding.

Coded events reflected the on-line nature of executive control processing and many were cognitive actions taken to serve metacognitive goals, for example, self-questioning served monitoring and planning purposes. Where two codes were applicable to an event the most salient executive control process was recorded where at all possible. In some cases dual coding was unavoidable. The codes used were as follows:

a) **Monitoring** The lowest common denominator of executive control processes appears to be monitoring activity. The learner monitors levels of understanding, the outcome of actions, his or her present position in a task and overall task progress. Without continual monitoring, other executive control processes would not be brought into play. Evidence that monitoring was taking place included changes in focus of attention in response to information gained (e.g. the student focuses on titles of books once the correct Dewey number has been located), comments regarding the outcome of events (e.g. as the student locates the Dewey number he/she says "Here it is!") and comments about understanding ("This doesn't make sense.")

b) **Metacognitive experiences** Overt metacognitive experiences are included as a sub-category of executive control processes rather than a category in their own right since they provide a clear sign of monitoring activity. They may or may not lead to regulation of activity but are characterised by a strong affective element, e.g. the student expresses puzzlement or surprise, often in the context of unexpected events,e.g. "It's not here!" "Oooo, there it is!" "This is awful!"

c) **Checking outcomes or decisions** Here the student was seen to repeat part of an action sequence for the purpose of ensuring no mistake had been made, e.g. he or she searches the index of a book for a second time without changing the search term used, looks back briefly at a page just examined or rereads a text segment.

d) **Self-questioning** This action serves monitoring and planning purposes. In every case the student asked a rhetorical question, e.g. having found several Dewey numbers, he or she asked "Which should I choose?" or having been distracted said "Where was I?"

e) **Prediction** This seems to be a logical precursor to planning and is evident when students suggest the outcome of future actions or events, e.g. "If I look in the subject headings I'll find what I want" or "It won't be in a book about sea birds".

f) **Planning** The events to be coded as evidence of planning varied in size from a single statement referring to the next action the student must take, e.g. "I think I'll look for nests in the index", to a string of related events which could include details of alternative actions to be taken under certain conditions.

g) **Revision/regulation** Inclusion in this category as **revision** demanded clear evidence that the student had modified his or her approach to a task in response to events as they occur, e.g. he or she selected a different search term for a subject or turned to the index when a table of contents was not present. **Regulation** was taken to describe greater changes in the direction of action such as abandoning one approach in favour of another, e.g. the student stopped looking for Dewey numbers and searched the shelves randomly.

h) **Self-correction** This code referred to revision and regulation behaviours that were strongly based on prediction. For instance, the student begins to approach the fiction catalogue and says, "No, that's not right" and then moves to the non-fiction catalogue.

An additional category was defined when it was found that students often noted a failure of short term memory.

i) **Memory prompt** The student re-reads his or her questions to bring the target of searching back to memory. Often this behaviour was inferred from visual evidence that the student looked back to the question sheet in the middle of another task, then verbalised the question that was to direct information searching.

Metacognition: Metacognitive knowledge

Learner characteristics

Data included in this category took the form of direct statements, indirect comments or actions from the thinkaloud/concurrent interviews, together with converging evidence from other sources (where available), such that it could be inferred that one of the following applied:

a) **Ability** The student believed or knew something about him/herself as a general processor of information, e.g. "I can't think of questions easily", "I'm good at finding information", "I usually do it this way".

b) **Knowledge state** The student knew something about his/her general level of understanding or state of knowledge, e.g. "I don't know much about birds".

c) **Prior knowledge** The student was drawing on topic or general knowledge, or procedural knowledge gained before the interview, e.g. "They lay eggs and some of them fly, but other animals build nests too."

d) **Tactical knowledge** The student implied or outlined a sequence of actions that led to a particular outcome, e.g. "If I write it down I'll remember it." Such sequences could be general or task specific and sometimes included conditional knowledge concerning their use.

e) **Interactions** The student had declarative knowledge of an interaction between his/her learning characteristics and one or more of the other sets of variables within the learning situation, i.e. he or she mentioned how behaviours had to be adjusted in response to differing materials, learning activities, criterial tasks. In each case the elements of the interaction were noted, e.g. ability/topic knowledge and task difficulty.

Learning situation

As stated earlier, knowledge about learning activities, the nature of learning materials and the criterial tasks used to assess learning also contribute to a student's metacognitive knowledge. However, the individual student's knowledge in these areas was not verbalised to a great extent. Comments tended to be about two or more aspects of the learning situation and were difficult to separate into three distinct categories. Thus, events explicitly referring to such knowledge were included in a single **learning situation** category and where possible were given additional labels indicating whether they concerned primarily with learning activities, materials or the criterial task.

Occasionally, students evidenced some awareness that properties of these aspects of learning situations had combined effects that occurred irrespective of their own learning characteristics e.g. Some questions cannot be answered using books. Such statements were coded as learning situation with an additional label indicating that a combination of factors was involved.

Coding distinctions

Potential ambiguities in using the codes for metacognitive activity were addressed by noting that executive control codes refer to the dynamic use of procedural knowledge, sometimes accompanied by declarative knowledge statements uttered in response to the interviewer's request for clarification of events. In contrast, learner characteristics and learning situation codes refer to statements about declarative knowledge components which can be drawn on for dynamic use. Learner characteristics and learning situation codes were distinguished on the basis that knowledge about the former always involved qualities the learner brought to the learning situation, whereas the latter concerned qualities that the learner believed to exist in the learning situation regardless of his or her involvement.

Overall impressions

In addition to coding the data, the researcher's more global impressions about individual student's thinking processes were recorded in the form of memos. These were retained for reference during the interpretation phase of data analysis.

Think aloud/concurrent and retrospective interview differences

The two phases of the interview procedure differed in content and this influenced coding procedures and the analysis that followed. For example, in the think aloud/concurrent interviews groups of cognitive actions were coded in terms of the information retrieval process goal they were intended to achieve. In the retrospective interviews the phase of information retrieval being discussed could be identified for reference, but attempts to identify cognitive actions were inappropriate as actions at this point were centred on answering the researcher's questions, not retrieving information.

Similarly, the content of on-line processing, compared with later reflection on that processing, dictated that think aloud/concurrent and retrospective interviews be considered slightly differently. Although metacognitive coding itself proceeded in the same manner for both, events occurring in retrospective interviews were scrutinzed to determine whether they added totally new information or confirmed points made previously. This allowed converging and conflicting evidence to be identified and added to the think aloud/concurrent interview for consideration during data analysis.

Coding reliability

Individual video tapes were viewed prior to coding attempts and again during the coding process. Other materials were then examined for further converging evidence and notes were entered on the transcript as appropriate. Expectations for student performance were easily influenced by the quality of final project reports, therefore these were not examined until coding had been completed.

The writer and a research assistant coded four data sets together, discussing and documenting confusions until 100% agreement was reached and both were satisfied that the coding criteria were clearly specified. An initial comparison of an independently coded data set was carried out at this point, using the formula:

$$\text{Reliability} = \frac{\text{number of coding agreements}}{\text{agreements + disagreements}}$$

The comparison took into account the size of the unit identified for analysis as well as the code assigned and resulted in an agreement level of 86%. The researcher then completed the coding of all data sets. She recoded three sets of data, selected from different points in the coding period, in order to check rater consistency. Across 232 categories, reliability was found to be 0.87.

The research assistant randomly selected a further three data sets and coded them independently. A comparison of the two raters' codings produced a reliability coefficient of 0.82 across 199 categories. Within this, agreement on information retrieval process codes was 92%. For the 174 metacognitive codes the reliability coefficient was 0.81. Here disagreements tended to be about codes within a section, e.g. executive control self-corrects or regulates, rather than between categories such as learner characteristics and executive control.

The ways in which the data were further prepared will be discussed in relation to specific questions and the answers being sought. In the interests of clarity this information will be presented as part of the results.

CHAPTER SIX

RESULTS AND DISCUSSION: PART ONE
LEARNING IN CONTEXT: THE LEARNING SITUATION

Analysis of the data exposed both cognitive and metacognitive aspects of knowledge, resulting in abundant and complex findings. To make presentation simpler and more coherent, these are discussed in the following two chapters.

Part one of the results reviews levels of metacognitive activity then deals with the Form 1 students' knowledge of those aspects of the learning situation that affect how they retrieve and use information. Much of this knowledge is cognitive but it clearly influences metacognitive decision making. The second chapter of results concerns the quality of students' metacognitive knowledge and the executive control processes which operate to determine the path of action during information retrieval.

For the sake of clarity, the implications of the students' knowledge and metacognition for information retrieval success will be discussed as findings are reported.

METACOGNITIVE ACTIVITY

Data analysis initially concerned the degree to which students differed in quantity of metacognition, as reflected by code occurrence, and the proportions of executive control and metacognitive knowledge codes assigned to individual interview transcripts.

Before this simple code count could take place it was essential to check that codes occurring in the retrospective interviews were only counted where they provided new information. One of the purposes of the retrospective interview had been to provide confirmation and clarification of earlier events, thus some duplication of data was expected.

It was found that the total number of metacognitive codes, (those concerned with learner characteristics and executive control processes) assigned for both think aloud/concurrent and retrospective interviews ranged from 35 for Subject 9 to 111 for Subject 20. The mean for the group was 67.3 and the standard deviation 18.4. Similar levels of variability were evident in the proportion of codes associated with executive control processes alone, here the mean was 53.5% with a standard deviation of 18.9. The proportion of learner characteristic codes assigned was smaller, as was the variability across the group (mean 34.9%, s.d.= 11.5).

In general, the students made relatively few statements concerning the demands of the learning situation, the mean proportion of codes being 11.9%. Variability in the number of learning situation codes was considerably less also (s.d.= 4.9). (See Table 2)

It can be seen that all the Form 1 students interviewed were metacognitively active but that the levels of activity varied greatly. A basic question arising from this observation was whether the more active students were also more able in academic terms. Global feelings about the students' demonstrated abilities suggested that this was not the case. Rank order correlations of overall frequencies of metacognitive code occurrence and percentile ranks on Progressive Achievement Tests of Reading Comprehension (Elley & Reid, 1969) and Study Skills (Reid, Croft & Jackson, 1978) were carried out. These data are routinely collected and were available from school records but did not include raw scores.

It was found that there was no significant correlation between the rank order dictated by the quantity of metacognitive codes and percentile ranks on PAT Reading Comprehension or Study Skills (rho =0.09 and 0.03 , $p > .05$).

Given that Saracevic et al (1987) found verbal abilities (e.g. word association) were correlated with success on library information retrieval tasks with adults, a further rank order correlation was carried out with PAT Reading

TABLE 2: Percentage of code occurrence

CATEGORY	MEAN N=23	STANDARD DEVIATION
Total code frequency	67.3	18.4
Percentage of individual students' codes due to metacognition:		
a) executive control	53.5	18.9
b) metacognitive knowledge:	34.9	11.5
Percentage of individual students' codes due to learning situation	11.6	4.9

Vocabulary percentiles (Elley & Reid, 1969). This was similarly statistically non-significant (rho = 0.18, p> .05).

Good strategy use is often assumed to be associated with better reading comprehension. It might also be assumed to be associated with greater quantities of executive control. A rank order correlation, based on the proportion of executive control codes assigned to interviews and PAT Reading Comprehension percentiles, suggested this was not the case in the context of the present information retrieval task (rho = 0.18, p> .05).

Garner (1987) has pointed out that discussing strategy use in unitary terms results in observations of users and non-users, a distinction that sometimes results in the implication that non-users are not metacognitively active. Such perceptions deny access to the information necessary to fostering the development of strategies and combinations of strategies. The present study examined components of metacognition rather than strategy use per se and the foregoing correlation indicates that greater quantities of executive control processing are not necessarily related to good strategy use and higher academic ability. The transcripts of less able students accumulated executive control process codes with a frequency rivalling that of their more able peers. Thus these results tend to highlight the role of executive control processes in managing tasks for which strategies have yet to be developed.

Further, an examination of executive control process categories for which some students provided no data failed to distinguish between less and more able students (as determined by a median split of PAT Reading Comprehension ranking). Eleven students did not verbalize self-questioning episodes, of these four were above the median rank and seven were below. Similarly, both more and less able students were equally represented amongst the twelve students who provided no overt evidence of monitoring understanding. Other categories for which some data were missing were not examined in this way as the number of students involved was fewer than seven.

In terms of the information retrieval task itself, the data did not reflect thinking processes equally across all phases. Opportunities for activity were restricted by limitations of time and the degree of success experienced in early phases of the task. Thus the thinking associated with information extraction and more complex information processing is less well represented in the data.

Activity associated with selection and evaluation of information sources elicited the largest proportion of codes (mean 30.7%) but this phase also evidenced the greatest variability (s.d.=17.1). On average, the location phase accounted for 25.4% of codes while the analysis/ question formulation phase accounted for a further 22.2%. For these phases of information retrieval, the variability within the group was less than that for selection, the standard deviations being 10.1 and 8.1 respectively.

The proportion of codes associated with the information extraction phase ranged from 0% to 39%, averaging 18.3%. That for processing the information gathered ranged from 0% to 10%. These results are displayed in Table 3.

TABLE 3: Percentages of code occurrence for phases of the information retrieval process

CATEGORY	MEAN % N=23	STANDARD DEVIATION
Analysis of information need and question formulation	22.2	8.1
Location of information sources	25.4	10.7
Selection of information sources	30.3	17.1
Extraction of information	18.3	14.2
Processing of information found	3.8	3.3

As one might have expected, the quantity of cognitive and metacognitive activity made available for scrutiny was not indicative of levels of academic performance.

Flavell (1979) noted that metacognitive knowledge, like other forms of knowledge, can be incomplete or flawed. Cognitive and metacognitive knowledge provide the building blocks for executive control processes. If those blocks are flawed, executive control processes can be neither effective nor sophisticated. As one moves from novice to expert status the quality of subject knowledge and related metacognitive knowledge changes. Presumably, this enables parallel changes to occur in the realms of executive control processes. The next task for data analysis was thus to explore qualitatively the content of the students' cognitive and metacognitive knowledge, with a view to finally examining how executive control processes were brought to bear on the task of information retrieval.

THE LEARNING SITUATION

The tetrahedral model, used by Brown et al (1983) to describe variables that expert learners come to consider when designing learning plans, provided broad categories through which cognition and metacognition could be viewed. Resnick (1987) holds that higher order thinking abilities are essential to basic learning and thus one might expect young learners to have a degree of knowledge and awareness concerning these same variable and their interactions.

The first step in assessing the quality of that knowledge and the thinking processes used during information retrieval tasks involved an examination of knowledge and expectations about features which are essentially outside the students, i.e. characteristics of the learning situation consisting of the information retrieval process (learning activity), the library system and books (materials to be used) and the production of a project report (criterial task).

Miles and Huberman (1984) stress the importance of retaining the context of coded events during qualitative analysis and indeed, in this case, separation of context and coded event frequently rendered the data meaningless. For example, students often spoke in terms of "they" and "it", the true referents of which could appear several utterances away from the coded event. It was therefore essential to prepare the data so that the coded events could be viewed against a summary of their original context, retaining also the student's identity and the phase of the information retrieval process that generated the statement. To facilitate access to the original transcript, transcript page numbers were also included for each event. Summaries for all learning situation codes were prepared in this way, allowing items to be separated from the transcripts and then grouped according to content. An excerpt from one such summary is included in Appendix 6.

Knowledge about materials

In an earlier study, think aloud/concurrent interviews with this particular group of Form 1 students had been analysed with respect to the problems inherent in the library system and books (Moore, 1988). This produced information about the students' perceptions of library materials. Such perceptions contribute, in the present context, to metacognitive knowledge. The data preparation and analysis for the current study, described in Chapter 5, differs from that of Moore (1988). Some repetition of the earlier findings is inevitable but here they are extended and the emphasis will be on their implications for students' metacognitive functioning.

In a library learning situation the materials to be used vary greatly. The students' comments and expectations could be grouped as follows:

a) the library system:- where does one begin searching
- the catalogue
- interpreting subject headings and Dewey numbers
- shelving

b) individual books:- selecting appropriate titles
- expectations of indexes
- expectations of contents
- books in general

The library system

Where does one begin searching?

Carrying out library research independently of this study would have begun differently for five students. Having generated some questions, they would normally have gone straight to the Learning Resource Centre (LRC) as they knew they would find encyclopaedias there and could thus avoid problems of locating materials. Student 18 provided an additional reason in that she said using the main library system takes longer. Encyclopaedias are arranged alphabetically and this makes the task of finding information within books faster and easier. Student 11 knew that the New Zealand collection (appropriate to some of his questions) was also housed in the LRC. These students might not have found, nor perhaps needed, the 35 BIRD books in the main library. Denied access to the LRC, they were swift to state that the catalogue was the starting point for information seeking. All 23 students were secure in this knowledge, although only 10 specifically named the non-fiction catalogue. Lack of familiarity with library layout led two students to examine the fiction catalogue briefly. Only one student carried out a prolonged fiction shelving search because she gets "muddled up" over fiction and non-fiction.

Selection of the appropriate catalogue is one of the first major decision points encountered in library use once the focus of the information need has been decided. However, active selection between catalogues may not have been an issue for the four students who simply said they would use the catalogue, without specifying which part. These students gave no sign of knowing there were two catalogues and could possibly have chosen the correct one because it was the closest.

The catalogue

To use the catalogue for this research exercise a search term had to be chosen. The obvious choice for all but two students was BIRDS, which was matched exactly by four cards in the non-fiction subject headings index. Several students were asked, retrospectively, what it means if a particular subject word is not in the catalogue. Three of these (subjects 8, 18 and 23) were certain that it meant the library would not have any information on the topic sought. Subject 21 demonstrated the difficulty students had in coping with the possibility that a search term would not be present (throughout the transcripts five dots indicate a lengthy silence):

Interviewer: When you're doing projects and you've got a subject word in mind and you go to the catalogue, look it up and it's not there, what do you do?

S21: Um.....well, if you know the author or something, you can look it up in the author [index] but.....

A restatement of the question to make it clearer that absence of a subject heading in the catalogue was the problem resulted in a very long silence on the subject's part. However, given a familiar, concrete example she replied quickly.

Interviewer: Say you wanted to know about elephants and there isn't an entry in the catalogue for elephants, where do you look?

S21: Well, they might look under animals and then there might be a big book on animals, get that, have a look in that.

Questioned in the same way, two boys, who had previously had difficulty coming up with different search terms, easily generated alternative terms for topics in which they were interested.

These three students' behaviours changed markedly when the topic was better known to them, thus supporting the view that prior topic knowledge and experience are essential elements in appropriate regulation of behaviours during information retrieval tasks. Generation of alternative search terms is not an option for students who know little of a topic. Nor is it an option for those who interpret search term absence from the catalogue as meaning that the library has no information on the topic.

Expectations about the contents of the catalogue were also disclosed when two students had been unsuccessful in finding sufficient resources and considered choosing another path through the information maze. Subject 20 had looked for BIRDS and found a few mis-shelved books which she took to be the entire collection. She considered returning to the catalogue to search for ALBATROSS but decided not to as she did not expect the catalogue to contain subject headings for both BIRDS and ALBATROSS. However, she did not test her hypothesis and although she was right on this occasion, given a different topic such an expectation might seriously hinder her information retrieval success.

Another difficulty centred on the actual choice of catalogue search terms. Subject 7 had been hunting unsuccessfully in general animal books for information about birds nesting. She considered using NESTS as a catalogue search term but stated that the information this would access could be irrelevant as many different creatures make nests. She had begun her search by looking up ZOOS in the catalogue and came to the conclusion that she would have to look for BIRDS instead. The ability to change the breadth of search terms appropriately seems to be an obvious factor in information retrieval success but again, it is one that depends on knowledge of the topic and, as Saracevic et al (1987) point out, the ability to think of associated words.

Interpreting subject headings and Dewey numbers

Library search patterns rest to some extent on students' knowledge and expectations about the meaning of the subject heading cards themselves. Four cards were of central interest in this study and these are illustrated in Figure 3.

BIRDS 598 598.2 598.29931	BIRDS - PETS 636.61
BIRDS - NEW ZEALAND 598 NZ	BIRDS - PROTECTION 333.9

FIGURE 3: Non-fiction subject index entries for **BIRDS**

Fourteen students simply worked from the first card seen, whereas eight of the 23 students came to the task knowing there could be more than one card. Hence they looked beyond the first card encountered and found a range of Dewey numbers from which they could select one appropriate to their purpose. Few comments were made about the actual subject headings or the cards themselves. However, one student was convinced that there was one card present for each book on the shelf (Subject 8). This student was also certain that BIRDS - PROTECTION would refer the reader to a general book which would be unlikely to focus on New Zealand birds. Predictions of this nature are essential to narrowing the field of search but while she thought she was ignoring just one volume, she was in fact ignoring at least six. As will be discussed later, other students also seemed to know that the 'right' Dewey number could be selected by comparing subject headings with the question to be answered and predicting the range of topics associated with those headings.

Another student (Subject 2) expected to find different aspects of the topic on different cards and this expectation was met, apart from the card displaying three variations of 598. This particular card brought student understanding of the Dewey system into focus. While all but one student clearly stated or demonstrated that they knew identifying a Dewey number for a subject would help them locate books on the shelves, only one student (Subject 14) was able to give any explanation of the difference between 598, 598.2 and 598.9931.

Interviewer: Okay, do you know what all these numbers mean?

S14: Yep, there's different birds 598, that's probably birds, you know, birds, and then comes two different kinds of birds

Interviewer: Yes, what about this bottom number here? The .29931, what does that mean?

S14: Oh, that means, well, getting more complicated and different sorts of birds.

While this was an attempt to explain, it was pretty hazy! Asked directly, students usually said they knew the numbers were Dewey numbers and that they "tell you where to look" but questioned more closely they showed that they were typically uncertain about the meaning of the decimal points. These they explained in terms of the points being "just another number on the book" (Subject 12) or they simply said they did not know.

Six students based their later shelf search on the knowledge that there was one book for each Dewey number. For example, Subject 8 (who had earlier indicated that she thought there was one book for each card) took a book and carefully ticked off a Dewey number that she had previously recorded. The following exchange took place:

Interviewer: When you ticked that off, what did you mean by that?

S8: I've found my book that I was looking for.

Interviewer: How do you know that that's the book you were looking for?

S8: (Indistinct mumble)

Interviewer: Is that simply because of the number or.... what is it?

S8: Well, I think so. It's what was in there (points to catalogue) and it's got the New Zealand sign so it's...I think it's the book.

An additional example is provided by Subject 3 whose behaviour prompted the following question:

Interviewer: Do you think there's only one book with 598.2 on it?

S3: Yeah, there's likely to be. Cos they don't have many of the same number because if they do, you wouldn't know which book is the one. Say if they had two 598.2 instead of having a 2 after it, they'd put a different number.

This sort of knowledge also led to problems when a few mis-shelved books were located. It made reasonable the assumption that the entire BIRD book collection consisted of three books, and having found the book for which they were searching, some students working independently might well think that further searching in this library would be futile.

Shelving

With regard to the actual shelving most students knew that 598 books should be "in the 500s". Only one student (Subject 20) specified that they should be at the end of the 500s, near the 600s, and began her search accordingly.

Subject 18 voiced a problem that many seemed to experience but failed to put into words. Although she could use the shelf guide to find the beginning of the 500s, she said she did not think it was very clear were she should look once she came to the end of the shelf. Subject 11 agreed, during his retrospective interview he said that where they put the books muddles him up. "When they stop here, you never know if they go on there or not... sometimes they go along there or they go to here and then they go along". Part of this problem lay in students' perceptions of the shelving method. Seven students gave clear evidence that they expected the shelving to be continuous. Figure 4 elucidates the problem.

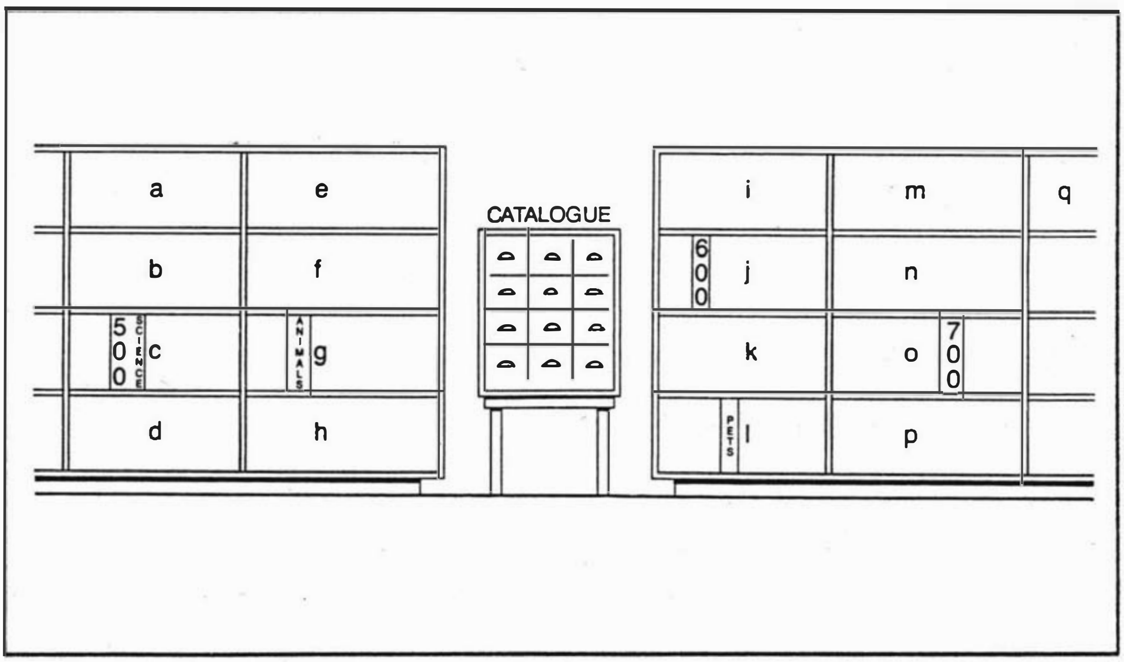

FIGURE 4: Shelving of the non-fiction collection relevant to searching for Birds, Dewey 598 and 598.2

The library shelving consists of adjacent bays which are filled top to bottom in turn. Some students expected Dewey numbers to be continuous across shelves **a** and **e**, and **b** and **f** etc. This perception affected search patterns, leading some students to ignore relevant books and to spend much time searching inappropriately. In contrast only three students clearly demonstrated that they came to the interview knowing that books were shelved bay by bay.

The accidental inclusion of a few mis-shelved BIRD books at location **h**, illustrated above, exposed varying levels of student knowledge about library systems as a whole. Some students expected the system to be perfect. For example, Subject 5 did not think to look past the mis-shelved volumes because he thought "it stopped there" and Subject 15 said retrospectively that he expected all the BIRD books to be together, so he would not look anywhere else. Yet libraries are often forced to shelve part of a collection separately, simply because of the size of the books. A few members of the class seemed more aware of this. In the course of general discussion about locating books Subject 3 said that books are sometimes mis-shelved and Subject 4 recognized the problem as soon as she encountered the mis-shelved books:

> S4: It goes up to 595... oh, it seems to be out of order.... the rest of the bird books are somewhere else.

In total, eleven students located the mis-shelved books but only four of these searched for the rest of the collection unprompted.

The expectation that books would be shelved in strict numerical order led also to predictions about the availability of particular books. Subject 1 knew that if she searched systematically and found a Dewey number higher than her target number, the library did not have "her" book. One got the impression that she would therefore stop looking but, perhaps because she was in an interview situation, she persisted, saying "I don't think they'll have it." She reacted with surprise when a book was located a few moments later.

On a purely subjective level, it seemed that when a Dewey number was not located as expected, students attributed the failure to the library not having the book (although the catalogue listed a subject heading) or to someone having borrowed it. Few students seemed to be prepared to examine their search strategy and indeed their "knowledge" of the system may have precluded this.

Individual books

Selecting appropriate titles

All students were faced with the selection of books relevant to answering their questions. However, their knowledge concerning how the properties of the materials can be used to help them was usually demonstrated rather than being stated, consequently this issue will receive greater attention when tactical knowledge is discussed in the following chapter. It is clear, however, that students relied heavily on matching titles and cover illustrations to the content of their questions. The three students who did specifically mention book properties expected to find a title with at least one word present from their questions. This was highly appropriate for the student seeking information on New Zealand birds, as it allowed him (Subject 11) to ignore books discussing birds in general. It was not helpful for the girl (Subject 2) who wanted to know what birds eat. She sought EAT in a title, failed to find it and concluded that "they don't write many books about what birds eat". The remaining student who commented on the nature of book titles was seeking bird information in zoo books. She observed that the best book for her purpose might not have ZOO in the title at all (Subject 7).

Tables of contents

Having found or selected a promising volume, students face the task of locating information within it. What do they know about the books themselves that will help (or hinder) them?

Only one student failed to use organization aids such as the table of contents. Subject 12 claimed that he did not use indexes or contents pages "because you don't really know what you're going to find". Thus he preferred to look for interesting pictures and was quite stunned when faced with examining a large volume on birds. He observed that "It's going to be hard to read all of it" but did not respond to prompting that there were other ways of approaching the problem.

The knowledge of other students varied from confusion between contents and indexes (and consequently harbouring the expectation that entries in tables of contents would be alphabetically ordered) to knowing that chapter headings indicate the level of text generality. The extent of the confusion was evident in a speech by Subject 19 who announced that "good books have an index" while he busied himself with searching the table of contents! On the other hand, Subject 14 was able to reject one volume after a cursory glance. He wanted a book that focused on specific bird species, not birds in general and used the table of contents to gauge the focus of the book.

Many students quite reasonably expected chapter headings to reflect accurately the content of text. The predictions based on such expectations varied widely in depth and accuracy, as will be discussed later. In general, however, students knew that the contents could be used to locate information, only one student went beyond this to using the contents to predict the scope of the material included.

Indexes

The other major aid to discovering book content and organisation is the index. The students revealed that they had specific expectations for the format of these and two observed that not all non-fiction volumes actually have indexes. One of these (Subject 17) claimed she could predict from the general appearance of a book whether or not it would have an index. She was correct on two occasions during the interview period and one wonders whether she would have bothered checking had she been unobserved.

As expected, there was heavy reliance on indexes, with 20 students making use of them at some stage of information seeking. Subject 19 re-shelved books immediately if no index was present, saying with strong feeling "This one's rubbish". The actual format of the index was an issue for some students as well. Subject 23 expressed a strong preference for indexes which had clear headings for each letter of the alphabet. Another student knew that some indexes have sub-entries which would allow him first to look for HAWKS and then for sub-entries for COLOURS and WINGS. He experienced some disappointment when the index he planned to use in this way was of the "right" format but did not include his chosen search terms.

The search procedure for five other students was similarly disrupted when they found that indexes of BIRD books often list only the names of bird species covered, not general items such as FLIGHT, NESTS and FOOD. The effect of this failure of the materials to meet student expectations is illustrated by Subject 10 who decided further examination of a book was futile: "I won't get anywhere, it's just birds in there". Two other students (Subjects 5 and 22) came to the conclusion that the required information just was not available in books. As Subject 5 said of how birds fly, "Most books don't have it I suppose". In contrast, Subject 12 expected indexes to "classify all the different types of birds". However, when pressed, he said he thought one could find out about habitats and flying, but he was not at all confident that these words would appear in the index.

The issue here is the students' knowledge of words appropriate to index searching. Subject 17 was the only one to voice a definite opinion on this. She thought that some words were better for searching than others. She wanted to know which birds live in hot and in cold areas and stated that neither HOT nor COLD would be right, but then, neither would she expect to find AREAS.

It seems to be only a short step from expecting something to be the case to "knowing" that it is or is not and tailoring learning activities to match. If most books are not expected to include information on how birds fly, why bother looking?

These comments on indexes also raise once more the question of what students know about the absence of a search term. At one end of the knowledge continuum there were students like Subject 23 who was certain that absence of a chosen search term meant that the required information was not in the book. Two others, asked direct questions about search term absence, were uncertain whether the topic would be covered in the text somewhere. The other end of the continuum was illustrated by Subject 14 who automatically and easily generated alternative search terms, excusing the author's omission of his chosen term on the basis that he or she might not have known that term when writing the book!

Overall, students expected to find the keywords from their questions in indexes and if they were absent, few were prepared to generate alternatives. Only six of the 23 students spontaneously thought of a different search term while searching indexes. Others appeared to assume that the book was lacking, not their method of search.

Individual books in general

Comments reflecting the students' general knowledge about books and book use led to some interesting evaluations of volumes. For instance, some knew that the information recorded in books can be out-dated and therefore may be inappropriate. Two students specifically discussed checking publication dates and accepting the more recent information. One of these (Subject 11) had some interest in birds and was also aware that "bird books of the world don't usually have much about New Zealand birds".

He tailored his selection of books accordingly. However, this narrower focus led him to reject a book on birds of prey that would have provided him with more of the necessary information about falcons in general than he was able to locate in books about New Zealand birds.

Other students were able to use the structure of books as an aid to information seeking. Knowledge ranged from the simple level of knowing that sub-headings can be used for location of information, for example, the heading "flightless birds" might contain information about kiwis (Subject 21), to more critical comparison of overall style. Subject 13 spontaneously read the cover notes of a volume, having glanced at the text format, and concluded that the author was giving personal opinion about bird characteristics. She turned to another volume saying:

> S13: This one's got all about the bird itself, it's not like that (touches previous volume). This one looks like it's from an encyclopaedia.
>
> Interviewer: More like an encyclopaedia?
>
> S13: Well, it's got the bird's name and then it's got written all about the specific bird.
>
> Interviewer: Right. That one's better for your purpose is it?
>
> S13: Well, it is for finding out the New Zealand birds.

Subject 14 also demonstrated a great awareness of the implications of book structure for finding information. He had identified the bird he wished to know about in one book and, leaving it open at the right page, he picked up a second for further information. However, the first was organized according to individual bird species, the second grouped birds by their habitat. Instead of using the index to check the inclusion of the bird of interest, he returned to the first book and read the text to find out about its habitat. Thus he used information from one volume to help him negotiate the organizational structure of the second.

The overall appearance of books clearly had an effect on information seeking also. One girl (Subject 13 again) rejected a book as "not having much knowledge" because it appeared to be "jokey". This was in direct conflict with the aim of publishers who probably thought they had presented the material in an appealing manner with lots of pictures, no large blocks of text and the odd true/false question for added interest. Similarly, another student (Subject 20) became most concerned as she encountered page after page of photographs: "Don't tell me it's all pictures in here!". There was a great sigh of relief when text was finally found.

As previously mentioned in discussing the selection of books, these Form 1 students relied heavily on the cover information. They expected to be able to predict something about the content from it but could be led astray by the nature of their own predictions. The most extreme example of this came from Subject 23, a boy who was highly able to talk about his thinking but had some difficulty coping with text.

Interviewer: (After the boy made a detailed prediction of book content) So you can get quite a lot of information from the outside of the book?

S23: Yeah, ... I sometimes look for interesting books, that look interesting but they turn out not to be interesting as say......I get a bit disappointed but they look, they look pretty interesting but they didn't turn out to be it.

A few seconds later he took a book Black Robin Country off the shelf as follows:

S23: Birds of the Country might have some of it in. This should have something in it.

Interviewer: Now what do you think that book's going to be about?

S23: (Without opening it) It's going to be about the country and it's going to tell you things that happen in the country.

This last was said with great confidence but the book focused on Chatham Island fauna and he finally rejected it as it offered no answers to his questions on fantails.

Other expectations about the materials to be used in this task centred on the exact format of information within the books. For example, Subject 11 expected to find a list of endangered birds that he could copy but the information was scattered through several books and was less easily accessed, and Subject 16 expected the answer to her question about kiwis to be answered simply:

> S16: That one (book) doesn't say anything... I thought it would just say that, how many eggs that it usually lays.

A few seconds earlier she had read aloud, saying "when the clutch is greater than one, the second egg...", however, she did not recognise this as information about how many eggs are laid.

Knowledge about materials: Summary

During the interviews, the Form 1 students in this study shared only a small part of the cognitive knowledge and expectations about the materials that contribute to the metacognitive knowledge they bring to bear on information seeking tasks. They clearly have experiential knowledge of where resources are housed in the library and how one should begin a formal library search. It is evident, however, that some would not normally use the catalogue to begin a search, although they know how.

In general, their knowledge of the catalogue did not appear to extend to an understanding of the implications of failing to find a chosen search term, although this was not fully tested within the research task. Similarly, although they could locate subject heading entries, their knowledge of the relationship between the information displayed and the actual books on the shelf was not secure. The number of cards and the decimal points of the Dewey numbers led some students to expect to find a set number of books which were to be easily identified as "the book I was looking for". If this were the case, selection strategies requiring the evaluation of content would not be required.

Only three students obviously came to this task with accurate knowledge of the shelving conventions which dictate effective visual search patterns. Seven students were convinced that the shelving was continuous and searched accordingly. The perceptions of the remaining 13 students were not clarified. Actual location of books was further disrupted by the expectation that the Dewey decimal order for shelving would be accurately adhered to - yet the students themselves did not seem to be concerned about re-shelving books correctly, most merely poked books in the general position from whence they came, only two were seen to check the Dewey numbers carefully.

When it came to the books themselves, it was heartening to find that all but one knew that tables of contents and indexes reveal the informational content. However, Subject 14 seemed to be alone in knowing that they also reveal the organization of that content. In general, the students' expectations for books were strongly tied to their current purpose. The language was expected to match the students' own, in particular that used in their questions, and absence of search terms was often taken to mean that the topic was not included in the book, or indeed, in the entire library.

The reactions of the students to book layout and language raise a major suspicion that many approached this information retrieval task with the expectation of finding the exact answer to their questions in the exact format required. The notion of constructing an answer was not apparent. This in turn brings into question their general expectations about what is involved in research based learning tasks. These will now be examined through their stated knowledge of the learning activity and their statements about producing a project report.

Knowledge about the learning activity and criterial task

The students' knowledge and expectations about the learning activity were often tightly bound with those of the criterial task, thus the two will be discussed together. In general, students made considerably fewer statements about these aspects of the learning situation than they did about the materials with which they had to work. This cannot be taken as evidence that they knew more about the materials than the activity, but it may indicate that features of the library system and books were more salient to students during the interview and were a more familiar topic for discussion.

Task parameters

That students know project assignments vary in requirements for content and format can be inferred from student questioning about task parameters. Five students sought information about the number of questions they should tackle and similarly, five asked about the type of questions to be included. For example, Subject 17 wanted to know whether she could ask questions for which she already had answers, while Subjects 20 and 21 explored the scope of the information required - were there any limits? Could the student follow any line of questioning? Could all questions be about one type of bird? Everyone else assumed that they knew what was involved in the task although they had completed only two projects under the guidance of their present form teacher. They did not spontaneously question evaluation criteria at all. However, asked how many questions they would normally attempt, they were in fairly close agreement. Five students thought three or four questions were enough, four others opted for five to eight questions and one student claimed he would do ten questions. This was hastily revised downwards when the interviewer accidently allowed her surprise to show! This student (Subject 22) was the only one to enquire whether a booklet would be a suitable format for the end product, everyone else just went ahead.

Defining information needs

The task of formulating questions attracted some student comment. Subject 11 noted that for topic work in the previous year (Standard 4) "we didn't really make out questions, we just did it generally". Subject 8 (recently arrived in New Zealand from overseas) said questions were usually set by teachers but other students were able to compare the ease of completing projects using teacher-given questions with those in which they generated their own. Subject 20 preferred to choose her own questions and Subject 17 (in common with several others) found question formulation difficult. She also observed that making a contract to answer certain questions is very limiting as she often thinks of "better" questions when she begins searching for information. To her the contract was binding. This cannot be said of the other students, since only 48% of questions set during interviews were actually answered. The other 52% seemed to be substitutes tailored to fit the information found.

Some of the students' assumptions about what is involved in information retrieval tasks and about the nature of the criterial task were apparent in their efforts to define the information needed. Three students (Subjects 6, 8 and 9) stated that the questions they set themselves should extend the knowledge of the people who would eventually read the project. Subject 8 put it most eloquently:

S8: I think most people know where they (birds) live so if somebody was going to read my project, they might not want to know, read something that they already know. They might know that birds live in trees.

Interviewer: So when you write a project, do you write it to tell other people about the subject?

S8: I write it to give information like a book or something.

Subjects 17 and 20 seemed to agree with these students in that they both rejected question ideas "because most people know that". The basic requirement as they saw it was that the information included had to hold the attention of the reader.

At least one student (Subject 12) had some conception of what types of information were available in books. He rejected two questions that came to mind (what type of climate does a sparrow need to live in? and why do birds eat what they eat?) because "there's not, you wouldn't be able to find much information on that". This was essentially an untested prediction but three other students made similar predictions while actually carrying out searches. The effect of such predictions can be gauged from a study using adult information searchers in which Saracevic and his colleagues (1987) found that expectations about what is public knowledge clearly influenced what was found.

To some degree students did know that the type of question asked constrains the activity that follows. For example, Subject 12 suggested that What different types of birds are there? implied listing every bird in a particular book, which would be boring. On the other hand, Subject 21 did not consider detailing all the birds in existence, preferring to suggest that the answer to that same question would require descriptions and drawings. Neither considered whether their method of answering the question would meet a teacher's requirements for the criterial task.

Research activities

In general, students had little conception of the activity necessary to complete the research task they set themselves. Most questions were broad and rather vague, as can be seen from the following examples:

What kinds of birds are there? What do they eat?
What birds are near extinction? Where do they live?
What are birds in danger of? Which birds camouflage?

Without some notion of the size of the task and what it involves students may not be able to re-define the information need in terms of questions that can realistically be answered within a given time-frame and range of abilities. Some refinement of questions did occur during the course of searching, as will be discussed later, but at this stage of the data analysis the overall impression was that students' knowledge of the learning activity was insufficient to allow extended planning that integrated the activities essential to each phase of the information retrieval process. It appeared that they were forced to progress through the task phases in a piecemeal manner. There was one exception. Subject 14 made no direct statements about the learning activity and only two comments about the criterial task but demonstrated a high level of knowledge. He proceeded quickly and efficiently from the start of the interview and seemed to be "on automatic pilot". He quickly selected two ducks that he would like to know more about and decided that information about their size, general appearance and habitat would be appropriate. It was almost as if he had a formula that he applied to all project tasks and a ready-made plan that would get him through the task as quickly as possible. His approach to the task is explored in the section on executive control.

Sufficiency of information found

The students were not expected to locate sufficient information for their projects during the interview period but ten did comment on the sufficiency of the material found to answer their questions. Four (Subjects 3, 16, 18 and 21) were sure they would have to return to the library for more information but six others were at least partially satisfied with their efforts. Subject 14 said he had found enough to write one or two pages, which was all he thought it necessary to do, while Subject 23 thought he could write about one of the birds of interest and get more information on the others. Subject 20 had posed questions that could be answered with single sentences - what is the wing-span of an albatross? where do they live? - and the interviewer had to agree with her that she had found enough information to answer them. However, three students (Subjects 9, 19 and 22) were sure they had sufficient information when in fact they had found virtually nothing that related to their questions. The issue here was not just the information found but the nature of the questions that students thought were appropriate to project work. There was no clear evidence that any student considered the questions formulated in terms of the criterial task of report production, yet the questions themselves dictated how much and what type of information would be needed.

The final report

Subject 18 was the only one to make direct comment on the final presentation and content of the report. She said "[The teacher] wants us to create our projects so they won't look scruffy, so they don't be a boring one." This seems to be in line with earlier comments about holding the reader's attention. Other comments from which it can be inferred that students are aware of teacher requirements included those from two students who noted that the final effort would have to be written in their own words (Subject 5 and 21). Subject 21 was also aware that she might have to take information from several sources to find enough to write about. However, the project she handed in suggests that her approach was not one of integrating information, rather she simply accumulated and presented it.

Further evidence that students held widely differing expectations about what would be required at the evaluation stage of the task is apparent in the reports themselves. These varied from mostly artwork, with a couple of written sentences, to several pages of written text which often bore a close resemblance to the published works found.

Knowledge about the learning activity and criterial task: Summary

The participants in this study made relatively few direct statements about the nature of the learning activity in which they were engaged or about the task they hoped to complete. Most merely assumed they knew what was required. Only five students sought information about the number of questions to be answered and five asked generally about the content areas to be covered. A further ten students were specifically asked how many questions they would normally include in a project and seemed to agree that between three and eight would be satisfactory. However, no student appeared to consider whether the complexity of the questions posed would affect the number that could reasonably be researched in the time allowed.

Although students recorded their questions on a contract form, only one saw this as binding. Of the answers appearing in final reports 52% were responses to questions other than those set during the interviews. The relationship between the task of defining the information need and the production of a final report cannot be said to be clearly perceived by these students. Indeed, they seem to be like those whose note-taking was reported upon by Sheingold (1987). In that study it was found that the notes taken bore little relationship to the information problem to be solved, and the solutions offered were only indirectly related to the notes taken.

Five students provided evidence of considering, at the very beginning of the task, the needs of those who would read the finished product. This awareness affected their choice of questions, if not the actual information gathered. One of these (Subject 20) also sought information about other general requirements of the criterial task. Irving (1985) indicates that the definition of the topic questions, the purpose of the assignment and the audience for whom it is intended must all be considered if the later task of note-taking is to be meaningful. Subject 20 may not have been able to coordinate and integrate her activities very well, but she certainly appeared to be building up the elements of knowledge necessary to the development of effective information retrieval and use.

The students' knowledge of what was involved in answering the questions set was rarely stated in terms of the learning situation alone. Only one student changed a question because of its implications for later action yet six other students seemed unaware of the consequences of defining an information need in very broad terms. This lack of understanding extended to student evaluations of the relevance and sufficiency of the information found. As will be discussed later, some students did not seem to know what they must do with the information found. Thus they were in no position to make an accurate assessment of the sufficiency of that information for answering their questions.

If the students did have more knowledge regarding the learning activities and requirements of the criterial task, there was little evidence to indicate that they could spontaneously activate it as the basis of finding out what they were expected to do. Indeed, this assignment was typical of Sheingold's (1986) description of category-based tasks and was extremely ill-defined, yet the students generally accepted it without question. Specific questioning based on these points would clarify whether that acceptance was due to ignorance or perhaps to a reluctance to challenge requests made by adults.

Learning in context: Summary

This chapter began by examining briefly the quantity of metacognitive activity engaged in by Form 1 students during an information retrieval task. Although the literature generally associates higher levels of metacognitive activity with better academic performance, no significant correlations were found between students' ranking in terms of the quantity of metacognitive codes assigned to transcripts of their interviews and their percentile ranking on PAT Study and Reference Skills, Reading Comprehension or Reading Vocabulary. However, it must be recognised that whereas much of the literature discusses metacognition in terms of strategy use, the present study included examination of the components of knowledge essential to strategy development as well as their application.

If one considers the above findings in light of the view held by Garner (1987) that metacognition is essential to the development of strategies as well as to their application, the assumption that there are metacognitive and non-metacognitive students becomes untenable. The overall quantity of metacognitive activity is unimportant, rather there appear to be differences in the quality of the knowledge brought to bear on tasks and these would seem to constrain the quality of the metacognitive activity that can be applied in a learning situation. Moreover, metacognition is not an all or nothing affair. As Resnick (1987) points out, high order thinking processes develop along side those considered in the past to be more basic to learning and it follows that they will vary in their sophistication and consistency of application. Distinctions between students' levels of academic performance and metacognitive functioning must rest partially on the content of their metacognitive knowledge and the flexibility with which they apply it during cognitive tasks.

As a result of the interview technique used in data collection, the number of responses on any one aspect of the learning situation was small. What is more important here is the range of knowledge that students brought to the task.

In general the 23 students disclosed more of their knowledge and beliefs about the materials they must use than about the learning activity or the criterial task. Despite some students having a preference for using encyclopaedias for information retrieval tasks, all students expected to locate appropriate materials through use of the catalogue and Dewey system. Levels of understanding of the library system supported confident, efficient information retrieval by very few students. Misunderstandings centring on the relationship of subject heading cards, Dewey numbers and the books actually on the shelf led to reduced expectations concerning the number of books to be found by several students. Further, only three students appeared to come to the task with accurate knowledge of the shelving conventions which dictate the visual search patterns necessary to purposeful location of target materials.

Students were sometimes surprised when the layout and language used in texts failed to meet their expectations, particularly when keywords from their questions proved to be ineffective in accessing information. The unvoiced assumption seemed to be that books would match their reading levels, levels of prior topic knowledge and be organized according to their conception of the topic.

With regard to the learning activity itself, i.e. retrieving and using information, most students assumed they knew what was involved (answer between 3 and 8 questions) despite the fact the task was very poorly defined. Only five of them specifically sought information on how many questions were to be attempted and only five tested the limits of content in any way. That the learning activity can be adjusted to meet criteria for the evaluation of learning appeared to be totally unrecognised except for four students who were concerned to formulate questions interesting to an unspecified audience. Without knowledge of the relationship between learning activities and their intended outcome it would seem to be rather difficult to define sub-goals and plan action appropriately. Evaluation of progress on the overall task would also appear to be impeded.

This perceived lack of continuity between the learning activity and criterial task is also reflected in the students' attitude to the contract used to record their path through information seeking. Most apparently viewed this in a very flexible manner, changing questions in response to the information found with no dire consequences expected.

Information retrieval tasks are evidently extremely complex and provide a grand arena in which metacognitive abilities can come to the fore. That the students made few comments about the nature of the learning activity and criterial task is not too surprising since they lack familiarity with such learning activities. Books and library systems are more familiar and provoked the disclosure of more knowledge, both accurate and inaccurate. However, this knowledge is only part of that brought to bear on information retrieval tasks. The following chapter will examine metacognitive knowledge (including tactical knowledge and the children's perceptions of themselves as learners) together with the executive control processes that co-ordinate the whole information retrieval task.

CHAPTER SEVEN

RESULTS AND DISCUSSION: PART TWO
METACOGNITIVE KNOWLEDGE AND EXECUTIVE CONTROL PROCESSES

Having explored the content of students' knowledge of the learning situation, attention now turns to knowledge of themselves as learners. It is in this section that the relationship between executive control processes and the acquisition and use of metacognitive knowledge was most evident. Executive control process outcomes contribute to the knowledge a student has concerning his or her learning characteristics, thus distinctions between these two aspects of metacognition may sometimes be blurred. While the first part of the chapter deals with self knowledge of learner characteristics, the second part will focus on how students coordinate the knowledge elements discussed in this and the previous chapter to direct the course of information retrieval from libraries.

METACOGNITIVE KNOWLEDGE

Learner characteristics

Data concerning learner characteristics were categorised in terms of knowledge of interactions among aspects of the learning situation and their implications for activity, knowledge of general learning abilities and approaches to learning, states of knowledge, prior topic knowledge and tactical knowledge, as detailed in Chapter 5. Analysis of data in these categories proceeded as before, with contextual summaries being made to accompany each coded incident prior to grouping events by their content.

Interactions betweeen aspects of the learning situation

While the number of coded events in this category was relatively small, statements and inferences based on the Form 1 students' metacognitive knowledge in this area were diverse. Their content was concerned with the following issues:

a) questions

b) keywords for locating information in books

c) using contents tables and indexes

d) processing information

e) time management for project assignments

f) others

Questions

This group of statements was by far the largest within the interactions category, comprising some 24 items, concerned with the conditions which influence the ease of question formulation. Two students (Subjects 1 and 14) stated quite clearly that what is known of the research topic determines how easy it is for them to come up with questions. While an additional four students agreed that knowing something of the topic before you begin makes the task easier, three others seemed to think it was easier to think of questions when the topic was previously unknown. Subject 17 said she knew "a fair bit about birds and I can't think of other things I need to find out". Subject 21 was in a similar situation and concluded that "there's not many questions I can ask" while Subject 5 suggested that having prior topic knowledge would make it easy to ask questions for which answers were already known, but it would be hard to think of questions that extended knowledge.

In all nine students were able to provide information retrospectively about the general influence of prior knowledge on the task of identifying research questions. Despite this awareness very few students attempted to review in depth their knowledge of the topic BIRDS when defining their information needs. The way prior knowledge was actually used will be discussed later in this chapter.

Other factors seen to influence the ease of question formulation included actually being given enough time to think (Subject 2), being interested in the topic (Subject 11, who had a great deal of prior topic knowledge) and the expected availability of the required information in books. This last was identified by three students. For example, Subject 10 said it was pretty difficult to come up with questions and went on:

> S10: "You have to think about what questions are ... like are they going to be easy to find or hard to find ... or are they going to be able to be found in the library, things like that ... It's hard to find a good question that you know you'll be able to find answers for."

Subject 14 had a solution to this problem. Asked how you make sure it's going to be easy to find, he replied:

> S14: "It's got to be a wide question, and it's got to be an encyclopaedic sort of question, a book sort of question, like what are the birds in New Zealand? and it'll be easy to find."

These two students were able to be quite explicit in discussing the qualities of questions appropriate to information retrieval tasks. Subject 18 was aware of that a problem existed but had no specific solutions other than thinking hard. Other students certainly shared some awareness that there are "good" and "bad" questions for researching but were more concerned with whether they already knew the answer (Subjects 8 and 17), whether it was boring or too easy (Subjects 12 and 21) and whether it was too hard to find a simple answer (Subject 19). In each case, students knew there was some sort of interaction between the type of question set and the activity necessary to answer it, but managing the situation to their own advantage was an option only for Subjects 10 and 14.

Keywords for locating information in books

Few comments were made about the relationship between keywords and the activity of locating information. Most students seemed to think they should use their questions as a source of keywords for locating information in books but this proved to be less easy than expected. For example, Subject 4 knew she would have to adjust her search terms to the demands of texts. She was asked how she decided what the keywords should be and replied:

> S4: Well, if you're looking up in an index ... what they'd most likely come under. What sort of birds are getting extinct? I'd probably put EXTINCTION.

A few seconds later she ran into trouble trying to identify search terms for the question What is a bird?

> S4: Well, look under BIRD. Well, if it was a book on birds, to look under bird would be a bit queer.

In this testing situation she completely forgot her earlier statement and selected WHAT, IS, IT as search terms and actually looked for WHAT in the index!

Subject 9 thought he should adjust his keywords in light of the information actually found. Having very successfully located a page of text on how birds fly, he informed the interviewer that "Looks like my word 'flying' isn't a very good one... there's a lot of words 'flying' here." He later explained that it was a good search term for locating information within the book, but a more specific term was necessary to identify the right place on the page. Apparently he did not expect to have to read an entire page to answer his question.

Although six of the 23 students spontaneously sought alternative search terms during the interview period, only two voiced their awareness that the keywords they select for searching books may need to be changed. Subject 14 commented that finding information is sometimes hard because he does not always know the most appropriate search term. He gave the example of failing to find information about Pascal's triangle but succeeding later when he used a term gleaned from reading. Somewhat surprisingly Subject 8 also commented specifically on the need to generate alternative terms when a chosen search term is not present in an index. Earlier she had declared that absence from the catalogue of a chosen search term indicated that the library would hold no books on the topic.

This knowledge apparently did not hold for single volumes and supports the view that aspects of metacognitive knowledge can be inconsistent.

Using contents tables and indexes

When faced with actually using contents tables and indexes some students were aware that they had marked preferences. For example, two students preferred contents tables. In the case of Subject 10 this was due to the difficulty of scanning a large index:

> S10: I mean it would take me a long time to look through all of them [entries] cos I wouldn't, don't even know ... what I'd really be looking for, like B or A or something like that.

The notion of spot searching an index for a particular keyword did not seem to be an option. Subject 23 knew which letter began his search term but he too was reluctant to use indexes. On the basis of observing his attempt to locate a subject heading card in the catalogue one can infer that his knowledge of alphabetical order within a word was insufficient to narrowing the field of search further.

Two students knew they would have difficulties using contents tables. Subject 19 rejected all books without indexes because he claimed that using the contents makes finding items about specific birds hard. Subject 17 was aware that using the contents was complicated by the fact that she simply could not understand the vocabulary used. This sort of knowledge certainly influenced the path of information retrieval and the chance of achieving successful outcomes.

Processing information

The present study was not designed to focus in detail on how students would process the information found but some revelations were made. For example, Subject 17's knowledge of herself as a reader surfaced again when she located material of interest. She reacted with dismay when a large block of text was encountered and in discussing the problem said that she would find it easier to understand if there were more diagrams. Long paragraphs were mildly irritating to Subject 4 also:

> S4: It's hard if there's a big paragraph and then you see the word... like I was looking up EXTINCTION... and you see the word extinct and you've got to go all the way back to find out where that started. Sometimes it takes a long time...

Expectations for the work involved in processing the information were verbalized by two students in the context of the interactions category. One (Subject 20) had posed a question about where albatrosses live but when searching for that information came to the conclusion that she "couldn't get a proper answer for it because they live in all different places". One infers that she expected to find a single location as an answer but lacked a method of dealing with information that did not meet her expectation. Her final project simply said they live at sea.

Subject 2 was one of the few students to demonstrate an awareness that information from different sources would have to be combined. For many it was not an issue since the information fragments found were not seen to overlap in content. However, Subject 2 intended to answer her questions by listing as many bird species as possible. Consequently, she scanned everything in sight for items to add to her list and checked back to a contents table in one volume to verify that they had not been seen previously. Her awareness of the need to integrate information did not extend to grouping the birds listed by any particular feature however, she merely added new items to the end of the list.

Time management

In designing the present study, no expectations were held concerning the students' awareness of time as a factor in managing information retrieval tasks. It was therefore somewhat surprising to find that three students specifically mentioned time management. Subject 10 thought about time from the very beginning of the task. He said he wanted to come up with questions that were not "too widely spaced". Asked for clarification, he replied:

> S10: Well, so it won't take me too long, like one question may take me ages and ages and I won't get anything else done, just that one question.

That one question might be sufficient was not considered. In contrast, Subject 13 was only aware that she often ends up rushing her work to get it in on time. She said that if she's having difficult finding information she "mucks around" and is forced to do work hurriedly. A third student (Subject 18) commented on time management in two ways. In the context of writing notes she stated that she would take notes but not for long:

> S18: Well, just a little bit and then I could go on to the other books so I won't waste all my time.

The point seemed to be that taking notes from one book was not sufficient, other books must be examined, but time would limit how long she could spend on each one. She was later asked whether she ever changes questions in response to the information found and again, time was the deciding factor. She concluded that if she had "quite a lot of days, I would change the question, and so I'd get a better mark for my project."

Others

The remaining events that were categorized as interactions serve mostly to confirm events detailed earlier as part of the learning situation. Additional insights into how elements of that situation interact with the learner's personal characteristics come from Subjects 13, 20 and 23.

Subject 13 mentioned project work currently being undertaken in the classroom and observed that group work is alright only if she is with friends who cooperate. Where cooperation is lacking pressures of time are more evident and working alone is to be preferred.

In relation to actually locating books, Subject 20 had some difficulty distinguishing between fiction and non-fiction. She explained that some fiction is based on real events and the division between fact and fiction becomes blurred. Apparently, knowing that the distinction is not always clear contributed to her difficulty in deciding which section of the library was appropriate for this task.

Although Subject 23 had no difficulty selecting the non-fiction catalogue, he had some trouble locating subject headings within it. He was later asked whether he had ever thought of using a different search term to access books using the catalogue. He said he had not thought of that before but went on to explain that he cannot understand what the subject headings mean:

> S23: ...the big words I can't understand that well, but small words, I can understand what they're saying.

His problem was similar to that of Subject 17 who could not understand entries in book indexes.

Interactions: Summary

The events discussed in this category reflect part of the Form 1 students' knowledge concerning how their own learning characteristics and factors in the learning situation are mutually influential in determining the course of information retrieval. The data revealed most about the activity of defining an information need through question formulation.

Here it was found that students were aware that prior knowledge of a topic influences the ease with which they will be able to generate questions. While six thought prior topic knowledge was of benefit, three felt it to be a hindrance in asking questions for which answers were not already known. This experiential knowledge supports Miyake and Norman's (1979) conclusion that to ask a question, one must know enough to know what is not known. Success in framing questions for research tasks must also depend on the student carefully reviewing prior topic knowledge. The students' abilities in this area will be discussed later.

While several students voiced opinions on what makes good questions in terms of interest level and knowing the answers, it was interesting to find that two students (Subject 10 and 14) had some conception of how the available information influences the type and format of questions that can be easily answered. They were able to use this knowledge to coordinate activities whereas many of the interactions noted by students were tied to the activity at hand. For example, identification of keywords rarely included generation of alternatives to be used if the first choice is not present.

A few students indicated that they were aware of features of texts or their own abilities which influenced their preferences for using indexes or contents tables. Where preferences are strong enough to preclude the use of either, information retrieval may be hindered. However, it is recognised that students may not be aware of, nor have access to, the differing strategies essential to efficient searching of both indexes and content tables.

The difficulties of coping with large blocks of text were mentioned by just two students, one being more concerned with the time taken to locate relevant information, while the other implied that pictorial information is easier for her to process. The latter's request for more diagrams should perhaps be compared with Subject 13's rejection of a book which contained only small blocks of text and many drawings. This was seen to be "too jokey". The responses of these two girls illustrates a problem discussed by Hartley (1987) who observed that a typographic designer is asked to provide a single solution to serve multiple reading goals and the differences between individual readers. He goes on to say that publishers and designers "have remained peculiarly resistant to the notion of individual differences in readers" (p59). The implications here for selecting materials to support children's project work and indeed for stocking a school library are many.

Of the 23 students participating in this study, three were aware of time issues impinging on their actions. One tried to take time into account at the point of framing questions, while another was unwilling to spend a lot of time taking notes from a single book. The third was simply aware that when information seeking is not going well, time seems to race away and forces her to finish projects hurriedly. One gets the impression that the task of coordinating independent information retrieval activities and the time available gets little attention or support in the classroom, yet work that obviously suffers from being hurried attracts adverse comment.

Although the present study was designed to explore the difficulties of unsupported independent project work, this type of task is frequently undertaken by groups at the Form 1 level. Cole and Gardener (1979) comment that in this situation talking often takes the place of reading for some students. While group work may enable some students to achieve more than would otherwise be possible, other effects could be less positive. The level of co-operation between group members was identified by one student as a factor determining satisfaction and how much actually got done in the time available. This knowledge appeared to strengthen the student's preference for working alone or with friends who could be relied upon to co-operate.

Abilities

The label for this category is slightly misleading, as the data included students' knowledge of their usual mode of cognitive processing in addition to direct comments about specific abilities. The data often seemed akin to tactical knowledge. However, to be coded as **tactical** knowledge, statements had to centre on a sequence of events and their outcome. The events classified as **ability** generally involved reflection upon the use of an unspecified tactic rather than provision of declarative knowledge about the content of that tactic. Topics by which the data were grouped were as follows:

a) formulating questions
b) searching for information
c) approaches to aspects of information retrieval
d) difficult phases of project work
e) others.

In addition, four students commented on the research methodology, generally agreeing with each other that they could think more easily when they were not being watched. Asked whether this difficulty extended to being watched by other students, subjects 3 and 12 said that it did sometimes. A third student (Subject 6) was more specific, saying that it depended with whom he was supposed to be working. Interestingly, Subject 9 was the only student in the entire group to evidence prolonged awareness of the camera. yet he made no comments concerning the effect of being observed while seeking information.

Formulating questions

Situational factors contributing to the ease or difficulty of question formulation were discussed previously. Here attention is on the students' perceptions of their own abilities to generate questions for research tasks. A total of 12 students stated quite explicitly that in this instance they found question formulation difficult and a further three said that it was easy only sometimes. Others, such as Subject 22, obviously found the task challenging and engaged in long, unproductive periods of covert thinking without commenting on their abilities to complete this phase of the task. Subject 4 linked difficulties at this stage with those of other phases of information retrieval. She said that:

> S4: I think the hardest part [of project work] is working out the questions and what you're actually going to do for it [to answer them], like you might set up interviews or something like that.

As discussed ealier, nine students were aware that prior topic knowledge influences the ease of question formulation, yet overall reviews of topic knowledge were not a salient a feature of student interviews. Thus while the influence of prior topic knowledge was recognised, students did not make reference to using that information as they discussed their usual processing methods and abilities. Typically, they responded to a direct question about reviewing what they already knew by emphasing the unknown. For example, Subject 11 said "I don't really think of what I know. I like to find out things that I don't know, so I know more." Two others answered similarly and Subject 19 was adamant that he did not think about things he already knew about birds, "No, no way!" In contrast, Subject 20 said she did think of known information, but promptly qualified that statement by saying that she does not always begin project work in that way. Finally, Subject 13 commented on the question formulation process quite spontaneously.

> S13: I noticed that when you're thinking about it, sometimes the topic [question] just comes to you by surprise.

The techniques that students used to generate questions will be discussed further when tactical knowledge and executive control processes are examined.

Searching for information

Retrieving information demands the ability to identify keywords that can be used as search terms for use in the catalogue and individual book indexes as well as contents tables. Five students recognised that they had difficulty identifying appropriate search terms and a further two said that they found thinking of alternative terms to be troublesome on some occasions but easier on others. None explained why this might be the case.

Just one student was convinced that she could think of other terms easily. In replying to a rather leading question, Subject 2 agreed very uncertainly that if a chosen search term could not be found she would think of another with the same meaning. She went on to say this was easy to do and to the interviewer's surprise quickly demonstrated with an example:

> S2: If I look for "different kinds" and it's not there, I could look for "unusual".

That "different kinds" and "unusual" are not quite synonymous and that they were unlikely to appear in indexes did not alter her perception that she found generation of alternative terms simple. If the relationship between the type of word generated and success in locating relevant material goes unrecognised this type of self-knowledge is unlikely to be modified in the event of failure, as it will never knowingly be tested.

The only other aspect of the information retrieval task that attracted student comment about abilities in searching for information was that of using the catalogue. Here six students were asked a direct question relating to the frequency with which they use the catalogue in information seeking. Only one (Subject 17) claimed to use it often, thus implying that she was certain of her ability to do so, while four said they rarely used it. Two of these students felt catalogue use was unnecessary since they knew where their favourite books were located. However, Subject 23 admitted that he did not use the catalogue, not because he knew where the books were located, but "'cos I can't, I do use it sometimes but that's if there's a certain book. I normally just look for all kinds of books." In the previous chapter this student's awareness that he was unable to understand the subject headings was mentioned and he later commented that he did not really know much about the catalogue, thus he had reason to avoid using it.

General approaches to information retrieval processing

The students' awareness of learning abilities associated with other phases of the information retrieval process were less frequently expressed. The most complex comment came from Subject 4 who observed quite spontaneously that her method of taking notes had changed over time. Previously she had copied text word for word but "Now I just read a sentence and put it down in my own words - that makes it a lot shorter". She later confirmed this and added that changing text to her own words is not a problem, even when the language of the text and her own vocabulary differ markedly. However, the accuracy of this perception was not put to the test.

Two students were aware that during the interview they did not follow their normal path of action. For example, Subject 18 had not attempted to carry out an information search in the library before. She had always used encyclopaedias, despite the fact that she claimed to have been trained as a student-librarian and was presumably familiar with the main collection. Similarly, Subject 2 had selected one book to answer each question but claimed that she did not always proceed in this manner and that although she had not read any text in selecting books on this occasion, she did on others.

These comments were considered to be too general to be coded in terms of declarative knowledge of tactics, rather, they reflected the students' recognition that they had done something differently on this occasion. In contrast, six comments about generating questions, initially coded as **ability**, were set aside for discussion with **tactical knowledge** as they illuminated types of tactical knowledge held.

Difficult phases of project work

Clearly, the students know that the task of defining an information need in terms of questions is difficult, but when asked generally about easy and difficult sections of the overall assignment, few identified the questioning phase as problematic. Instead, four students (Subjects 5, 8, 20 and 21) said that actually finding and gathering information was the most troublesome. However, none disclosed the reasons behind their evaluations or whether the problem lay with location of materials or extraction of the required information from texts. A further student (Subject 22) appeared to have great difficulty with this assignment from the start. Asked during the think aloud/concurrent interview whether he was experiencing difficulty, he was reluctant to agree, saying only that it was "sort of difficult". During the retrospective interview he was asked whether he could identify a point at which his difficulties had begun, to which he replied very promptly, "When I looked up birds." From the observer's perspective, the problem lay in comprehending the text and knowing what to do next. One cannot rule out the possibility that this boy may have been reluctant to admit to needing help because he was in an interview situation. However the learner who does not recognise limitations of ability is not well placed to take remedial action of any kind.

This same student was one of three to comment on the ease of taking notes. He personally thought the task was easy and qualified his comment by describing text copying but Subject 3 said that note-taking was, for him, the hardest part of project assignments.

> S3: You mostly write it out from the book the same, not your own words, but if you do it, try to think it in your own words, it takes quite a while ... because it's quite hard.

The remaining student in this group (Subject 21) found note-taking easy compared with the task of finding the information in the first place. In addition, Subject 8 came out with an ambiguous statement that could be taken to refer to note-taking, defining the information needed or writing up the project report.

> S8: The bit that is the hardest is coming up with what I want to write down in my project.

Finally, one student spoke of the conditions necessary to making projects easier for her.

> S17: I usually like to work with other people because then I've got somebody to help me or I can help them... Being able to do interviews with people makes it a lot easier too.

As will be seen in the following section, Subject 17 was very aware of difficulties she encountered with independent library research assignments.

Others

Incidents appearing in this section were diverse and highly individual. For example, Subject 17 spontaneously said, "I can't do too many questions 'cos I'm not a very good, I mean I can't". This was taken to mean that she thought she was not able to do independent project work well. Her lack of success in finding information later prompted her to say that her questions were too hard. When asked what she could do about it, she replied, "I don't know. I'm not really very good at making decisions when it comes to this point." It transpired that she usually sought teacher help to overcome the problem. A short time later information retrieval was hindered when she encountered a large block of text. This proved difficult to read and she commented that such blocks of text do not present problems if she can take the text home, but when time is limited she finds them hard to deal with. Her view of her abilities in this context did seem to be borne out by her performance.

Both Subject 18 and 23 observed that they were not good at spelling and the latter went on to note the novelty of suggestions made by the researcher. For instance, asked whether he had ever thought that a different subject heading might be needed to access a particular book, he replied that he had not thought of that. Similarly, he had not thought of asking for help to find and understand books, although he knew he was having considerable difficulty.

Another student (Subject 15) was aware that he often gets mixed up between contents tables and indexes. He also failed to find the bulk of the BIRD collection and when asked why that might be concluded "Probably 'cos I wouldn't think to go and look in another place."

Abilities: Summary

The students' assessment of their abilities in terms of information retrieval tasks emerged mostly in the context of difficulties experienced. The greatest level of agreement was found with regard to question formulation. Twelve students specifically stated that they did not find this easy, however, none spontaneously identified factors making it difficult. Similarly, seven students were aware of limitations in their abilities to think of search terms other than those from their questions. Again, they could not be precise about what was going wrong, but they knew the task was difficult on some occasions, easy on others. This sort of awareness is certainly a necessary precursor to the recognition of key factors influencing outcomes and the devlopment of strategies to deal with the problem.

The other areas in which students knew they had difficulty were gathering information (four students) and note-taking (two, perhaps three students). A few students commented on general abilities such as spelling and decision making and three were aware of changes in their thinking or information processing over time. The most specific of these was Subject 4 who had realised how her approach to note-taking had changed.

Overall, the students' accounts of their abilities and general thinking were sparce and weighted towards the negative end of the scale, perhaps because when things were going well there was no occasion to comment and no time, since they were fully engaged on the task.

From the students' comments it seems that knowing about one's own abilities is a double edged sword. Student 23 sees himself as unable to use the catalogue and therefore avoids it, not thinking to ask for help. Subject 17 knows she is not very good at making decisions during information retrieval tasks but, although she prefers to use interviews to gather information, she does know she can ask for help from teachers and other students. The former is limited by his self-knowledge but the latter has ways of compensating for her weakness. Attempts to increase students' knowledge of their learning characteristics should be accompanied by interventions aimed at increasing the range of strategies they have available and conditional knowledge about appropriate strategy application.

Knowledge states

Awareness of the state of one's knowledge is clearly the result of monitoring the accumulation of information and as such is essential in library information retrieval tasks. The whole purpose of information retrieval is to increase topic knowledge in one form or another and every addition to the knowledge base has implications for the future path of the activity. In addition, the learner encounters numerous decision points at which procedural knowledge must be checked if strategies are to be appropriately chosen. The events included in this category therefore reflected student assessments of initial and changing knowledge states concerning the topic BIRDS, library systems and procedures. They were distinguished from prior knowledge in that they all implied evaluation and ownership rather than a simple declaration of knowledge.

The topic BIRDS

The topic BIRDS was selected on the assumption that all students would at least have some knowledge of kiwis and other well-known New Zealand birds. However, nine students said that they knew little of the subject, while only four claimed to have knowledge ranging from a "wee bit" to "quite a lot". (Two of these said they had completed BIRD projects during the previous year).

The first step of the information retrieval process involves the identification of an information need but, as noted earlier, thorough reviews of topic knowledge were not common among this group of students. Just five students (Subjects 4, 11, 14 and 16) provided definite evidence of assessing the state of their knowledge in order to identify specific gaps. For example, Subject 11 said he was thinking about the black robin:

> S11: I think they put them on some island... but I'm not sure what one it was... so I'll find out where they are and how many are left.

Subject 16 was concerned with endangered and flightless birds:

> S16: I know some birds that can't fly... I know the kiwi and the takahe doesn't fly, but I don't know of any others......I've always wanted to know what endangered types there were, like I wanted to know whether the kakapo was endangered or something.

In each case these students gave some indication of the limits of their knowledge and definitely used these as the basis of questioning.

Five other students focused on knowledge gaps without displaying consideration of limits in the same way. For instance, Subject 20 was aware that she did not know whether an albatross is a bird of prey but did not persue the question further. Subject 8 seemed to be looking at knowledge limits but in a more vague manner, "I remember a budgie in a cage. I was wondering whether there are any others (types of birds kept as pets)". A further two students (Subjects 13, 22) knew what they wanted to find out but were even less specific, for example Subject 13 said, "I want to know how they live".

Three of the students who were able to discuss the limits of their knowledge were also those who claimed to know something of the topic. The fourth was Subject 14, who said he knew nothing about birds but quickly identified a couple of species for which he could find out about appearance, size and habitat.

Cursory assessment of topic knowledge states by the remaining students led to conclusions that they too knew little of the subject. Therefore, although as mentioned earlier, nine students were aware that prior topic knowledge influences the ease of formulating questions, these assessments themselves may have signalled that thorough memory search would be futile. To clarify this point, in the following section statements of subject knowledge collected from students before participation in the study will be compared with those occurring during the interviews.

It appears that accurate assessment of initial knowledge states is crucial to the definition of an information need but it is equally important that this aspect of thinking be revisited many times during the entire information retrieval process. Efficient learners must continually seek relationships between information fragments and must assess the limits of their changing knowledge base in order to control the direction of information seeking. This may seem to be a skill beyond the abilities of Form 1 students but direct questioning revealed that students did attempt to assess information found in terms of what they knew and their requirements.

Again, having read about falcons, Subject 11 provided an illuminating response.

Interviewer: Is that useful information?

S11: Yeah. From what I know at the moment it is...I thought they might eat rabbits and hares, but I wasn't sure about birds, that they eat birds and insects.

He repeated this kind of performance with regard to kakapo.

Interviewer: Does that add to the information you'd got?

S11: I don't know. I knew they were in Fiordland but I didn't know that they were on Stewart Island or Little Barrier. There's actually more birds than I thought there was. I thought there was only a few, but there's at least 35, maybe more.

The role of this kind of knowledge state assessment in directing information seeking was demonstrated by Subject 14 who had in one book identified grey teal as the species of interest. When he failed to locate it quickly in the next book he suddenly returned to the first because "it might be a rare bird or something - I don't know if it is or not". This information had to be extracted from the first book to help determine which chapter should be searched in the second.

These examples expose the dynamic nature that knowledge state assessment can assume and were, for this sample of students, unusual in their depth of discussion. Each occurred during the extraction phase of information retrieval, a phase that not all students reached. Many students, just like those observed by Cole and Gardner (1979), seemed to be more concerned with simply locating anything that could be used. If one accepts that they did not know much to start with, it follows that the kind of knowledge state analysis revealed in the above examples would be beyond their reach for this topic. Several did, however, assess their changing knowledge states in terms of the novelty of the information found. For instance, Subject 6 identified items that were new to him and others about which he was uncertain, while Subjects 3 and 8 registered uncertainty about the relevance of some material. Two other students (Subjects 7 and 20) recognized some text events as adding to their knowledge but did not really know what to do with them. In each case the flow from identifying relevant information to recognizing its implications for the next step of information seeking was missing.

Assessment of knowledge states is not always easy, even for college students (Brown et al, 1983) but it provides the departure point for the information retrieval process, guides the direction of action and determines when the need for information is satisfied. Although on this occasion only two students made public strong abilities in monitoring changing knowledge states, a total of 13 other students commented on the sufficiency of the information found. Their judgements were made in isolation of actually having to process the information further and may well have been modified in light of preparing it for inclusion in a report. The nature of those comments was discussed in the previous chapter (p 129).

The library system

Information retrieval tasks have, throughout this thesis, been shown to demand the co-ordination of many areas of knowledge and just as students assessed the state of their topic knowledge to different degrees, so too did they assess their knowledge of library systems. When confronted by a subject heading card displaying three Dewey numbers many of the students were asked whether they knew what the numbers meant. Of the 23 participants in the study, 12 replied that they did not and a further four initially stated that they understood the meanings but changed this view when questioned a little more closely. In general, they knew that the Dewey numbers were the key to locating books but the decimal points were not understood. As Subject 3 said "I don't really know...I haven't been taught that much." While this lack of understanding was ignored by many students, it prompted three (Subjects 1, 10 and 17) to consider the possibilities. Subject 10 simply said he did not know which one would help most, while Subjects 1 and 17 decided, on some totally unknown basis, that 598.2 would be more helpful than 598, and searched accordingly.

Knowledge state assessment played a role in the location of books on the shelves also. When students failed to find materials as expected, they tended to express uncertainty about their knowledge of the system. Subject 8 provides the example. She questioned whether books were shelved numerically by Dewey or by subject headings, such as PETS and BIRDS, as both numerical and word shelf guides were present. When clarification was sought of her understanding of the relationship between Dewey numbers and the number of 598 books on the shelf she replied, "I think I know there's two...". Further observation of what was actually on the shelf and questions aimed at gaining clarification of her perception resulted in a marked change.

Interviewer: So you think there's only one New Zealand book on birds?

S8: Not any more.

Procedures

The events discussed in this section reflect the students' recognition that on occasion they did not know how to proceed or that they were not sure of the basis of previous action. Where students could give such information in detail, the events were coded as **tactical** knowledge. These two aspects of procedural knowledge will be considered together later.

Students often assessed their procedural knowledge in response to interviewer questioning aimed at clarifying the basis of a difficulty. For example, Subjects 7 and 20 were not making progress on the generation of suitable questions. General attempts to prompt them into thinking about prior topic knowledge failed and both said that they did not know what to do to come up with questions. Similarly, five other students were asked what sorts of things they could do to make it easier to come up with questions, all replied that they did not really know.

In actually seeking information, four students (Subjects 5, 12, 17 and 19) reached points at which lack of success left them with no alternative actions. Subject 19 failed to find EAGLES in the catalogue and was asked whether there was anything else he could do to find the information. He replied, "No, I don't think so" and left the catalogue to look randomly at the shelving. Luckily, he accidentally found the BIRD collection at this point. Subject 17 failed to find relevant entries in a book index and similarly resorted to random searching as she said she did not know what to do next. In the same way, Subject 5 was asked what would help him decide where to look in a book. He replied that he just was not sure but went on to suggest that the chapter on "perching" might include something about birds' flight. Subject 12 was the only student who did not use indexes or contents tables and expressed his problem by questioning the interviewer. He said it would be hard to find out something about different types of birds and where they live and, when asked to clarify the nature of the problem, promptly asked "Well, how am I going to find more information about them?" Like the others, he then resorted to random scanning.

As students selected books the interviewer was prompted to ask several how they identified appropriate books for inspection. Most said that the title and cover illustration were the first things they looked at but Subject 17 said, "I don't know, I'm just getting them anyway". Subject 22 likewise could express no reason for taking certain books.

The remaining area in which students assessed their knowledge states as inadequate was that of identifying search terms. The influence of topic knowledge on generation of alternative terms was discussed earlier and behaviours were shown to change markedly when the topic for searching was familiar. Here, however, the focus is on four students (Subjects 6, 13, 20 and 22) who admitted that during part of their search they had no idea what words they were seeking. In every case, the resulting search was random and met with little success.

Knowledge states: Summary

During information retrieval tasks frequent assessment of knowledge states seems to be crucial in that the whole point of such tasks is to build concepts and increase topic knowledge. Knowledge acquisition depends on the recognition of relationships between fragments of information and, as concepts are built and refined, the focus of information seeking changes. The few students for whom topic knowledge was organised in groups of facts about particular species were more able to examine the limits of small knowledge areas and to identify gaps which could reasonably be filled in a short time. However, the majority of students tried to work from the basis of a general category BIRDS, making few distinctions between types, habitats and feeding preferences. They were therefore less able to focus on the boundaries of their knowledge and to define questions clearly.

A problem-solving orientation with respect to searching memory for anything that might bear on the topic would seem to be a prerequisite for thorough assessment of initial knowledge states. Without this it seems logical that there would be little motivation to review prior knowledge if the topic is not of much interest to the learner. To achieve such motivation, subjects for library type assignments need to have a clear purpose, a defined audience and a value to the learner beyond that of simply meeting teacher demands. In addition, the data here suggest that for at least 30% of students help is required in developing methods of assessing knowledge states and applying the results to question formulation.

That it is possible for Form 1 students to dynamically assess the state of their knowledge in the service of directing information retrieval was demonstrated by two students who were obviously familiar with both the topic and the library system. Had the topic been more in line with other students' interests, it is possible that far more of them would have demonstrated similar abilities. If one is to assess and develop these thinking abilities, it would seem profitable to encourage students to deepen their knowledge of a known topic, rather than to introduce something new and perhaps of dubious interest to the learner.

An essential task encompassed by information retrieval and use is that of evaluating information in terms of relevancy. That students of this age often search for anything that can be noted and do not always consider the issue of relevancy has been observed by other researchers (e.g. Sheingold, 1987, Kobasigawa, 1983). It may be that some students do not realize that their own knowledge state and identified information need provide standards against which information relevancy can be assessed. Thirteen students in this study did distinguish between relevant and non-relevant material, but in many cases the information needs were poorly expressed and knowledge was assessed only in general terms. This must affect the accuracy of the judgements made.

In terms of the library system itself, these findings highlight the negative limits of procedural knowledge states. Eight students, that is 35% of the group, experienced difficulty at some stage or another in retrieving information from the library system. The range of materials in the library was extremely varied and their nature demands that students apply a range of techniques for accessing information. Not only is knowledge of several tactics necessary but conditional knowledge concerning their use must also be available.

In discussing evaluation of knowledge states it has become apparent that those students who have greater topic knowledge appeared more able to explore the limits of that knowledge for the purpose of identifying and defining information needs. Before examining the Form 1 students' tactical knowledge for dealing with these issues, a brief examination will be made of their stated topic knowledge.

Prior topic knowledge

Some weeks before students were aware that they were to take part in this study, they had been asked to write down what they knew about birds so that the teacher could plan a unit of work on the topic. This material was collected to provide a rough indication of the sorts of topic knowledge learners brought to the information retrieval task.

While discussion of topic knowledge can be divorced from that of metacognitive knowledge, the two are not applied in isolation. As Alexander, Schallert and Hare (1991) point out, knowledge forms "operate within a complex and intricate system" (p336). As indicated above, the depth and organisation of topic knowledge seemed to influence the degree to which students were likely to assess topic knowledge states thoroughly and thus influenced the path of action. The issue here is whether or not students activated sufficient prior knowledge to gauge their information needs adequately. To address the problem a comparison was made between topic knowledge statements collected before the study and topic knowledge drawn upon during the think aloud/concurrent interviews. "Facts" from both sources were tabulated for each student and the number of points recorded was compared. In addition, those facts appearing in both sources were noted.

On average, during the interview students based their analysis of the information needed upon the activation of just four items from prior topic knowledge. In general, this was fewer than half of the items they had listed in prior knowledge statements collected before the study began (mean = 10). Three students did not reveal any prior topic knowledge at all during interviews, yet had listed seven, eight and twelve items before the study.

The content of the topic knowledge declared before and during the study was also of interest. One might expect some overlap in content from the two sources but nine students did not repeat a single item, while eight students repeated one and three students repeated two items. The remaining three students (Subjects 1, 7 and 18) recalled three items during the interviews which had been listed in their earlier topic knowledge statements. It would thus appear that most students had considerably more knowledge than was revealed on either occasion.

In general the information held by students was accurate, with only nine misconceptions being recorded for all students. The most startling of these came from Subject 2, who relied heavily on concrete experiences for information.

> S2: A puffin's quite camouflaged, cos in Australia, I think they can be different colours... Yeah, they are colourful... cos I saw one when, I went to Australia. I saw them wild in the

trees. They were coloured birds and you could hardly see them cos they were camouflaged.

As one might expect, topic information recalled by the students in both prior knowledge statements and during the interviews varied widely. Prior knowledge items noted by four or more students are listed in Table 4, together with the number of students who recalled those same items during the interviews.

Apart from the general conceptual items listed, most of the information held by students referred to isolated facts about individual bird species. These facts were revealed in thematic clusters during the interviews by only four students. Subject 3 focused on flight and how differing sizes of wings might affect flying ability. Subject 11 recalled that some birds are endangered then listed particular examples. The other two students (Subjects 20 and 21) recalled information about a particular species of bird (kiwi and albatross) and tried to identify gaps in that knowledge

If the way in which prior knowledge was recalled reflects how it was organised in memory, the data suggest that the students rarely had access to grouped facts. Given that they knew little of the topic, it is likely that the information was only poorly organised in memory as suggested by Brown (1977). In addition, their conception of what was involved in information retrieval and use may have limited exploration of related facts. Inspection of project content revealed that only six students generated two or more related questions. In contrast, seventeen students researched several totally unrelated questions.

Prior topic knowledge: Summary

When the statements of prior knowledge were originally collected, the students were asked simply to write down some of the things they knew about birds. This is a very general directive and, not surprisingly, it resulted in the majority of students recalling general conceptual knowledge,

Table 4: Topic knowledge held prior to and activated during interviews

Item of knowledge	Number of students recording item prior to study	and during interview
Birds fly	15	9
Birds have wings	11	1
Birds have feathers	9	2
Some birds cannot fly	7	4
Birds live in nests	7	7
Birds have beaks	7	nil
Birds eat worms and insects	6	3
Birds lay eggs	6	5
Birds nest in trees	4	3
There are many kinds of birds	4	4
Some birds are nearing extinction	4	4

together with various isolated facts. Similarly, during the interviews when students had difficulty thinking of topic questions they were prompted, in a general manner, to activate prior knowledge, and again basic information was recalled. One cannot help but feel that most students knew more about this topic than was revealed spontaneously at any stage. This is in line with Sheingold's (1987) statement that students often have knowledge but that it is not available for use. It is paradoxical that prior topic knowledge should be an essential ingredient in successful library information retrieval but that the sections of that knowledge relevant to the task may be difficult to identify. Students must be able to assess the relevance of knowledge previously held so that they can determine its boundaries and identify the nature of the information needed. At this point metamemorial strategies are needed, but seem to be lacking for many students. This is not to say that they do not exist, simply that they were not applied to exploration of a topic for which they had little knowledge and perhaps little interest. As discussed earlier (page 112) three students displayed markedly different recall when their topic of interest was mentioned.

Most of the above data came to light during that phase of information retrieval concerning the analysis of the information needed and formulation of questions. Very little prior topic knowledge was recalled during the task of finding and evaluating information. Only five students modified their questions as they recalled further prior knowledge once information location had begun. One gets the impression that many students see texts simply as sources of "facts" but not as sources of prompts to help them activate their prior topic knowledge. Had they activated more topic knowledge, the students may have been better able to define and articulate their information needs but this is by no means certain.

Belkin (1980) describes the task of defining an information need in terms of movement from "anomalous states of knowledge" towards specificity. That is, as information is gathered, the boundaries of knowledge gaps become clear, concepts become sharper and it is easier to make statements about missing information. This implies a highly dynamic, elaborative approach to information processing throughout the phases of information retrieval. However, as mentioned previously, the majority of Form 1 students appeared to progress through the information retrieval process step by step, with little, if any, awareness of how activities in one phase influenced those of the next.

The task of defining an information need, of narrowing or broadening a topic, is immensely complex and highly dependent upon the activation of relevant prior knowledge. Yet these students recalled fewer than half of the items known to be in their repertoire. As Irving (1985) says, graduate students often require considerable aid at this stage of information retrieval yet the complexity of the task is often overlooked in classrooms. It may be that students need to be provided with a clear overview of the topic together with the opportunity to discuss appropriate questions and search terms before they can begin to generate a list of related topic areas.

Despite the problems inherent in retrieving and using library information, some students could describe the tactics they used to negotiate it. These are the subject of discussion in the following section.

Tactical knowledge

In common with previous sections, for the purpose of analysis, contextual summaries were prepared before the coded events were grouped according to their content. In general, events in this section were considerably longer than those analyzed earlier, as description of action sequences required extended comment. Once again, the topics by which data were grouped reflected aspects of information retrieval process as follows:

a) formulating and refining questions
b) search term identification, catalogue and index use
c) location of information
d) selection and evaluation of books
e) extraction of relevant information
f) miscellaneous others

In all 173 utterances were examined which reflected declarative knowledge of tactics. The majority of these were responses to direct interviewer prompting aimed at helping students focus on a way out of a difficulty (e.g. what sorts of things can you think about to help you come up with questions?). Others resulted from requests for clarification (e.g. what were you thinking about just then?).

Formulating and refining questions

The question formulation tactics used by eleven students were expressed in very general terms. For example, Subjects 10, 15 and 21 said they thought of "obvious" things, with subject 10 mentioning such things as wings and feet. Two students (Subjects 1 and 2) simply thought "of the birds outside", while two others tried to think of different types of birds. Questioned obliquely about about prior knowledge review, three students said they had focused on things they did not know. Two of these were able to explain a little further. Subject 8 said:

S8: I was thinking about things I don't know.

Interviewer: How do you know, no....

S8: How do I know about the things I don't know?

Interviewer: Does that mean you had to think about the things you do know and then try to go past that?

S8: I'll just see ..... where do they live? Er, what different types of birds are used as pets, yes, that's right. I know that they have pets but I think further and ask the questions so I can find out.

In contrast, Subject 17 said she "sort of" thought about things she knew already "but... then I was trying to think of, yeah, I thought of what I knew already but then I thought, well, I can't ask that question because I already know it!" She went on to say that the teacher says there is no point in asking things you already know. One wonders whether this dictum restricted her review of prior knowledge as that knowledge was seen as irrelevant.

Initially, Subject 15 said he did not know how he came up with questions, they just appeared in his mind, but he later said that he tried to think of obvious bird features. His questions centred on nesting, eggs hatching and birds flying. Generally, there was a definite difficulty in explaining how one goes beyond the known to formulate questions for information seeking.

Subject 18 explained the process thus:

S18: I normally think of what I do know and I just think of the other things that I don't know...

> So all the things I do know, I just shove aside and then I look at the things I don't know.

These students spoke very generally about the thinking underlying question formulation but some others offered more specific information. Subject 23 based his questions on what was known of a particular bird he had seen and what other people had told him. Subject 19 began in similar fashion, "I'm thinking of a bird I know... Yeah, so I can get some more information about that and that might lead on for some other questions about other birds." However, in his case no questions arose and he was finally asked what he usually does in this situation. He replied that he gets other people to help him. In retrospect he added that he had looked around the room for cues to prompt his memory, resulting in a mental comparison of the bravery of owls and eagles but no clear question eventuated.

Other tactics used as the basis of questioning were to think of the differences between bird species (Subject 3) and to seek common behaviours between birds and better known animals (Subject 5). The simplest approach was that of Subject 2 who said that if she knew something of the topic, she would just ask a question to which she already had an answer.

A total of four students seemed to recognise that one needs some information before questions can be asked. For example, Subject 20 thought she would set a single question initially and as she sought an answer, information in texts would trigger further questions. Subject 9 indicated that this was a possible approach, but only in retrospect, while Subject 13 mentioned it in passing when some "good" information had been identified. The only student to really apply such a method was Subject 14 who said that he usually identified a broad subject area, read a bit about it then focused further information seeking in response to the information gained. One could criticize this method in that it results in a product tailored to the information found, rather than one which is the result of genuine enquiry. However, it seems the most pragmatic way of dealing with project assignments that have to be completed quickly and are poorly defined to begin with.

It has been observed that many of the Form 1 students posed very general questions but only two tactical comments were made about refining these. Asked how she could make her questions a little easier to answer, Subject 17 replied as follows:

> S17: Sort of round them into an area like What is the biggest bird that has been found in New Zealand, or something like that... And what do birds eat: What do New Zealand birds eat, or something.

These were still major questions but she did have some notion of limiting the area of search. However, Subject 2, asked the same question, could only reply, "I just... like words I don't need, I just cut them down." Other students were aware of the need to adjust their questions but did not declare the tactic used, rather they demonstrated it, leaving the basis of action unclear to the observer.

Search term identification for catalogue and index use

As discussed in the previous chapter, all of the students appeared to know that catalogues are organised alphabetically and are divided into fiction and non-fiction sections. Of concern here are the tactics students said they could actually use to search for information. As emphasized previously, the success of such tactics hinges upon the selection of search terms and the generation of alternatives as demanded by the library system and individual books.

All but two students automatically selected the general term BIRDS for catalogue searching and used narrower terms for book selection and information location. However, few made direct comments which illuminated the underlying thinking. In total 14 students overtly examined their questions to identify keywords as follows:

> S5: I'd look up in the non-fiction under BIRDS then I'd look under something like if I wanted to

know How do birds fly, I'd look under something like FLYING. And for Do some birds hibernate? I'd look under HIBERNATION or something. And then What are birds in danger of, what animals are they in danger of? look under something like BIRD DANGERS or something about DANGER. And for How many babies can a bird have? it'd be something like BABY or something like NESTING.

This student identified the keywords then modified them grammatically for use as search terms. In contrast, Subject 2 sought BIRDS in the subject headings then looked unsuccessfully for titles and index entries which exactly matched the keywords she had underlined in her questions. Several students formally underlined question keywords and Subject 4 said this was done "... so that I can remember and just look down at them", thus suggesting that she knew that information retrieval is a lengthy task involving activities which interfere with memory.

Twelve students made statements showing that they knew that when their chosen search term did not appear in a catalogue or book, they should try to generate an alternative. Further, two students were able to indicate how they would cope if that term was also absent and two others explained what one should do if no alternative term was known.

Interviewer: What do you do if the word you want is not in the catalogue?

S4: Try and look at, see if it could be under anything else and if there isn't anything else it could go under, then I just look in another book and if I couldn't find it after looking through quite a lot of books, then I think I'd probably just wipe the question out."

Asked whether she would think of asking for help, she replied, "Well, I could ask someone who owns a lot of birds and ask what they think". This option did not occur to Subject 15, but he did think of using an encyclopaedia. If this failed to contain his search term he said he simply "wouldn't really know where to look". That librarians, while they may not have a great deal of personal knowledge of birds, are useful resource people in this situation occurred to only two of the 23 students interviewed. Even Subject 11 overlooked their expertise.

Interviewer: What would you do if the word was not in the index?

S11: I try to think up another word that means the same... say if I'm looking up kakapo and it's not there, then I might look under parrot 'cos that's a wider one of the same thing.

Asked what he would do if he did not know a kakapo was a parrot, he replied that, "I might ask someone if they knew about them."

Totally different solutions to the problem were suggested by Subject 10, who said he would go to a different catalogue, and Subject 16, who would change the question immediately. Failure to find an appropriate search term led Subject 19 to say he could search the animal section of shelving while Subject 22 came to an abrupt halt in the same situation. He claimed that he had no knowledge to help him pass this point and when gently prompted about thinking of other words, he just said, "I don't know any."

While 52% of the Form 1 students stated that they should think of alternative search terms in this situation, in practice only 26% actually did so and at least one student did not identify specific search terms at all. He said that he had no particular search terms in mind but when he located a potentially relevant text item, he commented that "That might have something about what sort of [birds], give me a better guideline of what sort of things I'm looking for." However, when asked whether it did help, he said he had heard some of the birds mentioned before but he did not use the information as a source of specific search tenms. Indeed, Subject 14 was the only student to obviously use texts in this way. For example, he came across the Maori name for a bird in one book and automatically used both English and Maori names as search terms in subsequent books.

Location of information

The students' tactical knowledge concerning information location was often revealed when they had failed to find books easily and were asked what they could do to solve the problem. For example Subject 10 had trouble locating 333.9 - BIRDS, PROTECTION on the shelves. He persisted without modifying his method of searching despite its lack of success, and when asked what he could do next he replied:

S10: Well, I'd just keep looking cos, I mean, just stand back and see just where things are.

Interviewer: So would you look on other shelves or further along the same shelf, or what would you do?

S10: Yeah, further along the same shelf, just step back, look see where all the numbers are then...

Interviewer: And if you're still having trouble, what do you do then?

S10: Well, oh... I'd just, might go to another shelf, might be different thing on another shelf.

In theory, it seems sensible to stand back and try to get an overview of where particular Dewey numbers are, but if one sees continuous shelving, not adjacent shelving bays, the numerical organisation is not self evident.

In terms of locating books, only one other student made direct comment about possible tactics. Subject 23 had admitted that he rarely used the catalogue as he had little understanding of it. Instead "I just go over to that shelf there normally, and I just look through them". This level of approach was similar to that chosen by Subject 19 who resorted to random scanning of shelving when he failed to find EAGLES in the subject headings. Paradoxically, Subject 19 was the only student to overtly examine the Dewey numbers on a book spine for the declared purpose of re-shelving it correctly. Other students apparently relied on memory for re-shelving books or replaced them in the general location at which they had been found.

Other information location tactics mentioned by students concerned finding additional information. For example, Subject 6 was willing to search the main collection a little longer then would return to the catalogue to find the Dewey number for BIRDS, PETS and would seek those books. Subject 23 thought he would turn to a dictionary for help and Subject 15 thought it better to search general animal books. Having failed to find sufficient information two students (Subject 6 and 19) decided the best course of action was to request the help of the librarian while Subject 3 said he would "go home and check my house or check a library near me or go to the Wellington library." Subject 22 was the most pragmatic of all - he would simply make up something about nesting! Finally, one girl gave the problem considerable thought then announced in tones of great surprise that "I s'pose I could look in other books!"

Seven other students said they would change their search methods by switching to other information sources, namely encyclopaedias, in which they would seek the same keywords.

In sum, while the group of students talked about and demonstrated several methods of locating information sources, individually they had little choice of action. Familiarity with the library layout and shelving conventions is essential to building a range of location tactics. Students need to know where the next book is shelved for both numerical and alphabetical organization and should be alerted to the fact that some books (e.g. large volumes and paperbacks) are sometimes treated differently by library workers. It is only then that problem-solving becomes an option.

While some students indicated awareness of additional information resources (e.g. encyclopaedias), it is not clear from the data whether they would be any more successful in locating the most appropriate volumes or whether they would modify their search procedure to match the demands of those books. It is of concern that only two considered seeking expert assistance when difficulties arose.

Book selection and information extraction

Many of the students were asked what made them take particular books off the shelf. While seven students stated that they first looked for specific Dewey numbers then selected books on the basis of titles and cover illustrations, Subject 22 simply said he looked for the biggest book. This implies that he got some sort of physical overview of the collection and chose accordingly. Similarly, Subject 5 was observed to take the first book seen with the correct number, with no active attempt to distinguish between relevant and irrelevant books. Admittedly, he had located three mis-shelved books which he may have thought to be the entire collection and therefore selection among them may have been less important. However, Subjects 3, 8, and 9 found more books and similarly ignored the evaluation cues present in titles and cover illustrations. Although it is not clear why subjects 3 and 9 acted in this way, Subject 8 stated that she was looking for the **one** book in the library bearing the number 598.

Having taken a book from the shelf, students are faced with the task of deciding whether it contains the required information. While the previous chapter reported on the students' expectations and knowledge concerning the format of contents tables and indexes, the focus here is upon the way in which they said they could use these organization aids to assess book relevance. The most detailed description came from Subject 4 who had demonstrated the use of indexes and was asked what else she used to discover whether the book would be helpful.

> S4: Usually I just go to the index and look up the pages that have [my topic]... Sometimes I go through all the pages, sometimes to look for

> photos or... but not very often. I usually go to the index.

Asked what she would do if there was no index, she replied, "I just start looking through it...Looking at titles of pages". She did not think to look for a contents page.

Searching books page by page was the preferred assessment method of Subject 12, who stated quite clearly that he does not use contents tables. This was also the approach to which Subjects 7, 13 resorted when the contents did not contain an obviously appropriate entry. Subject 7 explained her actions a little further by adding that she was reading sub-headings and looking for keywords from her questions. While six students relied exclusively on index searching at this stage, eight others used only the contents and a further eight used both contents and indexes flexibly. However, the way in which these aids were scanned was dictated by expectations about alphabetical organization and the question(s) in mind. For example, Subject 2 said, "I just look at the index and I look at the contents and if there's nothing there, I just put the book back". She had matched a single title to each question and looked only for the keywords from that question. In contrast, Subject 17 rejected books as unhelpful only after searching them for the keywords from all of her questions.

Three other students were clearly unwilling to evaluate volumes on the basis of index and contents entries alone. Subjects 5 and 9 spoke of skim reading relevant portions of text before deciding whether the book was helpful and actually having done that, Subject 14 went on to identify several other text segments that could have a bearing on the information retrieval task. Reading was, however, generally kept to a minimum, with Subject 20 claiming to have read a single sentence to determine the usefulness of one book.

Reading text for the purposes of selecting books frequently led students into the extraction phase of information retrieval. However, the reading tactics revealed concentrate more on information location than literal and inferential comprehension and are discussed below.

Eight students specifically mentioned skim reading to check whether the text was relevant to their needs but their interpretation of this term differs from that of adults. They seemed to be agreed that skim reading involves examining pages for words that appear in their questions or which are related to them in some way. Students differed in the degree of clarity with which they could discuss this. For example, Subject 22 said, "I just skim read it, I might pick up the good bits..." but when asked what he was looking for he could say no more than "Um, good words". In contrast, Subject 14 explained that:

> S14: I was skim reading to find out if it was a small bird. I look for the size, if it says the size at the top of it, then fine. If it doesn't, I just look for numbers.

Skim reading in this case appears to be a locational technique which involves scanning but is not associated with speed reading and comprehension. This was confirmed by the following exchange with Subject 6. Asked whether skim reading speeds up the reading process he replied:

> S6: No, you just go down [the page] and see if you can find any information. Say if I'm looking for different kinds of birds, I look down until I can find something that could tell me, either DIFFERENT KINDS or something, and then I'd stop and read it. Or if I found something else interesting I would read it.

Subject 9 also confirmed the locational nature of the students' skim reading concepts. Asked what he meant by skim reading, he simply replied, "Find the right places. When I start looking down there like this (running fingers quickly down text column) start looking where it was... read every word when I find it, I do." Subject 4 explained that having found the right place on the page "I stop and go back a bit and then sometimes I have to go back a couple of sentences to work out what it is saying" but this still demanded that every word be read.

These children indicated that they searched the text fairly systematically for keywords but others spoke of different tactics. Subject 13 was also searching for specific words but said, "I sort of started at the top and then I decided that I'd better start at the bottom and then I started in the middle. I don't think I read it all, I just sort of flashed...looked down the words". In contrast, Subject 3 stated that he had not skim read the entire text. If a book has pictures and he knows what he is looking for, he focuses on them, not text. Having identified an appropriate picture he claimed to skim read the text near it. However, the video recording of his search does not confirm this.

Non-fiction texts often have sub-headings which should indicate the content of the following paragraphs but only four students made any reference to using these for locating relevant text or evaluating content. In two cases students indicated that they turn attention to headings when the contents or index have failed them (Subjects 4, 7). Subject 15 was forced to read headings when he encountered a book with very few page numbers and just one student (Subject 20) claimed to read sub-headings after using the index or contents table successfully. Other students seemed to be unaware of the ways in which they could use the conventions surrounding structure of text to help them select and extract relevant information.

Many students did not find sufficient relevant information during the interviews to prompt revelation of the tactics used in reading to extract information. However, Subject 23 had great difficulty understanding indexes, tables of contents and text in general, and was asked directly what he does when he cannot understand. He said that "I sometimes make up words that might go with it, but they never work so I can't understand what it's telling me about. Or I syllabify it, break it up into little, like little parts so that I can read it a bit easier." His attempts to follow these rules during the interview did not increase his understanding of the material despite the fact that he seemed more able than most to publicly identify points of difficulty.

Miscellaneous tactics

Note taking was not a major focus of this study but a few students began taking notes or talked about the tactics they use to do so. Again, one of the clearest descriptions came from Subject 4. As previously discussed, she used to copy text verbatim, changing it only as she wrote the final copy of her assignment whereas she now claimed to abbreviate the information as she read it. She explained that she combines sentences from the text, missing some parts out altogether. In discussing the content of notes, Subject 6 revealed that he was writing down information that was new to him and some that seemed new but about which he was unsure. Finally, Subject 22, who had experienced grave difficulties with the entire task, was asked whether notetaking was easy. He replied, "Yeah... I just do all the good things that it says". When clarification was requested he could not be more precise but said that he copies down the things that he thinks are good, spontaneously adding that "I might change it a wee bit though".

Given that authors of children's books are sometimes experts in their fields who have distilled the information many times in an attempt to present it clearly, it seems ridiculous to expect students to take notes and present work only in their own words, especially when university students get credit for using apt quotations wisely. Subject 4's old method of copying text then changing the wording when writing the final report allowed her to gain an overview of the topic before trying to express her understanding of concepts. In terms of cognition this seems eminently sensible and as an acknowledged, legitimate approach, could be used to heighten students' awareness of both concept building and plagiarism!

The task of information retrieval, for whatever purpose, is lengthy and demanding of memory. In passing, some students provided information about the tactics they use to lessen the load on memory. For instance, six students carefully wrote down the relevant Dewey numbers before leaving the catalogue, and an additional student rehearsed the numbers audibly before going to the shelving. Similar rehearsal, this time of a page number, occurred when Subject 11 found a reference to falcons but he pointed out that he would be able to find it again in the table of contents if he did forget. This boy also gained information incidentally as he read to select materials and commented that he would normally take notes so that it would not be forgotten.

Finally, two students commented on the need to find certain books again later. One, Subject 3, said he would memorize the Dewey number and title, while the other initially said she would recall a particular book by its colour and size. When another useful book was located a little later, she said she would write down its title and number. She was one of only two students in the entire group to do this.

Some questions posed by students suggested a fairly obvious route through the information retrieval process but a few appeared so difficult that the interviewer questioned the students directly. For example, Subject 5 was asked how he was going to look up "the dangers for the bird". He replied, "I'll just find something... If I couldn't find anything in the index, um, the contents, I could just look up one bird and I could just skim read it to see if it's got anything about the danger... and then I could see if it's got any in that part what other, if any other birds get in the same danger." He later confirmed that he intended to look up several individual birds and search for information about unspecified dangers. Subject 21 was similarly questioned retrospectively about What birds eat? and came up with the same tactic. She had seen text relevant to one of her other questions so replied, "Well, they might have something like the kiwi had, the kiwi had a little part about how that ate." This was taken to indicate that she too would look up several different bird species to get an overview of what birds in general eat. It is unclear whether they would actually be able to integrate the information found or whether they would (as Subject 2 did) merely present it as a list of accumulated facts.

A very different approach was suggested by Subject 23. He had had little success using books to answer his questions so when asked how he would find answers to those questions remaining, he opted to "...watch birds throughout the school or see what birds do at home." While this is a practical solution, given that the birds of interest were to be seen locally, the time involved in gaining information from observation was not considered.

The tactics disclosed so far have concerned particular points within the information retrieval process, however, some students talked about their approaches to project assignments in general. For example, Subject 3 was asked what are his first actions when given a project assignment and replied as follows:

> S3 Think of questions then think of places where I could go and find it and if I don't find it there, I'd look in the LRC. Then I'd get some information. If I still didn't have enough, I'd look at home and at the library... some close and other libraries.

Again, as a general rule, this approach sounds sensible, yet we have already seen that when putting it into operation Subject 3 rejected the well-stocked school library after only a brief scrutiny of its reources.

A similar question to Subject 10 elicited a very reflective answer. He was asked what makes projects easier and replied, "Sometimes just sitting down and thinking about what I'm doing and what I'm going to have to do and where to put things and...that makes it easier. So I know what I'm going to do and how to do it so I won't be

stuck when I get to it and start thinking then."
Clarification of these points suggested that he forms an overall task plan before beginning work.

Tactical knowledge: Summary

Information retrieval consists of a myriad of associated tasks, all of which make heavy demands on students' general and tactical knowledge. Overall it appears that these Form 1 students had insufficient knowledge at both levels to come up with alternative action paths when a favoured approach to the task failed.

At the point of analysing the information needed and formulating questions students had few ways of providing themselves with memory cues to the prior knowledge necessary to succeed in the task. Tactics voiced were often rather vague and very general (think about the birds outside) and resulted in less than half of their known knowledge base being recalled. Although four students mentioned locating some information to catalyze their thinking and question formulation attempts, only one actually did so with any success. None of them were aware that a general overview of the topic could help them recall further information and identify gaps in their knowledge. Books for younger children often provide such information in an easily understood manner and reading them for the purpose of directing information retrieval should be encouraged.

Again, the lack of perceived continuity between the learning activity and the criterial task may have contributed to the fact that the need to refine questions went unrecognised and therefore attracted few tactical comments.

For most students the procedure of selecting a general topic descriptor for catalogue searching but using narrower terms for book searching was automatic. However, although more than half of the students said they should seek synonyms and related terms if first attempts failed, only a quarter actually did so appropriately. To a certain extent, lack of vocabulary could account for this but students such as Subject 2 did not recognise that her conception of the topic would not be matched by the language in indexes and contents tables. This suggests that some discussion of the language appropriate to information retrieval should take place in classrooms and, in the event that language fails, students need some notion of possible routes forward. In this sample only four students were able to suggest alternative ways of making progress on the task following the failure of their keywords to access information.

When it came to locating the required texts on the shelf it was again apparent that when the first tactic fails, few students have viable options available to them. Going to a different library, making things up and random scanning of shelves do not assure the student of any greater success. The students' knowledge of the shelving system severely limited their opportunities to regulate their behaviour sensibly. In terms of the physical layout of the library students need to know where to look next when the end of a shelf is reached. This is particularly true where shelf units are free-standing and are not arranged in neat rows.

Student perceptions of the activity implied by particular learning tasks have been said to influence whether they will engage in strategy application (Biggs and Telfer, 1987). While students perceive that a Dewey number indicates a single location, they are unlikely to develop strategies which include searching alternative locations and resources. Self-questioning, when shelf searching has failed, needs to include issues such as whether the information targeted could be in a large volume, a picture book or reference books as, dependent on the library being used, these may all have the same Dewey number but be shelved in different areas of the library. In addition that same number could lead to audio visual resources and vertical files.

Students finding several books on a topic are forced to choose beteen them and, although only seven declared the tactic, the majority of the Form 1 students searched for a particular Dewey number then read titles and examined cover illustrations for features which matched their questions. Beyond this point, their tactical knowledge sometimes failed. Most students relied on the index or contents to determine whether book inspection should continue. Only eight students used a combination of these organisation aids whereas other students were willing to reject books having inspected only one.

While reading featured in the book selection and information extraction tactics explained by three students, it was reading for the purposes of locating specific items, not reading for comprehension and concept construction. Reading at length was not mentioned at all and indeed, an impression recorded while observing Subject 2 suggested that having found a suitable entry in the index, she felt she had completed the task and actual text reading was not necessary. It appears that most of these students lacked tactics for determining the relevance of text to their purposes.

The tactics discussed above tended to be revealed by students just one step at a time. Few students volunteered a series of actions and the conditions which linked them. Thus the planning and regulation elements that translate tactics to the level of strategy use were not often evident in declarations of tactical knowledge. To understand the dynamics of information retrieval one must turn to an examination of the executive control processes applied.

EXECUTIVE CONTROL PROCESSES

Although the Form 1 students were surprisingly forthcoming in verbalizing their thinking, it was apparent that much of the executive control processing was operating smoothly and therefore drew no comment. Thus it would be easy to focus only upon difficulties arising during the information retrieval process. However, one gets the impression that not only do students differ in their response to processing difficulties but that differences exist in the way they engage executive control processes successfully. In order to explore this notion and to illustrate the dynamics of executive control during information retrieval the think aloud/concurrent interviews from two subjects will be presented as case studies. Similarities between their approaches to the task and those of the other participants in the study will then be discussed, as will marked differences.

The subjects chosen for this purpose were selected on the basis that one (Subject 14) was highly efficient and encountered few problems, while the second (Subject 23) was less familiar with the task but was able to discuss the root of his problems.

The flow of cognition and executive control for the two students was mapped by excluding those portions of the think aloud/concurrent interview that were concerned with the secondary task of answering interviewer questions on peripheral issues and by focusing only on cognition and executive control coding. Cognition had been coded in terms of the information retrieval process by examining the goals of action taken. These codes and those assigned to executive control processing are detailed in Chapter 5.

The direction of the flow between cognition and executive control was illustrated by including arrows which joined elements from both aspects of thinking. An additional column allowed inclusion of comments and aspects of metacognitive knowledge which clarified decisions taken by the students. Coded interviews and executive control process maps for each of these students are included in Appendices 4 and 5.

Case studies

Analysis of information need and question formulation

Having been told that the subject they were to research was BIRDS, the two subjects began this task in a similar manner. Each identified a general area of interest, where birds nest for Subject 23 and the appearance of individual birds for Subject 14 (although this latter was only clarified as the interview progressed). Both recognized a need to focus their search on specific species. However, Subject 14 put no effort at this stage into identifying the birds upon which he would concentrate. Instead he very promptly said he could not think of one and engaged in planning a course of action that would lead him to relevant information, which in turn would determine the subject of his project. He appeared to be very aware of the minimum necessary to satisfying the unspoken evaluation criteria for this assignment and tailored his analysis of the information needed and questions of interest accordingly. Any information answering basic questions would do, he had no personal need to inquire more deeply. In this case the monitoring event of "I can't think of a bird at present" resulted in a plan to circumvent the problem and direct entry into the location phase of information retrieval.

Similarly, Subject 23 named a couple of bird species then made a monitoring statement, "That's all I can think of". However, this monitoring event did not prompt action to overcome that problem. Instead of finding a way of recalling more species or planning to search books more generally, he appeared to refine his first question to consider only where sparrows and fantails nest.

Another difference between the boys is evident at this point. Subject 14 appeared to have no need to formulate questions to drive the information retrieval process. He focused on species appearance and the sub-set of information relating to size. Whereas Subject 23 felt it necessary to write down questions until he could think of no more. Thus he came up with two questions about sparrows and fantails (where do they nest and what do they like to eat) and one which became more general (what are the enemies of birds). At this point he made the monitoring statement that he could think of no more questions and was asked whether he would like to look for some information. Thus there is no certainty that this event triggered the move to the location phase of information retrieval independently of the interviewer's question.

Location of information sources

When both students had indicated what they were seeking, they were asked how they would look for information. Subject 14 never answered this question and the interviewer later discovered that he had a hearing impairment severe enough to result in a slight dislocation in the continuity of conversations. As will be seen, neither this, nor the fact that English was his second language, in any way effected his efficiency as an information seeker.

Subject 23 responded to the same question with a plan which was very general in terms of location tactics but which specifically mentioned looking at pictures and captions to extract the required information, not reading text.

Both students moved without hesitation to the non-fiction subject heading index but while Subject 14 quickly and easily located a card containing three references to birds, Subject 23 struck some minor problems. Firstly he started looking at the cards about 50 from the front of the drawer then some sort of metacognitive experience prompted him to check the earlier ones. Thus he inspected the cards in front of BIBLE in order to find BIRD before finding a card with a single reference to birds. Again, the decisions the two students faced at this point were different. Subject 14 found three Dewey numbers on one card and made a monitoring statement to the effect that there were other numbers but he did not need them at the moment. This implied perhaps that he would remember their existence for future reference while choosing just one to explore for now. He rehearsed the number correctly then moved to the correct shelving location.

In contrast, Subject 23 found a relevant index card, shifted his attention to the single Dewey number it bore ("Ah, birds, 598") which he then rehearsed incorrectly. He seems to have almost picked up his mistake in that he could be considered to be registering uncertainty with the monitoring statement "I think it was 596". However this did not lead him to check the catalogue again. Instead he scanned the shelving, locating the animal section and predicting that he would have to return to the catalogue as he was not sure that the library would have 596.

Returning to the catalogue, he identified a different index card but did not spontaneously comment on that difference, perhaps because his declared knowledge of the materials made the existence of several numbers quite acceptable. He showed no curiosity when he failed to locate the first card he had seen for a second time, again missing the opportunity to pick up his reheasal error. Luckily, as he stood by the catalogue he glanced to the right and monitored the fact that the books there were labelled 598. Even this did not prompt the realisation that he had been searching for the wrong number. Thus there seem to have been three points at which monitoring failed him in the location of Dewey 598 and he had no basis for perceiving that he could perform differently on another occasion.

Selection of information sources and information extraction

These two phases of the information retrieval process tend to become intertwined as reading for selection purposes sometimes leads to the incidental accumulation of information. Thus the two phases will be discussed together. Further, Subject 14 demonstrated one way in which the analysis of an information need and selection of materials can overlap as he redefined his interest while reading book titles.

For example, one title was rejected as "I didn't want to find out about town birds so much as birds of the rivers, lakes and open country", this being stated after he had monitored the presence of a book on the latter and announced that "Ah, that sounds quite interesting!" He justified this with a prediction about the book contents which he tested by glancing through the pages at random. He noted that it had a few of the unspecified birds he had in mind then planned to read part of the text to find out which bird he found the most interesting. This method of information retrieval is assured of success, rejection of the book as irrelevant was not considered!

Having read for a short period, he revised the target of his information seeking, fixing on ducks as the main topic for the assignment. The cynic would perhaps suggest that he simply focused on the first information seen, almost without discrimination. However, this is reasonable given that the assignment was non-specific and that he was seeking a starting point. The information retrieval activities which followed were highly discriminatory. Subject 14 then read a little more and identified which duck he wished to research. During this activity he extracted specific information i.e. search terms for later use, and was prompted by the interviewer to verbalize his assessment of where he was in the overall task.

He gave the impression that this approach to starting a project was known to be successful and was well practised. He could work on several levels of the information retrieval process almost simultaneously and iterated through them with ease.

Having selected a book which gave direction to his information retrieval effort, he then returned to the task of selecting other books, leaving this first book open on the floor for easy reference.

The book <u>Birds of New Zealand</u> was rejected after a search of the contents failed to find the general term duck. The index was not searched at all in this case. The next volume examined was rejected when its contents were found to deal with birds in general, not specific species. Subject 14 was the only student in the group who repeatedly assessed book structure in this way and used that assessment to guide his actions. For example, the third book was found to be organised by habitat and prompted him to state that he needed "To find out where it [teal] lives because these (pointing to contents entries) are, you know, birds of forest and mountain and I don't know if it is a mountain bird". This monitoring activity prompted him to read the first book with a view to extracting just that information. However, as he read he was aware of other reading goals and identified a second duck that he could include in the assignment.

On his return to the book in hand he examined the contents and finding nothing, revised his search to look for an index (there was none) before concluding that the book did not contain the information he required. Previously, he had rejected a book on the basis of a contents search which resulted in the monitoring statement "There's nothing here". This time he made a similar statement but did not reject the book. Instead he suddenly thought of an alternative term (which he did not verbalize) and quickly rechecked the contents saying that the chapter on rare birds might be helpful but that he did not know whether the teal was rare. Again, this monitoring activity sent him back to the first book. Only after monitoring the fact that the first book did not contain that information did he reject the book in his hand.

At this point he was moved to note that he usually uses encyclopaedias, a comment that might be taken to indicate a level of frustration with such ineffecent searching! However, encyclopaedias were not available to him so he spontaneously went back to scanning the shelf for likely volumes. He selected one, predicting that the words New Zealand in the title indicated that it could be useful. This time he found ducks in the contents but, where other students would have looked at the text of that chapter, he promptly turned to the index to see whether teal was included. This seems a much more efficient way of determining which pages in that chapter should be examined but it implies a belief that indexes are accurate and complete whereas Beal (1980) found that in children's non-fiction they rarely are of good quality.

Failure to find that search term resulted in the prediction that he might find a relevant entry if he searched for a Maori name. Yet again, he read the book on the floor to bring back to memory a Maori name seen earlier. Much to the interviewer's amazement, he then located the desired information in the book in hand and turned to the relevant pages. Monitoring at this stage prompted him to comment that he would usually move on to writing down the information found but, for some undisclosed reason, he did not do so.

Asked whether he had enough information now, he said he required a bit more on both ducks. This statement was followed with a planning episode but he was scanning the shelves as he spoke and monitoring activity diverted his attention to the title Small birds, which he read aloud. This caused him to change the direction his activity as he now wanted to know whether teal are small birds. Instead of picking up the book Small birds and checking the index, he returned to the book on the floor and read silently. The text did say how large teal are, but Subject 14 needed to check this visually. He therefore held his hands apart saying "52 centimetres, that's quite big for a bird". Small birds was consequently not removed from the shelf for inspection.

This episode was followed by comments about two books which did not include New Zealand in the title. The first was rejected as Subject 14 predicted it would contain little if anything about teal, but the other title was selected for further inspection. He turned to the contents, but found nothing worthy of comment then checked three locations in the index. At this point he began to turn to a particular page, then rechecked the index, presumably to prompt memory, commenting that this book would probably have little about teal. This time he scanned the relevant page saying that it was "just birds in general". This did not prompt him to reject the book, rather, he returned to the index intending to look up **grey duck** before deciding that the book would not help.

It is not clear why Subject 14 used such different tactics on books which were essentially similar. In addition to treating them differently on the basis of their general titles, he did not use the table of contents in the one selected in the sophisticated manner used for books chosen earlier. Could this be a sign that lack of easy success was disrupting his normal strategies? One could only find out by engineering a situation in which the cummulative effects of continuing failure could be assessed.

The next title he saw on the shelf seemed familiar and he made the monitoring statement that "I've looked at that one I think". He carefully checked whether he actually had inspected it by looking at the back page before replacing it and moving on to the next book, thus illustrating his use of memory in guiding the path of information retrieval.

Even at this late stage of the interview, the reference book on the floor was not entirely forgotten. When a few moments later his attention was captured by a book of sea birds, he checked the first book to see whether teal could be considered to be sea birds. They could not, so he passed on to make a prediction that a book on bird watching might be helpful. The earlier strategy of using the table of contents to assess text structure was reinstated at this point and the book quickly rejected.

It can be seen that Subject 14's approach to project assignments was to locate some topical information of general interest which could be searched for a focus for future information retrieval. He clearly used the contents to discover the structure of books frequently but not on all occasions and used the index to reduce the number of relevant pages to be searched. In addition, he processed text very actively to distil from it those words which would speed his search. There is a suspicion that his sophisticated strategies might give way to less efficient ones when several failures have been experienced but this is by no means certain.

The path of Subject 14's executive control processes was extremely smooth. In all situations, he followed monitoring statements with actions tailored towards success. He required no help to overcome gaps in knowledge or deficiencies in texts, this can not be said of Subject 23.

As was described earlier, Subject 23 set out to retrieve information to answer three questions. Although he expressed these in general terms he subsequently focused on answering two of them with regard to sparrows and fantails. It is unclear whether he intended to answer the third question in a similar way or make it more general. He had located the relevant book collection more by accident than purposeful searching and was now faced with selecting books.

Like Subject 14, he read book titles but his intent was not just to find a title reflecting an interesting aspect of the topic. He particularly wanted sparrow and fantail information so selected the title Town birds, presumably on the basis of prior knowledge of their habitat, although this remained unspoken. The book itself made his experience of information retrieval different to that of Subject 14. He turned confidently to the table of contents, located an entry for fantails and tried to turn to the right page, but the book was not organised for information retrieval. He commented on this saying the book could help "that's if I could find, if they gave us page numbers". He was thus forced to come up with an alternative approach and quickly scanned each page saying he would have to look at the names of the birds thereon.

Having recognised that he had reached the right page, he moved on to his first attempt to extract information. The text was fairly brief and succinct and was accompanied by a large picture of the bird in question. Having looked at the double page spread in silence, he then reported on the foods that fantails like. However, there is doubt that he read the text since he said fantails pick up insects from the ground, whereas they actually catch most of their food on the wing. Questioned about the amount of information he now had, he monitored where he was in the task in terms of analyzing the information still to be found. The result was that he turned attention to a different question and looked at the next page in the book, noting that it had some information about nesting. However, he saw that this was about a different bird and returned to the previous page.

At this point he read aloud the caption to the fantail picture but did so very inaccurately. Despite the fact that he was aware that something was wrong (he commented "I don't understand what they're saying here") and was able to give two ways of dealing with the problem (make up words or syllabify the existing ones) he put the book back on the shelf without trying to improve his understanding. In sum, he had found relevant information fairly easily, despite the lack of page numbers, but did not apply the tactics that he said he would normally use to improve his comprehension of text. One reason for this could be that as he outlined the tactics, he also evaluated them as unsuccessful (making up words never works). His only option appeared to be to plan to look at other books and he returned to the selection phase of information retrieval.

Just as Subject 14 had rejected book titles on the basis of knowledge gleaned from the first book found, Subject 23 rejected some on the basis of what he already knew about sparrows and fantails. Thus a book about sea birds was easily passed over but one on bird watching prompted the prediction that it might be useful. A look at the table of contents brought swift recognition of a relevant entry and he turned to a chapter on nesting. Having found it, he monitored where he was in the overall task, commenting that he had got to find out what a nest was. An additional monitoring statement occurred as he briefly inspected the text only to find that it was about nesting but not fantail nests.

Without any prompting Subject 23 turned back a page, predicting that the desired information might be found if he read a little bit of text. However, he soon reported that he was unable to find anything. The book was returned to the shelf and he continued to read titles, saying that he was looking for an appropriate title and cover illustration to prompt book selection. As an example he pointed out a volume containing a picture of a heron and related this to the question of what birds like to eat. It is worth noting that although he was aware that the book could answer the question in relation to herons, he did not change the focus of his search, he persisted in looking for fantails and sparrows. Several other students, notably Subject 2, had modified their questions or become distracted by pictures in a similar situation.

While he was explaining how he selected a book he used a random scanning technique to work through the book but having come to the end of the explanation and having monitored the fact that he had found nothing, he changed his tactics, saying he must look at the table of contents. Here he found an entry for sparrow and quickly turned to the correct page. He read briefly and then commented that "Oh, these are um, this is one of the dinosaur ones that I thought might be a sparrow". The discrepancy between the chapter title and the content stopped all further systematic search in that book, he returned it to the shelf.

The next book was selected for examination after he had mis-read the title and made the prediction that it would tell him about the country and things that happen in the country. Again, this book was opened at random and again pictures rather than text held his attention. He happened to have turned to information about another insect eating bird and he clearly monitored some of the similarities between the information in this and the previous helpful book. Although he was prompted by the interviewer to check which species of bird it was, he came to the conclusion that the information was helpful. Thus it seems that this time information about diet of a different bird species had distracted him from the fantail and sparrow information search. As before, he suddenly revised his search tactic from random page scanning to searching the table of contents. Somewhat surprisingly, he then returned to page by page inspection of the book. The reason he gave was that "I can't, I don't, I can't understand what the index (sic) is trying to say to me so I just like, skim through by looking at the pictures to see if they've got the certain bird that I'm looking for." Finally he rejected the book as it did not meet his expectations.

He was a little more successful with the next book. This time he turned immediately to the table of contents, apparently still looking for fantails. Fantails were not included but he noted an entry for sparrows and planned to look at that if fantails could not be found. This time the text matched the contents entry and he read two consecutive sentences accurately and declared that he had an answer to one of his questions, repeating the relevant information in his own words. At this point the think aloud/concurrent interview ended.

In the above, the executive control processes of the two students were described in terms of the phases of the information retrieval process upon which they were working. The following compares their performance in terms of specific aspects of executive control and indicates how other students responded in similar situations.

Coordination of knowledge and action

Monitoring

The executive control processes of Subjects 14 and 23 were similar in that both verbalized some form of monitoring on 25 occasions during the think aloud/ concurrent interviews. Although there were some similarities in the content and outcome of these events, there were also major differences.

Both students made many monitoring comments that reflected events as they caught attention ("Ah, here it is."

"Birds - 339.") However, for executive control processes to work efficiently, monitoring must lead somewhere and some of the students' comments included recognition of that point. For example, Subject 14 commented on the consequences of monitoring events on seven occasions and progressed to other forms of executive control (planning, checking, monitoring of different types) in thirteen other incidents. Thus he could be seen to be actively using the outcome of monitoring to further his cognitive goals. In contrast, Subject 23 indicated the consequences of monitoring events on only four occasions and moved directly from monitoring to other executive control events in six cases. He appeared to be less active in using the outcomes of monitoring for directing further action. Instead he made fairly simple monitoring comments which sometimes had no obvious influence on the action that followed. For example, having incorrectly rehearsed the target Dewey number, he later expressed a degree of uncertainty ("I think it was 596") but did not check the assumption. His most marked failure to respond to the outcomes of monitoring occurred when he spontaneously announced that he could not understand the meaning of the text and returned the book to the shelf without applying any of the tactics he at that time described as being appropriate. The irony of this was that the book in question contained the information he required to answer some of his questions.

Failure to take account of monitoring events was not common across the group. Subject 5 made two monitoring statements for which he detailed tactical knowledge then continued work without applying it. Subject 15 monitored the fact that he had, by his standards, found important information but made no attempt to process it, merely returning the book to the shelf. Finally, Subject 7 provided the most blatant example of ignoring the import of monitoring. She clearly stated that the goal of her subject heading search was an entry for **ZOOS** but opened the A - D draw, the cards in which just happened to be parted, making **BIRDS** visible. She read the word aloud then looked at the interviewer saying, "I'm looking for **ZOOS**, aren't I?" and shut the draw smartly. She then sought that word in another drawer, remaining totally oblivious of the fact that she could have modified her behaviour in response to the entry seen.

Comparison of the two case studies uncovered another difference in monitoring with respect to the information need analysis. To a degree both students ran with their first thoughts. However, while Subject 14 said he could not think of a bird species and wasted no effort on that task, he did engage in planning a route through the retrieval task that would identify particular species. This involved moving on to another phase of the information retrieval process and using its activities to define the information need. In contrast, Subject 23 thought of two species and, claiming he could think of no others, seemed to be forced to focus upon them when generating questions. He only moved on to the location phase of information retrieval when he made the further negative monitoring comment that he could not think of any more questions. In his case the negative monitoring events signalled a move to the next phase of information retrieval without suggesting ways of actively dealing with the difficulty.

The difference between the two students seemed to lie in that Subject 14 used the outcome of both negative and positive monitoring events to guide his actions, whereas Subject 23 could not always take positive action following a negative monitoring event. Four other students (Subjects 6, 15, 20 and 21) similarly stated that they could not think of more questions and used this monitoring event to signal a move to the next information retrieval phase but no students used the location activities to help identify a topic for the assignment as had Subject 14.

Planning

Subjects 14 and 23 also differed in the amount and quality of their planning events. Subject 14 spontaneously planned his subsequent action on five occasions compared with two spontaneous events for Subject 23 and one which was prompted by an interviewer question.

While both boys signalled their intent to search "other books" the basis for the move was quite different. After viewing the table of contents, Subject 14 said the book he was inspecting did not have the required information and planned to look at another, without first looking at the index however. Subject 23 simply could not understand the content of the book he was looking at so voiced his intention to hunt for another.

Two plans voiced by Subject 14 were concerned with focusing the information search but others were concerned with giving advance notice of his next action. In addition, one planning event was partially verbalized but was interrupted as he was able to simultaneously monitor scanning activities and his attention shifted to a relevant title, perhaps negating the need for a plan at that moment.

In responding to an interviewer question, Subject 23 outlined his plans for finding information but it was interesting to note firstly their general and somewhat vague nature, and secondly the fact that he specifically mentioned looking for pictures and captions, not text. This is yet another indicator of how his perception of his reading ability constrained his options for action.

The most complex plan that Subject 23 voiced was that of looking for information about fantails in one particular book but intending to look at its section on sparrows if fantails were not present.

As indicated above, planning draws on tactical knowledge and can vary in specificity and scope. Planning also requires that the individual has some idea of the goal of action and it was noticeable that across the entire group of students the majority of planning events looked ahead only to the next action required. This may have been a function of the interview technique, which concentrated on immediate events, but it also reflects the students' lack of understanding that phases of the information retrieval process and indeed the whole learning situation are mutually influential.

Revision and regulation

Subject 23's revision and regulation activities were fewer in number and simpler in content than those of Subject 14. Subject 23 was able spontaneously to change his tactics from searching for a specific page number to reading the headings in a book that had no page numbers. He also switched from random inspection of books to more systematic table of contents searching on two occasions. In each case he looked at the pages randomly while explaining to the interviewer a point about his knowledge or thinking. On completion of this secondary task he applied a more effective tactic to his search. In addition, he automatically followed one contents table search with a page by page inspection because he could not understand the contents.

In contrast, Subject 14 clearly regulated or revised his tactics on seven occasions in much more complex ways. On three occasions he revised the focus of his search, going from concentration on birds in general to ducks , then to grey teal, grey duck and the Maori name for teal. Similar changes prompted by individual books were observed twice when he moved from contents to index searching and where necessary generated an alternative search term. More dramatic changes in the direction of action were seen when he, on two occasions, redirected his attention to the book he had placed on the floor, with the intention of finding specific information to help in searching the book he was holding. No other students regulated behaviour in this way. Indeed, whereas subject 14 was always able to draw on a different tactic as needed, several others required prompts from the interviewer. For example Subjects 1 and 2 were unable to think of questions they wished to research and only made progress on the task following interviewer prompts to review their existing topic knowledge. Further, when it came to actually getting information from books students thought to be appropriate, five students (Subjects 2, 10, 13, 15 and 22) gave the distinct impression that they really had little idea of how to proceed. The effect of deficiencies in tactical knowledge discussed earlier in this chapter definitely limited the ability of students to take regulatory action.

Predictions

The predictions made during the course of the think aloud/concurrent interviews centred mostly on the contents of books, not the expected outcomes of actions. Subject 14 made eight predictions, seven of which concerned books and only one of which suggested a tactic that could be used to make progress on the task. Six of the former were promptly tested by reading text or searching the table of contents. One pair of predictions warrants further comment. Subject 14 consecutively read two book titles which did not have New Zealand in the title and made predictions that the first would probably not have much information about New Zealand's native birds but that the second could be useful. The first of these predictions was not tested but the second was, finally resulting in another prediction that mirrored that made about the first book. One wonders what prompted initially conflicting predictions for two essentially similar books.

As with categories of executive control events other than monitoring, Subject 23 engaged in fewer predictions than Subject 14. Three of his predictions concerned the contents of books and were followed by either a search of a table of contents, inspection of a page of text or a look at pictures. The latter two of these tests are less likely to provide tangible information than the reading methods applied by Subject 14 and the predictions themselves were based on mis-information (wrongly read titles) or detailed speculation based on cover illustrations. Given Subject 23's reading difficulties, it is apparent that reading to test predictions was not a strong option.

The fourth prediction made by Subject 23 provides some evidence to support a suggestion made in Chapter 6 about student attributions concerning success and failure in information retrieval tasks. Having wrongly rehearsed the target Dewey number and made a cursory search of the shelving, Subject 23 predicted that he would have to return to the catalogue because he did not think the library had a book labelled 596. In Chapter 6 the opinion was given that some students seemed to attribute search failure to deficiencies of the library rather than their own search techniques. The first line of defence was to blame the library, not to question search methods. Inspection of other interview transcripts found that Subjects 2, 5, 6 and 10 made similar comments. However, although one of these students, (Subject 6) initially suggested that the required book must have been taken out, he later suggested that a different book he was hunting for was "somewhere else in the library".

Self correction and checking outcomes

Both the self correction and checking categories of executive control were little used by Subjects 14 and 23. Subject 23 may have been self correcting and/or checking outcomes when he first looked in the subject headings and suddenly gave attention to the cards before BIBLE, but this is not certain. Subject 14, on the other hand did verbalize a self correction when looking for the grey teal in a table of contents and illustration list. He suddenly decided that he should look for the broader term duck but one wonders why he took this step. Is it perhaps an indication that his actions were more tactical than strategic than appears on first sight? It was noted that he seemed to search the contents for general terms and if an index was used, it was only after finding a relevant term in the contents so that he could locate the reference within a chapter. This action added a step to the search process that was not always necessary and which was usually omitted by most students who used the index as a first line of attack.

Although self corrections were few, Subject 14 did check outcomes on four occasions. Two of these were in the nature of memory prompts (am I looking for the right thing, have I seen this before?) and one involved reading a text again to see whether teal are sea birds. The most complex of his checking activities occurred when he tried to discover how big the ducks are. Having read the information, he held his hands apart about the right distance to determine whether the bird could be considered small.

Once more this comparison of the two case studies demonstrates that the boys differed in the quantity and quality of executive control processing. However, it must be remembered that although the quantity of executive control process codes assigned to interview transcripts favoured the more able student in this comparison, across the entire group the correlation between ability and quantity of executive control process codes was not statistically significant.

The two students differed markedly in their metacognitive knowledge and their experiences of this particular information retrieval task were influenced by the materials they chanced to find. Subject 23 had difficulty locating the relevant section of shelving and failed to find appropriate information in four of the six books he examined. The books that did contain the right information were incomprehensible to him. Subject 14 similarly found two helpful books and five which were dismissed as unhelpful. However, he had no difficulty locating the shelving or interpreting the text. We cannot guess how Subject 14 would have responded had the topic been more challenging for him to research or led him to books which assumed a higher reading level and more prior knowledge. It would appear though, that Subject 14 had an overview of the entire information retrieval task which enabled him to engage in effective executive control processing, whereas

Subject 23 was forced to take a more piecemeal approach to managing this complex task. Interestingly, the promise demonstrated in Subject 14's information retrieval routines was not so apparent in the final product. The report was brief and to the point but gave little information about teal and contained no more than six sentences which were obviously his own. However, the information given did go beyond that mentioned in the statement of prior knowledge collected before this study began. Not surprisingly, Subject 23 did not complete the assignment.

Self-questioning

Subjects 14 and Subject 23 were among 11 students who did not verbalize any self-questioning events and of the remainder only five students self-questioned on more than two occasions. In most of these incidents the questions seemed to be asked to prompt activiation of topic or systems knowledge. However, Subject 17 used rhetorical questions to aid choosing between Dewey numbers, to signal that she had seen something that could be relevant and as a memory prompt. The notion of using self-questioning to test outcomes and help in negotiating decision points seems to be relatively unknown amongst this group of Form 1 students.

EXECUTIVE CONTROL PROCESSES: SUMMARY

In beginning to explore the executive control processes illustrated by the two case studies it was suggested that the students would differ in the ways they dealt with successes as well as difficulties.

With regard to the information retrieval process it appeared that Subject 14, the more able of the two boys, had a much clearer view of how phases of that process interacted with each other. He put into practise an overall plan which would allow him to meet the expected evaluation criteria simply and efficiently and was sufficiently familiar with this method of working that he was frequently able to work on several levels simultaneously. Every time a tactic failed to achieve its end he quickly and easily came up with an alternative approach. In contrast, Subject 23 seemed often to move on to the next book or the next phase of information retrieval because he had run out of options to deal with difficulties. He focused on sparrows and fantails because he could think of no other birds. It is highly likely that he went to look for books because he could think of no more questions and books were rejected because he could not understand them. In addition, compared with Subject 14, he had much more difficulty negotiating the library system to access the books.

It is when discussion turned to aspects of the executive control process itself that differences in handling positive events became evident. It was found that while the students were equally active in monitoring their activities, the outcome of these events differed. The more able student invariably acted upon monitoring in more complex ways than did Subject 23 and the monitoring events themselves more frequently contained comments illustrating his interpretation of the consequences. In contrast, Subject 23 made some monitoring statements that were not acted upon, even when accompanied by an explanation of tactics he could apply. Four other students were observed to behave similarly to Subject 23. In addition, Subject 23 tended to simply monitor the focus of his attention with brief phrases ("Here it is") and to take cognitive action with no further reflection. Subject 14, on the other hand, often moved from one aspect of executive control processing to another, following monitoring with planning, revision or additional monitoring events. Overall his approach to information retrieval and use was very much more considered. Indeed, the way in which he managed this task appeared to be more strategic than tactical compared with that of other participants in this study. In all areas of executive control processing apart from monitoring, Subject 14 engaged in more frequent, more complex activity than Subject 23. This finding is in accord with other research on executive control processing. However, it is important to note that while Subject 23 was not acting strategically and rarely had a choice of actions available to him, he was clearly monitoring his focus of attention and was able to plan, revise and regulate his behaviours to some extent, thus supporting the notion that executive control processing abilities are an essential factor in basic learning and develop alongside that learning.

In defining the coding categories (Chapter 5), it was suggested that monitoring is fundamental to all actions within executive control processing. The students who fails to monitor is unlikely to recognize the conditions appropriate to alternative actions, even where alternative actions are in his or her repertoire.

Frequently monitoring occurred covertly, being reflected only in the action that it supported. However, for the 23 students who participated in this study a total of 311 events were coded as examples of monitoring. Of these the majority (236) were concerned with assessing the students' position within the complex task of information retrieval and appeared to be aimed at focusing attention on the immediate task. Monitoring progress on the overall task was limited to a total of 29 events. Other monitoring events were associated with levels of understanding (17) and those remaining concerned shifts in attention in response to action outcomes. In addition to these, 85 events were recorded as metacognitive experiences, which reflect detection of unexpected events and are thus closlely allied to monitoring.

While monitoring is essential to executive control processing, the above findings support the view that its occurrence does not determine the quality of that control. Indeed, in Chapter 3 it was noted that correct interpretation of monitored events is critical, as is the ability to act upon that interpretation.

METACOGNITIVE KNOWLEDGE AND EXECUTIVE CONTROL PROCESSES: SUMMARY

In Chapter Six the students' understanding of aspects of the learning situation external to themselves were discussed in terms of the ways in which they influenced the course of information retrieval tasks. Perceptions of the learning activity, the library system and books and of teachers' expectations concerning project reports were seen to constrain students' options. In the present chapter, attention turned to the students' knowledge of themselves as learners and the constraints that this in turn produced as they tried to retrieve and use information. Finally, two case studies were presented to illustrate ways in which executive control processes are brought to bear on this complex system of knowledge components.

Somewhat at variance with previous research, it was seen that metacognitive activity is not restricted to more able students. All students were guided by metacognitive knowledge and engaged in the higher order activities associated with executive control processes. The relationship between the quantity of metacognitive activity and academic standing within the group of Form 1 students was found not to be statistically significant. However, there were marked differences in the quality of the metacognitive knowledge upon which students operated and in the complexity of the executive control processes they used to orchestrate their knowledge and skills.

In the concluding chapter the source of these differences and their implications for constructing learning environments that support the development of higher order thinking abilities will be discussed. In particular, attention will focus on the use of information retrieval tasks to foster abilities essential to the independent learner.

CHAPTER EIGHT

SUMMARY AND CONCLUSIONS

This research began by outlining the dilemma faced by educators whose aim is to enable students eventually to take an active and productive role in a society that is changing very rapidly. The rate of change makes the prediction of knowledge and skills to be included in educational experiences most difficult. In this context the growing concern to foster thinking abilities and independent learning was discussed.

While many hold that the entire school programme should be designed to support such activities, Resnick (1987) says that in particular "special efforts must be concentrated on those parts of the traditional curriculum which are inherently enabling of further learning" (p44). The development of skills in information retrieval and use is a prime candidate for such attention since these are essentially concerned with complex concept formation and problem-solving. In addition, skills developed in this area are widely applicable as the information retrieval process itself is largely unaffected by the user's level of cognitive development and the subject matter being sought.

Ironically, while library skills tuition is one of the traditional curriculum areas meeting Resnick's (1987) criteria, a review of the literature suggests that it has often been ineffective in preparing students to learn independently. Irving (1985) has suggested that this failure has been due to a lack of attention to the thinking that underlies the information retrieval process. In accord with this, Liesener (1985) has commented that a much more sophisticated view of information use and users will be essential if higher order cognitive and problem-solving skills are to be taught more effectively. Thus empirical studies of the cognition and metacognition underlying information retrieval and use would seem to have implications far beyond their research context.

This study has used think aloud/concurrent and retrospective interviews with individual students to examine some of the demands of information retrieval tasks. The data reported reflect those aspects of knowledge and thinking that appeared immediately salient to the students themselves and thus do not fully reflect the extent of their knowledge. They do, however, provide the researcher with a series of points from which to develop a more structured interview for use with other students engaged on similar tasks.

The setting for the study was somewhat artificial in that many information retrieval tasks set at the Form 1 level are attempted by students working together rather than in isolation of peer support. However, such peer support may conceal individual difficulties without actually addressing them. By focusing on the individual, this study has provided information that could be used to help educators working in the classroom to detect and address problems directly.

The findings reported centre mostly on the initial stages of information retrieval tasks and it must be recognized that students' evaluations of the information found and decisions concerning future action would probably be modified in light of actually using it. To understand the demands of information retrieval tasks requires that a study be conducted which follows student thinking from recognition to satisfaction of an information problem. The task of organizing and restructuring the information found has implications for re-analyzing the original information problem and links this process to that of report writing. Without this sort of study, our understanding of information retrieval from libraries could remain divorced from normal classroom settings and the rest of the curriculum, a situation which has been decried by both Irving (1985) and Marland (1987).

Some issues arising from the present study were discussed as findings were reported. The discussion that follows extends the focus to broader issues and looks first at the concepts subsumed by the term metacognition. Attention will then turn to the information retrieval process itself and the ways in which it can be used to support the development of higher order thinking..

METACOGNITION

Discussion of the parameters of metacognitive concepts began by presenting the views of Flavell (1979; 1985) and those of researchers concerned with the executive control processing aspects of thinking (e.g. Brown et al, 1983; Garner, 1987). In the course of that discussion it was seen that many of the concepts involved are as yet poorly defined. However, to echo Flavell (1987), while these definitions are not truly satisfactory, they do help in thinking about the domain.

This study has attempted to examine not only individual elements of metacognition but their interactions. To do this, Brown et al's (1983) view of metacognition was adopted, that is, that what the learner knows about him or herself as a learner, about the learning activity, the materials to be used, the criterial task used to assess learning, and interactions between these variables all contribute to metacognitive knowledge. Executive control processes operate to coordinate elements of this knowledge as plans for learning are designed. While this conception provided a series of reasonably discrete categories for coding complex verbal data, the interactive basis of the model highlighted inter-dependencies, not only among aspects of metacognitive knowledge and executive control processes, but among different forms of knowledge in general.

In examining how students operated upon the metacognitive aspects of their knowledge, the distinction between cognition and metacognition began to break down, especially where students revealed knowledge about factors external to themselves and how these influenced mental and physical actions. This served to underline Alexander et al's (1991) view that forms of knowledge are neither acquired nor exist in isolation, rather they operate within a complex and intricate system. Sternberg (1982) has voiced a similar view, intimating that examination of a knowledge base without consideration of the processes that operate on it leads to distorted views of intelligent performance and its training.

An intriguing finding of the present study was that ranking by the quantity of metacognition (as reflected by the number of codes assigned to interview transcripts) did not correlate significantly with students' ranking by ability. This finding extended to ranking in terms of the proportions of executive control processing codes assigned and various specific aspects of metacognitive knowledge, the implication being that something other than the quantity of metacognitive activity accounts for differences in performance. This appears to be in conflict with previous research implying that less able students are not metacognitively active but does not deny that good strategy use and better academic performance are usually found to co-exist.

Much of the literature discusses metacognitive activity in terms of strategy use but Garner (1987) has commented that discussing strategy use in unitary terms results in perceptions of individuals as users and non-users and denies access to data concerning how best to support strategy development. In the present study students were not expected to engage in the use of well-rehearsed strategies since the task was unfamiliar and their prior topic knowledge was limited. However, they demonstrated that even in these circumstances they were metacognitively active, they all engaged in monitoring, planning, revising, regulating and prediction to some degree. This would seem to support Resnick's (1987) contention that higher order cognition is a basic human activity which is essential to all learning. It also suggests that differences in performance may be the result of variations in the quality of the metacognitive activity they employ, both in terms of metacognitive knowledge and executive control processing.

Metacognitive knowledge

Both Brown (1977) and Flavell (1979) have indicated that metacognition can be flawed and/or inconsistent and this could be an important consideration when discussing the development of the first requirement for good strategy use, i.e. a range of heuristic routines which can be combined to form "good" strategies.

As a group, the Form 1 students in this study were found to have wide ranging metacognitive knowledge and their performance on the information retrieval task often supported the view they had of their learning abilities and difficulties. Their verbalized knowledge of the learning activity (i.e. the information retrieval process) and the criterial task of producing a project report was, however, limited and this in itself must have an effect on their ability to select effective learning methods.

Brown (1980) has noted that children often fail to evaluate their behaviour against sensible criteria, to follow instructions blindly and to be deficient in the self-questioning skills that would alleviate these inadequacies. In this particular case, 17 of the 23 students did not ask any of the questions necessary to testing their understanding of the learning activity or criterial task. If they did covertly ask themselves whether they knew what had to be done, their private reply was "yes". Consequently, the instruction to do a project on BIRDS was followed according to the individual's perception of what was involved and was rarely evaluated in terms of external task demands such as the frequently unspoken requirements of teachers. Few students verbalized recognition that the criteria for evaluation would have implications for the way they approached the learning activity itself. The exceptions to this were those who tried to ensure that they captured the attention of the project assessor by choosing interesting questions.

In contrast, the students verbalized considerable awareness concerning the expected characteristics of the materials they must use and how these would interact with their own learning characteristics. They were also often aware of the immediate implications of materials for the learning activity, although they rarely considered longer term implications. Inaccuracies in their knowledge of the materials were frequently challenged, thus allowing the observation that they often lacked an understanding of relationships within the library system and between access structures and text in individual books.

In the course of analyzing the students' knowledge of themselves as learners, their declarative knowledge of tactics appropriate to information retrieval tasks was discussed. It was concluded that they had insufficient general and tactical knowledge to enable them to come up with alternative action paths when a favoured approach failed.

Metacognition has often been said to be a function of experience and expertise and McKeachie (1988) has observed that able students may perform better because their greater understanding of the material enables them to use more sophisticated strategies. This was reflected in the present study by the differences seen in abilities to assess knowledge states by, for example, students claiming considerable or little knowledge of the topic **BIRDS**. In addition, in much the same way that Garner (1987) suggested that text processing failures on one level can be compensated for on other levels, Subject 14 used his superior knowledge of the information retrieval process to circumvent problems arising from his lack of topic knowledge. Thus topic knowledge and an understanding of the overall learning activity would seem to be complementary factors influencing the application of strategies and information retrieval success. Lack of knowledge on both levels could be a major hindrance to learning in general and to the application of higher order thinking in particular.

If one accepts that all children are metacognitively active, one must then look at learning situations in terms of identifying how they do or do not support application of metacognition. Brown et al's (1983) use of the tetrahedral model to describe variables considered by expert learners can be a key factor in this. As educators, we can ensure that children know about themselves as successful learners by providing feedback that emphasizes the role of effort and the use of appropriate methods. We can work towards increasing their understanding of what is implied by various learning activities, for example, reading for information retrieval implies the use of inferential comprehension as described by Samuels and Kamil (1984), not just literal comprehension. There are implications here also for the type of instuctions given when assignments are set. For example, Baker (1985) noticed that the frequency of application of specific standards for the evaluation of understanding was influenced not by verbal ability, but by the type of instructions given before a reading task began. Similarly, expectations for the characteristics of the materials to be used can be questioned and unrealistic aspects of these challenged. Moreover, educators can ensure that the students are clear about the evaluation criteria by which their learning will be assessed. On this level, Anderson and Armbruster (1984) observed that as a learner's knowledge of the criterial task decreases, so too does the effectiveness of the studying techniques they select. There is no reason to believe that this relationship is any different in the context of information retrieval tasks.

Relationships between these sets of variables and their implications for managing learning tasks must also be made explicit. From this information students can build more complete and accurate metacognitive knowledge which will fuel executive control processes. However, this is not enough to ensure that metacognitive knowledge will be applied to learning. McKeachie (1988) comments that students "stumble on effective strategies only when by chance they vary their approach and find that one method works better than another" (p5). If teachers focus on learning processes and draw attention to the consequences of particular strategies and the fact that they can be varied, student selection of methods will be better supported. In order to do this educators will need to be aware of differences in executive control processing.

Executive control processes

With regard to executive control, Resnick (1989) observed that actual regulation of thinking processes is probably more important to learning than self-knowledge of the individual processes implied. Monitoring is fundamental to executive control but while Pressley et al (1987) note that in some situations young children are known to monitor and modify their strategies well, in general, it is an under-developed skill.

In the previous section it was suggested that educators can influence students' metacognitive knowledge, thereby increasing their opportunities for monitoring and more complex aspects of executive control. The point is that knowledge systems are interactive and that changes in one area are likely to have consquences for the content and application of other areas. However, awareness of the variables which constitute metacognitive knowledge does not necessarily imply ability to manipulate a learning situation to one's advantage. Thus attention must also be paid to the executive control processes which operate upon that knowledge. For example, consideration of the two case studies presented here indicates that student experiences of information retrieval tasks can be vastly different and that increasing monitoring per se is likely to be insufficient to improving executive control processing.

The texts found by students differed enormously in quality and this in itself dictated many of the decisions taken. While monitoring is essential, it is the interpretation of monitoring events and their implications for further executive control processes that is critical to success.

Monitoring in the case of Subject 23 was mostly concerned with noting immediate events, such as the focus of attention, prior to taking direct action. He openly reflected on how monitored events would effect future mental and physical actions on few occasions, consequently his opportunities to plan ahead were curtailed.

Further research is required to determine whether this paucity of linking monitoring with other aspects of executive control processing is typical of students performing less well in the classroom. If it is, attempts to increase monitoring should be accompanied by efforts to help children reflect on possible interpretations of monitoring outcomes and the use of these for metacognitive purposes. This could be achieved through self-questioning and checking. However, neither of these activities was common among the participants in this study. In this relatively novel task it may be that students did not know what sort of questions they should be asking themselves, thus self-questioning was restricted to attempts to activate prior topic and systems knowledge.

With regard to the revision and regulation aspects of executive control, it is evident that the students in the present study had few options for action. As a group they did have a range of tactics, but when these failed individual students sometimes had no option but to move on to the next book or the next phase of information retrieval. The problem seemed to lie in that they were unable or unwilling to examine why the tactic had failed (that is, to self-question). For example, some students attributed failures to the library system or individual books without considering whether their search methods could be modified. The specific context within which students were working strongly influenced whether they would revise search methods and again levels of both procedural and topic knowledge were critical. For example, students who were totally stuck on the task of generating search terms quickly offered alternative keywords and methods of searching for information when a better known subject was used as an example.

Of particular interest was the way in which Subject 14 used his learning activity knowledge to generate alternative actions where topic knowledge was lacking. Given that students are often faced with researching a poorly known topic, knowledge of search methods similar to those of Subject 14 may be widely appreciated. Modelling procedures involving shared problem-solving and reasoning would seem to be a powerful tool in this respect except that, where information retrieval tasks are concerned, there is the suspicion that teachers themselves may not have an adequate understanding of the task demands (Liesener, 1985).

This point brings us to consider how information retrieval tasks could themselves be used to promote higher order thinking in all curriculum areas.

INFORMATION RETRIEVAL

That efficient information retrieval can make exceptionally heavy demands on all aspects of thinking has become apparent during the course of the present study. This finding gives credence to the view that information retrieval tasks have the potential to provide an arena in which higher order thinking can be nurtured. While all of these Form 1 students were metacognitively active, their monitoring skills need to be developed so that planning, revision and regulation are better supported. To a degree these activities depend on an understanding of the learning situation. In general the 23 students voiced little awareness of factors external to themselves which would influence the path of their learning. Tuition aimed at exploring the effects of these variables and identifying points at which self-questioning is appropriate should increase knowledge of the information retrieval process itself and support higher order thinking.

For example, one of the points that seems to be missing from the students' knowledge of library systems and books is that previously mentioned by Hartley (1987). He states that designers of texts are asked to provide a single solution to serve multiple reading goals and differences between individual readers. Similarly, library systems depend on one organizational structure to serve a multitude of client search abilities and purposes. The information seeker who appreciates these restrictions is in a postion to question the demands made upon him or herself and to adjust search methods accordingly. This demands procedural knowledge not evident among the majority of Form 1 students observed. For instance, they were consistent in expecting the library system and books to reflect their own, sometimes idiosyncratic view, of knowledge organization. Consequently, they often tried to locate information using keywords from their own questions without realising that these were inappropriate or that they should also seek broader or narrower terms.

While it is true that ability to think of related terms is bound to be limited by topic knowledge, it is also apparent that student perceptions of what is involved in a learning task influence the knowledge and skills they will apply (Biggs & Telfer, 1987; Guthrie & Hall, 1984). Thus educators need to place more emphasis on helping students to express their information needs flexibly and to modify their subsequent search methods to meet at least some of the demands of the resources they must use.

This may seem to be a somewhat daunting task but the information retrieval process itself provides many opportunities for self-questioning which could be directed towards identifying points at which regulation and revision of search methods are required. Monitoring outcomes could be improved by introducing self-questioning in five aspects of the students thinking as follows:

a) knowledge state assessment

b) the nature of the learning resources

c) implications of the above for the learning activity

d) implications of the above for meeting the demands of the learning assessment task

e) overall task management

The students in the study reported here self-questioned infrequently and then mostly to serve the goals of monitoring (a) and (e) above.

Assessment of knowledge states is listed first since it underlies all information retrieval and use and makes continuous demands on the information seeker. In designing the present study, it was assumed that all students would have some knowledge of the topic BIRDS, and indeed they were all able to write down some of that knowledge prior to the study. However, in general they made poor use of it when it came to identifying an area of the topic that they would like to explore.

Self-questioning in the initial stages of information retrieval can be directed towards activating prior knowledge and identifying gaps in that knowledge. These form the basis of library research question formulation but if the students' knowledge of a given topic is small, it may be more productive to ask themselves how they can get an overview of the subject. Such an overview can be used to aid recall of relevant information or may itself assist in identifying areas worthy of further research. Indeed, general articles, or those written for a younger audience, often provide the searcher with a list of relevant search terms as well.

Whatever use is made of overviews, the student must organize the subsequent search appropriately, both in terms of search method and choice of learning materials. Thus further self-questioning on these levels will be required. Although information retrieval lends itself to fragmentation and tuition directed toward achievment of its sub-goals, students need a sense of being involved in a continuous process in which actions at one level influence subsequent events. For example, it may be that the knowledge gap identified leads to investigation of a single aspect of the topic. Information retrieval tasks that explore one aspect of a topic may give a student a more coherent view of a concept than those that address several superficially. They may also provide a firmer base for independently exploring related areas. Similarly, Form 1 students may find analyzing information needs and question formulation easier when asked to extend their understanding of an existing knowledge area, be it based on direct teaching or self-chosen. The literature (e.g. Baker & Brown, 1984a) also implies that under these conditions metacognition is more likely to be applied.

During information seeking, monitoring activities also must include assessment of the relevance of the information found. Self-questions at this level should include a focus on comprehension (both literal and inferential) and on evaluation of how the information adds to what was previously known. Irving (1985) holds that judgements involved in this evaluation are critical to information retrieval but that students receive little support for the activity. In addition, information importance must be assessed not only in terms of centrality to the topic but also in light of requirements embedded in the instructions for the assignment. Morreover, the student should ask him or herself whether the information found implies a change of focus for future information retrieval. Ultimately, the answer to this latter question will prompt the student to progress to notetaking or processing the information in depth and writing up results.

The phase of the information retrieval process concerned with analyzing the information need also has implications for the location and selection of resources. Students' self-questions at this point should include whether keywords embedded in their research questions are adequate for use as search terms. This may seem a difficult issue to address in the classroom but open discussion about suitable terms and comparison of those selected by students with those used in cataloguing new acquisitions should provide some insights. (New Zealand's

National Library supplies a simplified Dewey-based thesaurus (NASH) to schools as a cataloguing guide. Sadly, it tends to reside in the library and is not often perceived as a teaching aid.)

When students fail to locate resources on the library shelves their self-questioning should focus on where else they should look. A central problem here seems to be that in the past students have been taught that a Dewey number implies one shelf location, whereas it may refer to the main non-fiction shelving, the reference section, audio-visual materials, vertical files, big books and magazines. Students in the present study showed little awareness of the variety of locations possible and although they mentioned looking in the Learning Resource Centre, the teacher-librarian, considers that they would not have been aware that resources there are also organized according to the Dewey Decimal System. Catalogues, including card-based, microfiche and computers could include reference to the different types of resources a particular Dewey number includes just to remind students of their existence.

In terms of selecting books, the Form 1 students observed were in agreement that titles and cover illustrations are the first indicator that a given book might be useful. Beyond looking in contents tables and indexes for chosen search terms, most students did not know how to evaluate whether the book was useful or relevant. Reading activities were generally brief and centred on locating specific keywords, Once found, a few sentences around them were read and accepted uncritically. Although information processing during selection of resources is likely to be superficial, it must nonetheless involve an element of critical reading. However, one gets the impression that this point is generally not recognized.

As mentioned earlier, it is sometimes assumed that actual work begins once students return from the library having selected books. Irving (1985) points out a further problem on this level. She says that far too many children are given information tasks by teachers who have no idea whether suitable resources are available. The students themselves are often left to decide which resources are suitable but novice and poorer readers are known to have trouble distinguishing between easy and difficult texts, in identifying contextual contraints on meaning and sorting important points from trivia (Brown, Armbruster & Baker, 1984). In addition to these problems, where selection of appropriate resources is concerned, they must also assess text content in terms of relevance to a topic which they understand poorly, if at all! If it is true that teachers in general have a poor understanding of the demands of information retrieval, it is likely that those checking resources for suitability may themselves be limited to evaluating them in terms of reading for literal comprehension, not the inferential comprehension necessary to the task.

As far as the students are concerned, literature reviews (e.g. Wong, 1985) demonstrate that under certain conditions, attention to self-questioning aimed at activating prior knowledge and encouraging metacognition has a positive effect on prose prosessing. Self-questioning aimed at activating evaluation of texts in terms of difficulty level and topic content may also be necessary to help students become better able to select books wisely. Teachers can also contribute to this latter endeavour when actually stocking school libraries.

Educators responsible for acquiring resources should evaluate the quality of information access structures such as contents tables, indexes and sub-headings before purchase. Student awareness of the quality of these could be increased by getting them to check indexes for inaccuracies and to discuss the sorts of references they find. A single sentence mention of a topic can be just as frustrating to information seekers as finding that the reference is not on the page listed in the index. Similarly, students could be encouraged to comment on whether titles, chapter and sub-heading are an accurate reflection of text content. Such exercises should be accompanied by discussion of the implications for learning from text and the necessity of engaging in inferential comprehension and the construction of coherent concepts from information fragments. The students' strategic knowledge would thus be increased and a generation of discerning book buyers would emerge. Publishers and editors should be given feedback concerning the ways in which they can decrease the demands of reading for information retrieval.

Reading for information retrieval during the extraction and processing phases of the task was not a focus of the present study but is expected to demand thinking strategies that focus on relationships between idea units within a topic area. It is not sufficient to know what goes into the concept, one must understand functional relationships between elements and what these imply for searching associated information areas.

The complexity of information retrieval and use is such that it is unrealistic in the extreme to expect all young students to cope independently. As Swing (1982) says "if we do revive the activity or project method, we should not repeat its mistake of not directly teaching students the skills necessary for learning from texts" (p144). However, it is apparent that they also need teaching about the information retrieval process itself and assessment of their learning should focus on that process, not merely its product. Assessing process is not an easy task in itself but students could be encouraged to keep a log of their information retrieval activities. This could serve a dual purpose in that it provides students with an aid to reflecting on their own actions and teachers with insights into problems experienced.

Within the metacognitive literature, it is evident that higher order thinking skill development can be supported by the use of reciprocal teaching methods within which teachers and students model executive control processes and problem-solving (Palincsar & Brown, 1984). Given that adults in general are not well versed in efficient information retrieval methods and their underlying cognitive and metacognitive demands, such procedures could provide further insights on both sides.

The information retrieval process itself provides many sub-tasks which can be used as the focus for training in self-questioning. However, the driving purpose of that self-questioning should be two-fold. On one level it should increase students' awareness of the nature of the phases of the information retrieval process and how they interact and on the second level its purpose should be to increase monitoring and focus attention on the consequences of events. Self-questioning must be the spring board to further metacognitive action so must itself be supported by wide ranging procedural knowledge. An understanding of the conditions appropriate to its application is also necessary if planning, revision and regulation are to take place.

CONCLUSION

The study detailed in the foregoing chapters has explored the cognitive environment of Form 1 students engaged in information retrieval and has endeavoured to assess metacognition in this context. All of the participants were found to be metacognitively active, but only in proportion to their understanding of the learning activity, the nature of the materials, the assessment goal of the task and interactions between these variables. Overall, students' metacognitive activity was poorly supported by their declarative and procedural knowledge of the learning situation. It is suggested that explicit attention towards increasing that knowledge would enable them to improve their information retrieval efficiency and pave the way for further development of metacognitive abilities.

Success in the task of information retrieval from a library was shown to require analytical skills together with those of evaluation, inference, interpretation and problem-solving. All of these are considered to be an integral part of "learning to learn" and information retrieval tasks can be used as a forum for their public examination, discussion and development. Indeed, information skills cannot be effectively taught without reference to thinking. Moreover, the skills implied are not tied to any particular curriculum area and have wide application.

While completion of information retrieval tasks is extremely complex, and may be accompanied by more failures than successes in the early stages, each phase lends itself to explicit teacher attention that can be tailored to any level of cognitive development. The information retrieval process itself remains the same whether one is researching a primary school project or a PhD. The elements that change are the sophistication of the strategies used, the depth to which complex concepts are explored, and the resources upon which learners must operate.

The role of the teacher in providing expert scaffolding in terms of the thinking that underlies information retrieval tasks is crucial. Not only does it involve shared modelling of thinking skills but it also requires that interactions between variables in the learning situation are reduced to a level that students can realistically be expected to manage. This implies that clear information should be given about the activities necessary for information retrieval at any given level, that students understand factors determining how their learning will be assessed and that problems inherent in the task of locating and using information resources are addressed.

A limiting factor here is the teacher's own knowledge of the demands of information retrieval. As pointed out earlier, using the library as a focus for learning about learning demands that teachers and librarians apply skills which may not have been included in their own training. However, while the government has acknowledged the importance of information skills by labelling them **essential** in the Draft National Curriculum, it is at the same time intending to cease funding teacher-librarian positions in schools at the end of 1993. If information skills and their attendant higher order thinking abilities are to be promoted in schools, this conflict of interest will have to be resolved. Promotion of the required skills cannot be achieved without providing teachers with professional devlopment and support. At present the teacher-librarians provide a modicum of the necessary input, in and out of the library context but, in general, there seems to be some uncertainty over the exact educational role of school libraries and their staff.

In directing attention to the cognitive and metacognitive aspects of information retrieval and use, educators gain both a context within which higher order thinking skills can be fostered and a strong rationale for developing and using school libraries. This clarity of purpose is seen by some writers (e.g. Liesener, 1985; Beswick, 1983 and Marland, 1987) to be an essential ingredient in realizing the potential of school libraries to contribute to education.

However, further research is desirable to establish whether the experiences of the 23 Form 1 students observed here are typical of the age group and how perceptions of information retrieval tasks change developmentally. Further, given the strong English language bias of library systems, studies concerning how best to support information retrieval amongst the many cultural groups within New Zealand would be of benefit. Attempts to establish information skills across the curriculum will also be enhanced by action research, the aim of which is to provide professional development for educators.

Where teachers are encouraged to make expert scaffolding and reciprocal teaching part of their normal teaching practices the higher order thinking skills described by Resnick (1987) will be better supported at all levels of education.

APPENDIX 1

CONTRACT FORM USED BY FORM 1 STUDENTS PRIOR TO AND DURING STUDY

CONTRACT

NAME:

TOPIC:

DATE BEGUN:

DATE FINISHED:

QUESTIONS I WANT TO ANSWER:

REFERENCES I USED

PRESENTATION METHOD

PUPIL SIGNATURE:

TEACHER SIGNATURE:

EVALUATION:

APPENDIX 2

GUIDE USED BY STUDENTS IN TWO ASSIGNMENTS PRIOR TO THE PRESENT STUDY

RESEARCHING STEPS

DECIDING what you need to know
What do I know already?
Organise what I know
What do I still need to know?

FINDING the information you need
What kind of information do I need?
Book, person, pictorial?
Do I have the skills to locate this information in libraries, the community?

USING the information
Do I know how to get the information from the resource - book, person, encyclopaedia?
Can I use an index, a menu, plan an interview?

RECORDING the information
Can I skim, scan, read, view, ask and record the information selectively, or do I just copy, photocopy, record huge hunks of text?

PRESENTING the information clearly and interestingly.
Have I thought about what message I want to present and how best to present it?

EVALUATE how well you did as a researcher.
Which stage did I do well/not so well?
Where could I/should I have asked for help?
What do I think I'll be able to do better next time?

APPENDIX 3
INFORMATION AND CONSENT FORMS
Children's thinking and projects

Dear Parents,

I have for sometime been concerned by the trouble children have in finding information on their own. Now I am hoping to carry out a study (supervised by Massey University) which will help teachers, librarians and parents to understand the difficulties from the children's point of view.

Mr. Thwaites has given me permission to observe children in a Form 1 class as they go about finding information for normal class project work. Children whose first language is English will be asked to share their thoughts with me and a video recording will be made of what they do. As they watch themselves on video, we will talk some more about thinking. Sadly, there may not be time to see everyone in the class individually.

This study will give us valuable information about the difficulties children experience and will guide us in helping them and many other children. I'd like to stress that children who do take part will not be evaluated in any way - no one will pass or fail - instead, they will be teaching me and hopefully will have some fun along the way. In addition, their names and the way particular children go about seeking information will be known only to me. Anonymity and confidentiality will be respected and the children's permission to use the findings will be sought.

To register your consent, please complete the form below and return it to the school as soon as possible. If you have any questions about this study, please do not hesitate to contact Mr. Thwaites or myself (phone 792 352). The study will begin on June 7th and observations will then take four weeks to complete.

Sincerely,

Penny Moore

CONSENT FORM

Thinking about projects - Research study

I am/am not willing to let ________________________ take part in the study of children's thinking and projects.

Signed____________________________

Date______________________________

CHILDREN'S CONSENT FORM

Thinking about projects - Research study

I know that what I say and do while being filmed with the researcher will not be made public. Information about thinking gained from my interview will be put in a report but my name will not appear

I don't mind the researcher doing other reports based on this one, as long as my identity is kept completely private and the information is used to help other children and teachers.

Signed__________________________________

Date____________________________________

APPENDIX 4
CODED TRANSCRIPTS OF INTERVIEWS WITH SUBJECTS 14 AND 23

In the transcripts the abbreviations used were as follows:

- L.C. learner characteristics
- E.C. executive control processes
- T learning situation, i.e. learning activity/materials/criterial task

In each case the abbreviation is accompanied by a reference to a sub-code. Alternating colours were used to ensure that phrases and related metacognitive codes were easily identified. Where codes overlapped, brackets were used to indicate the extent of the second code. Phases of the information retrieval process were marked by placing a coloured line across the transcript where the goals of action changed. Associated cognitive and behavioural observations appear in that same colour.

Subject 14 think aloud/ concurrent interview	Metacognition codes	Converging evidence and comments	Information retrieval phase
S14: Well, what I want to find out is about, a bit more about individual birds.			**Analysis of info. need and question formulation** identifies an interest area
I don't want to find out what birds look like or anything because there are so many different ones.	L.C interaction (activity/ materials)		identifies what is not wanted
So I'll put um,.... I can't think of a bird,	E.C. monitoring		
so I'll just, to start me off I'll put um, yeah, what are some birds in New Zealand and that will	} L.C. tactical } knowledge		

give me a start, it'll give me more information, that'll give me a few and then I can work on them.	E.C. planning		formulates a general focus question
Int: So you'd use the information you'd find for that question to help you decide what the other questions are?			
S14: Yeah, that would probably be the first question I would do.		confirms strategic knowledge	other questions to be developed later
Int: Okay, now have you any idea of the sorts of questions that you might ask after that one?			
S14 Yeah, I just want to find out about some of them. I'll just find out how big they are and what they look like.	E.C. planning		identifies some aspects of general question to be explored
Int: How big and what they look like. Okay.			
S14: Yeah and that sort of thing about a few of them.			
Int: What do you call a few?	T. criterial task demands		
S14: Well, two or three			limits range of general question
Int: Two or three. Alright, okay. Would you like to go and look for that information right now?			
S14: Yeah.			

Int: That's the way you'd normally work is it?			location of information sources
S14: Yeah.			
Int: Okay, how are you going to do that?			
S14: (Walked to catalogue, opened draw)			moves directly to non-fiction subject headings A - D
Int: What are you looking for now?			
S14: I'm looking for BIRDS and (?) if 598 and the other ones - but I don't need them at the moment.	E.C. monitoring	rehearses 598.2 as first choice a little later	locates multiple entry for BIRDS selects 598.2 as target
Int: Okay, do you know what all these numbers mean?			
S14: Yep, there's different birds, 598, that's probably birds, you know birds, and then comes two different kinds of birds.	}L.C knowledge } state, } supported by } declarative } knowledge		Secondary task
Int: Yes. What about this bottom number here? The .29931, what does that mean?	} } }T organization of		
S14: Oh that means, well, getting more complicated and different sorts of birds.	} materials } }		Secondary task
Int: Okay, good.			

S14: 598.2. (Moves to shelving) 598. Int: Have you looked up these, have you looked up BIRDS before? .	E.C monitors focus of attention		Recalls/rehearses target Dewey number moves directly to correct shelf
S14: No. 598...<u>Town birds in New Zealand.</u> Ah, that's sound quite interesting, 'cos I didn't really want to find out about town birds so much as rivers, lakes and open country	monitoring continued E.C. metacognitive experience L.C. knowledge state	changes attention from Dewey to titles I/R phases of analysis and selection intertwined here	**Selection of infomation sources.** reads Dewey numbers, then titles, takes book basis of title match with previously unspoken info need
Int: Why is that one more interesting to you?			
S14: Well, cos that's probably common birds [<u>Town Birds</u>] like sea gulls and everything	E.C. prediction		
Int: Alright, okay. How will you use this book?			Opens book at random but near front
S14: Well, it's got a few of them.	E.C. monitoring		
I"ll just read a bit of it and find out which one I find more interesting	} E.C. planning		reads and glances at pictures
Int: Would you like to do that now?	}		reads first page goes on to next
S14: Yeah, I'm just going to skim read a bit.	}		

Int: Okay.			**Analysis/Question formulation**
S14 Well, now I've decided to do it on ducks	} E.C. regulates/revises		refines question to specific species
Int: You're going to do it on the ducks, okay S14: Yeah. And um, I like the grey teal in this book (indistinct sentence) And I thought it would be interesting, the story of it.	}	takes first information found but gives impression that he is genuinely interested	uses information gained to tighten focus further places book on floor open at relevant page
Int: Yes, and have you got enough information there to do your project?			
S14: No. But now I know the name of it, I can go just anywhere, say the LRC or everywhere, just looking	E.C. prompted monitoring L.C. tactical knowledge		<u>Extraction</u> identifies search term for use in other books
Int: Now we're going to be a bit mean to you today, we're making you stay in this part of the library rather than in the LRC. How will you find information in this part of the library?			
S14: Well, just look, you know. Um, <u>Birds of New Zealand</u> might have information of the grey teal.	E.C. regulation E.C. prediction	turns to top shelf again	**Selection of info sources** turns to read titles on top shelf takes book on the basis of title

Int.: Okay.			
S14: Or some other duck like that.		Not committed to grey teal? Will accept what is found?	turns to contents then a list of illustrations
Int: What are you looking for there?			
S14: I'm looking for grey teal ... oh, maybe I should look for duck first. There's nothing here.	E.C. self-corrects, revises E.C. monitoring		search term idenified as **grey teal,** turns back to contents, looks for **ducks**
Int.: There's nothing there?			
S14: No, I'll put it back. I'll have a look at this book. No it doesn't have anything on particular birds, it just you know...	E.C. planning T. materials structure		rejects book and replaces takes alternative , turns to contents evaluates as unhelpful, too general, rejects and replaces
Int.: It's just birds generally, is it?		Same title was mentioned before but this is clearly a different volume	reads titles, takes book, turns to contents and scans page
S14: Yeah. Birds of New Zealand, that sounds interesting			
Int.: Is that one more helpful?		On video seen to refer back to earlier book left open on the floor, conversation that follows confirms	**Extraction**
S14: Oh yeah, I've got to find some more information 'cos I want to see where it lives	E.C. monitoring		notes need for specific information places two books side by side
Int.: So you're checking back to the first book			
S14: Yeah.			
Int.: To find what?			

know, birds of the forest and mountain and I don't know if it [grey teal] is a mountain bird	L.C. knowledge state		chapter in second book
Int.: *Okay, so that book is* grouped in the areas that birds live...?		confirms previous events	secondary task
S14: Yeah.			
Int.: And this book will tell you where that bird lives, is that what you're checking against?			
S14: Yeah.			
Int.: So you're using this book to tell you where to look in that book?			
S14: Yeah. I'm also going to look for the grey duck here, so I can have two ducks	E.C planning		identifies other targets for search
Int.: Right.			reads first book
S14: And here it is. Oh, it might be ... No, it's not here, I'll look for.....	E.C. monitoring E.C. regulation E.C. monitoring		reads contents second book looks for index -not there
Int.: Were you, what were you seeking in the back of that book just then?			
S14: I was seeking for a duck. Ducks that live in rivers and stuff. It doesn't really have anything. Oh, it might be...	E.C monitoring E.C. regulation/revision		looks back to first book thinks of alternative term (unspoken), rechecks contents of second book

The only ... rare bird or something - I don't know if it is or not.	L.C. knowledge state	From finger pointing it seems that he checks contents entries for related terms	identifies chapter on rare birds as a possible source
Int:. You're not sure whether the grey teal is a rare bird?			
S14: Yeah. It doesn't say anything over there [in first book]. Usually I look in the LRC	E.C. monitoring		reads first book to decide whether rare bird chapter (2nd book) should be read
Int.: Yes, if you were in the LRC, what would you be grabbing, what books?	L.C. tactical knowledge		returns second book to shelf
S14: Oh I'd just look in encyclopaedias for the grey teal of the grey duck			
Int.: Mmhm.			**Selection of info sources** reads titles, selects one because it has NZ in title
S14: That might have something on it.	E.C. prediction		
Int.: What made you pick that one out?			
S14: Oh well, 'cos it says New Zealand and I'm looking for New Zealand birds.			turns to contents, tests prediction
Int.: Okay.			
S14: There	E.C. monitoring		
Int.: Found something that helps?			switches from contents to index having found approp. chapter
S14: Yeah. [turns to index]	E.C. regulates		

Int.: What was it that you found?			
S14: I found it had duck... well...			
Int.: So it's got a chapter on ducks?			
S14: It's got ducks so not I look in the back [index] and see if it's got a teal.	L.C. tactical knowledge		
Int.: Uhuh.			searches index for teal
S14: Not here.	E.C. monitoring		
Int.: It's not there. Does that mean that it's not in the book at all?			
S14: Ah... yeah, probably. I could, I could look under that Maori name . See here? I looked under the Maori name and it'd got it...(indistinct)	T. materials E.C. prediction E.C. regulation		locates Maori name in first book uses info to search second book index locates appropriate page
Int.: That was a good choice then, wasn't it?			
S14: Page 84, yep. Maybe when they wrote that book, they didn't have all the information for it. Page 84, there's grey ducks as well. Now I can find all the information about it. And now generally I write it down.	T materials E.C. monitors focus of attention and task progress L.C. tactical knowledge	reflects knowledge of overall process but he did not write	evaluates book as helpful

Int.: Okay. S14: So... it's also got a native black duck. It's other name's (?) Maori name and the black duck (?is it's Australian) name.		This report of text contents is really part of extraction phase but he quickly reverts to selection	reads and reports on contnts of text
Int.: Okay. Now does that give you enough information for the project?	} E.C. monitoring		
S14: Yes, but I still need to find a bit more on them both, yeah, more on both of them	} (prompted) }L.C. interaction activity }and criterial task		
Int.: And how will you do that?			
S14: Well, in the same way, by looking at other books and encyclopaedias and that sort of thing. Int.: Okay. S14: And then I'll	} } }E.C. planning } } }		
[looks at books on shelf while speaking] <u>Small birds.</u> I want to see if it's a small bird	E.C. monitoring E.C. regulation		reads title
Int.: So what's happening now? Have you seen a title that you think's appropriate ant what are you doing?			looks back to book on floor to read about size of duck
S14: I'm just seeing if it is a small bird.			

Int.: Okay, so you've seen a title Small birds and you're checking the information you've got there to see if it's a small bird?		Video: shows him holding hands apart .5m	
S14: Yeah ... 52 centimetres	E.C. checking		holds hands apart about 0.5m
That's quite big for a bird.	E.C. monitoring		evaluates book on basis of size of duck
I know it [book] won't *have information.*	L.C. knowledge state		rejects book
No I don't think there'll be anything in this one because it just says Birds, it doesn't really say anything about New Zealand. It doesn't have much.	E.C prediction		reads titles on shelf rejects one on basis of prediction centred on title being too general
Meet the Birds, that might have what I want	E.C. prediction		accepts next book despite its general title
(indistinct sentence) Teal			looks at contents, checks index in three places
Int.: So you're looking for teal now?			
S14: No, it just says teal, I was looking for (?) but it just says teal.			
Int.: So again you were looking for the Maori name?		confirms his use of info gathered earlier to direct search now	
S14: Yeah, because it wasn't in the English name			

Page 13. I don't think it will have much information about a teal. Birds, just birds, it doesn't really, you know, say much about it,	E.C. memory prompt E.C. prediction E.C. monitoring	Video shows him starting to turn to a particular page but stopping and re-reading the index	locates relevant entry in index turns to it runs finger down text to locate target word
so I'll just look for the other one.[duck]	} }E.C. regulation		
Int.: So from the chapter heading, you don't think it's going to give you much information?	} } } }		checks index once more
S14: Yeah. I'm just looking for the other one. Not under the Maori name. I'll look under grey duck.	} E.C. monitors E.C. revises		using two different search terms evaluates book as unhelpful, rejects it
(Indistinct phrase) This won't help me	E.C. monitoring		
Int.: Okay, is there anything else there that you think might help?			
S14: .....I've looked at that one I think. Yeah, I did	E.C. monitoring E.C. checks		reads titles, takes one checks back page, replaces it
Oh, there's sea birds. It doesn't really matter. I've got, you wouldn't um, tell you a lot about them if they were sea birds but, you know, they aren't	E.C. monitoring E.C. regulates	Video shows him checking book on floor to see whether teal are sea birds	reads titles looks back to book on floor for specific info passes on to next book on shelf without opening sea birds
Int.: Right.			takes book, looks at contents
S14: Um, Birdwatching might be alright. Just tells you how to do birdwatching	E.C. prediction E.C. monitoring		then rejects and replaces

THINK ALOUD/CONCURRENT INTERVIEW ENDS

SUBJECT 14 Retrospective interview	Metacognitive codes	Converging evidence and comments	Information retrieval phase
Int.: Do you find it very difficult to come up with questions for projects, or do they come fairly easily?			analysis of information need
S14: Ah, it depends. If I choose a project or, I mean I choose a sort of subject like I did then, I get a wide topic like birds, yeah, I do. I get a , I don't have any problem, but otherwise I do. Int.: So if it's a wide topic you find a... S14: I find it easy. Int.: You find it easy. S14: Yeah. Int.: If it's a narrow topic it's much harder? S14: Yeah.	} L.C. interaction learner and activity		
Int.: Does it make a difference if you already know something about the subject?			
S14: Er, yeah. You see, if I know some birds of New Zealand that I like, then I	L. C. interaction		

find information about those.	learner and activity
Int.: Okay. What sorts of thing do you think of to come up with questions? Do you think about the sorts of things you already know or...	
S14: No, I think of oh, I don't realy know. I just think of (indistinct) I think of what I'm going mmm, what I found interesting, or what would be easy to find.	L.C. interaction materials and learning activity
Int.: How do you know it's going to be easy to find?	
S14: Well, it's going to be very unlikely to find if I say who discovered that bird, or who discovered this bird. It's going to be pretty hard to discover that.	
Int.: What makes... when you're thinking up a question, how do you make sure it's going to be easy to find? Can you tell me what sort of thing you have to think about?	

S14: Well, well, it's got to be a wide question and it's got to be an encyclopaedic sort of question, a book sort of question, like what are the bitrds in New Zealand and it'll be easy to find.

L.C. interaction materials and learning activity

Int.: Do you use encyclopaedias alot?
S14: Yeah.
Int.: Do you use them for most of your projects?
S14: Yeah.
Int.: So you haven't used that section of books very often at all before?

Location and selection of information sources

S14: Ah, I use them when I just want a book to read sometimes I do. And er, I use them sometimes, not that often. It's just faster to go to the encyclopaedia, open it and look for it - once I chosen what I'm looking for.

L.C. tactical knowledge

Int.: Okay.
S14: Like birds in here and then I find New Zealand, I'd probably look for a New Zealand book and look for birds.

L.C. tactical knowledge confirmed

confirms what was done during think aloud interview

Int.: So the way you approach it, you come up with a question and find some information and then you use that information to make the next questions?		aims to identify a gap in his knowledge	**analysis of information need**
S14: Yeah.			
Int.: And that's the way you *usually work is it?*			
S14: **Yeah, if I, if I don't know anything about the topic, cos I didn't know anything about, oh, I knew some birds, I knew Kiwi and I knew too much about it. So I thought I'm not going to find something about it because it's too boring, I know about it.**	previous code continued	Searching for what is known is boring!	
Int.: Now you've got some, have you got enough information at this point?			
S14: Oh yeah, to do one or two pages of writing, yeah, I've got enough information	T criterial task demands		
Int.: Okay, will you look for any more?			
S14: Oh yeah, if I was allowed to use the encyclopaedia in			

the LRC and New Zealand books and all that.

Int.: Well, you will be able to, you can now, it's just that while we were recording we wanted you to stay in this part of the library. Okay, can you tell me what happens when you go to the catalogue and look up a subject and find that it's not there, what do you do?

S14: **Oh, it depends, well, you see if it's a subject like um, videos and it isn't there you look for t.v. or something. If you're looking for calculators, you look for computers, you might find it there. You just go there. When I was looking for holograms and it wasn't there then I looked for lasers and it was there. And then there's holograms in the laser section, cos holograms are made of lasers. It sort of works like that.** — T materials -system level — **location of information sources**

In.: When you're skim reading, what do you really do? Do you just read the occasional sentence or...

S14: Well, I, see I was skim reading to find out if it was a small bird, I look for the size. Um, if it says the size of it at the top then fine, if it doesn't, I just look for numbers.

Int.: Look for numbers?

S14: Yeah, when I'm looking for the size, cos it'll say um, 55 centimetres or something.

L.C. tactical knowledge

Int.: Yes, okay. Can you tell me anything else about your thinking when you're doing projects?

S14: Oh yeah... no, not really.

Int.: Things that you find difficult, things that you find easy.

S14: Oh, sometimes it eas.., sometimes it's hard because I'm looking for Pascal's and I um, I wasn't looking for everything. I was looking for Pascal's triangle.

Int.: Yes?

skim reading appears to be locational in this case

selection and extraction of information

location of information

Basically seems to be saying that he has difficulty when he doesn't know what to use as a search term - see over

S14: And then I, and then I, it wasn't under anything so then I, a book told me that sometimes it was called (indistinct word) triangle and I looked for that and it was there.	L.C. interaction learner ability and activity		
Int.: Right, so you needed a bit more information and that helped you decide where to go next?			
S14: Yes.			

Interview session with Subject 14 ends at this point.

Subject 23 think aloud/ concurrent interview	Metacognition codes	Converging evidence and comments	Information retrieval phase
			Analysis of info need and question formulation
Int.: You can write your questions on the contract form there.			
S23: I can't spell that well.	L.C. ability		
Int.: Never mind, I'm not going to be looking at your spelling.			
S23: Ah... um,.....			
Int.: What sort of questions do you think you could ask?			
S23: Er....where some birds nest. Oh, like all kinds of birds that...	L.C. prior topic knowledge		interest area identified

Int.: You like all kinds of birds, did you say?		
S23: Oh no, where um, um, for question where do, where do certain birds nest.		question formulated
Int.: Mmhm. Have you any idea what certain birds you're thinking of?	L.C. prior topic knowledge	prompted to activate specific prior knowledge
S23: Um, sparrow, fantail, um, that's all I can think of.	E.C. monitoring	
Int.: Okay, well that's a good starting place.		begins question formulation - not pursued or written down
S23: Um... um, how do they live, what are their dangers of living in nexts and what are their, they've got dangers, like all kinds of dangers. There's cats but the question is what are the dangers for for birds, what is it like, enemies for the birds.	L.C. prior topic knowledge	refines question: dangers to enemies
Int.: Mmhm, how will you write that one down?		
S23: I'm, not sure. Um, ...	L.C. knowledge state	writes question as formulated
Int.: ..[reading what he had written] What are the birds...		
S23: Dangers.		

Int.: Dangers, right. And by that you mean like their enemies?			
S23: Yeah.			
Int.: Right, are you going to come up with any others do you think? Any other questions you want to know answers to?			
S23: What is their food that they like most, well what is the sort of food they like eating that um, that humans can give but their food that they like the most.			formulates another question, basis unknown
Int.: That's an interesting one too. Do you know much about birds?			
S23: No, but we feed them a lot. They seem to like lots of bread.	L.C. knowledge state L.C. prior knowledge	Modifies this in retrospective to say he knows a wee bit	
Int.: Okay, so are you asking a question that you think you already know the answer to?			
S23: No, I'm not. Some like, two of them I don't know, and maybe the food they like best I don't really know that much.	L.C. knowledge state	Video: Very confident in his answer on this	prompted assessment of knowledge gap

Int.: Okay.....Do you want to think of another question at this stage?		Video: takes time to genuinely think of another question	
S23: Er,.....I can't think of another.	E.C. monitoring		
Int.: Okay, would you like to start looking for some information?			
S23: *Okay, yeah.*			
Int.: Where abouts would you start looking do you think?			**Location of info sources**
S23: Um, in a section where birds are or um, in the true, fict... catalogue.	T. materials organization		details path through library
Well, I forgot what it was called and I think it was the non-fiction catalogue.	L.C. knowledge state		
Int: That's right.			
S23: And I'd look up under BIRDS and then I'd look for, then I'd go, I'd look through the books to see what birds, where birds nest um, nest or what the pictures show of bird, are showing of birds nesting, I mean the information that they've got below [the illustrations].	E.C. planning combined with L.C. tactical knowledge		

Int.: That sounds like a pretty good idea. Let's go and do that, shall we?....Do you use the catalogue very much?			goes directly to non-fiction A - D subject headings
S23: No. Ah.....	E.C. metacognitive experience	Video: shows him stop searching cards then begin again at the front of the drawer	searches card before BIBLE to locate BIRDS
Int.: You think it's before BIBLE?	E.C. checks		
S23: I'm not sure really, cos I don't, I don't know much about the catalogue. I don't use it that much.... Ah, BIRDS - 598...586 um 596 (indistinct)	L.C. knowledge state E.C. monitoring	Possible self correction of rehearsal but still incorrect	locates single entry card and reads number rehearses it incorrectly reads Dewey numbers in end bay to left of catalogue
Int.: Sorry, what was that?			
S23: I think it was 596 but I don't know whether that will be here. 59.....59.....	E.C. monitoring		searches in silence
Int.: What's that you've found?			prompted to report on materials found
S23: 590, which is on foxes or (indistinct) like wolves and all that.			
Int.: So, so it is animals, isn't it?			
S23: Yes, cos it says ANIMALS on the block [shelf guide] but I'm looking for 596 and I don't know if they've got one at the moment, so I'll have to have another look.	E.C. regulation/revision		returns to catalogue

Int.: You don't think there is a 596?			locates a different card, accepts 339 as new target number
S23: No, I don't think so.....Ah, BIRDS 339.	L.C. knowledge state E.C. monitoring		
Int.: 339?.... Is that the number you had before?			
S23: No, it's a different one because it's more likely to have a bit different things about birds, different than the other books, cos they um, do um, make other books that er have a bit more information than the others	T. materials		
Int.: Mmhm.			looks casually to right of catalogue
S23: Oh, 598!	E.C. monitoring, leading to regulation		abandons search for 339 when 598 is located
Int.: Ah does that ring a bell?			
S23: I just saw it. Bird, Town bird in New Zealand.			**Selection of info sources** takes book, basis unknown turns to contents, reads
Int.: Do you see anything there that is going to help you?		video: shows clearly that book had no page numbers on table of contents	
S23: Yep, the fantail, that's if I could find, if they gave us a page number.	E.C. monitors L.C interaction activity/materials		locates relevant item
Int.: They didn't though, did they?			examines book page by page until fantail is seen **Extraction of information**

S23: No... just have to look at the names. Fantail. The food they mostly, I think they like is insects that live on the ground cos they, they, they go round picking up insects in their beaks, they have to be like ants, ***small bugs sort of.***	E.C. regulates/revises E.C. monitors	Video: appears to use pictures not headings to locate right page	**looks at picture** reports information gained, continues to look at book
Int.: Does that tell you very much that's helpful?			
S23: It tells me what, they eat but it doesn't tell me what, what one of their favourite foods are,	E.C. monitoring progress through task		**analysis of info need** identifies information gap
so I s'pect that one of their favourite foods is insects.	L.C. knowledge state		makes inference to fill it
Int.: Yes.			
S23: I have a feeling that it's insects.....			
Int.: Does that give you enough information to do you project or do you need some more?			
S23 I need some more for um, for um,.... to er, find out what, where, how they nest and all that.	E.C. monitoring (prompted)		identifies aspects of topic still unknown

Int.:	Mmhm.		**Extraction of information**
S23	They've got one nesting here [in Town birds] but that's the grey wobbler or whatever they call it.		turns page, looks at picture, reports content
Int.:	Grey warbler.		turns back to previous page,
S23:	Warblers. Uh, oh it tells you a bit about their nests here.	E.C. monitors	reads aloud
	They've got 16 centimetres of accessed, excess aleck aleck whatever they call it, nest or up to 5 broads in a season, whatever...		
	I don't understand what they're saying here	E.C. monitors	
Int.:	Okay. What do you normally do when you don't understand a bit like that?		
S23:	Well, I sometimes make up words that might go with it but they never work so I can't understand what , what it's telling me about or I syllabify it, break it up into little parts so I can read it a bit easier.	L.C. tactical knowledge	

Ah, that's what I do but (indistinct). I think I can (look at?) some more books, might have a bit more.	E.C. planning		replaces book on shelf
			Selection of info sources
Int.: Okay.			
S23: Birds of the New Zealand Shore.			reads title, rejects on basis of prior topic knowledge
Int.: You put that one back, why?			
S23: Because I'm not looking for shore birds, cos fantails they, they mostly live in the forest. They are I think they were really mostly in the forest.	E.C. monitoring L.C. prior topic knowledge		
Int.: Yes.			
S23: Birdwatching might be interesting cos lots of people like watching birds. Ah, there.	E.C. prediction E.C. monitoring	He was pointing to chapter heading NESTS	takes book because title looks interesting turns to contents, reads identifies relevant entry turns to appropriate page looks specifically for fantail nests
Int.: Anything there that's useful? Oh, nests might be useful	}		
S23: Nests. Now I've got to find what um, what a nest... is ... oh	} E.C. monitoring task position and planning		
they don't have it, they've only got some nests. Oh, they might have it there...	E.C. monitoring E.C. prediction	video shows him turning back to previous page	

Int.: So were you actually looking for nests of fantails in there?			
S23: Yes. They might have it in if I read a little bit.	}L.C. tactical } knowledge		
Int.: Yes, they might do.	}		reads in silence
S23: If I skim read it.	}		
Int.: Does that help at all?			
S23: No cos I couldn't find any	E.C. monitoring	verbalization prompted	evaluates as unhelpful
Int.: Okay.			returns book to shelf
S23: (indistinct phrase as he returns book to shelf) Country Birds, Kingfisher.....			reads titles
Int.: What sorts of things are you looking for on those books to tell you which one to take off the shelf?			
S23: Um, you really look by the cover or the title of it. What they um, like um, they, they're trying to show you, like the, like a diagram for infor ... all the kinds of birds they've got and they show you what kind it is and how they, what they eat.	L.C. tactical knowledge		takes book, basis unknown, flicks through pages to illustrate what he is saying
And this one seems to like fish.	E.C. monitoring	Video shows him pointing to illustration of a heron	notes info of peripheral interest to his question, reports inference made from photo

Int.: Mmhm.			
S23: And how they get their prey and this one ...			
Int.: So you can get quite a lot of information from the outside of the book?			
S23: Yeah, or you can find, if, I sometimes look for interesting books, that look interesting but they turn out not to be interesting as say... I get a bit disappointed but they look, they look pretty interesting but they didn't turn out to be it.	T materials L.C. learner and materials	During this speech he turned pages singly, without checking index or contents, i.e. opened at random then worked towards front page by page	inspects pages while speaking to answer secondary task questions
Int.: Okay ... is that book being very useful to you?			returns to primary task
S23: I haven't found um, I have to go back to the um, the contents to see what they've got.... Sparrow, 7. Oh these are um, this is one of the dinosaur ones that I thought might be a sparrow.	E.C. monitoring E.C. regulates E.C. monitors	His purpose becomes more goal directed here	turns to contents identifies a revelant entry, finds it evaluates information as unhelpful
Int.: Because it said sparrow in the title, didn't it?			

S23: Yes, but it's not, it's not a sparrow so I'll put this back. Birds of the country might have some of it in. This should have something in it.	E.C. prediction	Title was actually Black Robin Country	returns book to shelf misreads next title, takes book
Int.: Now what do you think that book's going to be about?			opens book at random
S23: It's going to be about the country and it's going to tell you things that happen in the country.	E.C. prediction prompted		
They've given you little drawings of them and their insects that they, they			**Extraction of information** reports content, based on pictures
seem to have shown me a bit of the informtion that I found in the other book on fantails. They're showing it on a certain bird.	E.C. monitoring		recalls information seen earlier
Int.: Mmhm. Do you know what that bird is?			
S23: Um, ...I can't find it's name, it's probably here.	E.C. monitoring	Video shows him turning back to previous page	turns back to find name looks more closely
Int.: You can't find it's name did you say?			
S23: (indistinct phrase) It's a Chat them island thing			locates name reads aloud

Int.: It's a Chatham Island tit, that's right.			
S23: Top bird there. It seems to like wetas, small wetas, white grub and cockroaches.	E.C. monitoring		makes inference based on pictures
Int.: Now is that helpful to you, to answer your questions?		Does not notice that bird is not the one he was seeking	
S23: Yes, cos that's the food that um, that bird likes.	E.C. prompted monitoring		prompted evaluation of information found
Int.: Yes.			
S23: One of the most of that food that it likes. Now they're showing me what um, the size of this robin is. I think it's the same drawing of the same picture.			reports further content of pictures
Int.: Uhuh.		He can't understand the contents page so use an alternative location method	turns to contents
S23: Have to go through these papers to find what I'm looking for.	E.C. regulation		searches page by page
Int.: You're going to have to look through it page by page to find out are you?			
S23: Yes, because I can't, I don't, I can't understand what the index is trying to say to me			

	so I just like skim through, I just skim through by looking at the pictures to see what, if that they've got the certain bird that I'm looking for, or the name of the bird.	L.C. tactical knowledge		
Int.:	Mmhm.			
S23:	Now they're, they were showing us um, sea birds or sea animals apart from birds. Some birds.	E.C. monitoring	pages inspected have little text	reports content based on pictures
Int.:	Is that helpful for your questions?			
S23:	No, cos, cos they're on different animals and it's a different subject. Mine's on birds, not on sea, sea animals.	E.C. monitoring		
Int.:	So what can you do to find some more information on your questions?			
S23:	Um, maybe look in a dictionary to, to um, to see what they say. They normally give you meanings about the um, the word that they're saying and you can read through it and see what they give you. But if they don't have anything else,	T materials constraints		

you probably keep searching from the bird that you reckon might be, well the book that has the birds, like fantails and how they make nests or else someone's got it out from the library that you really want it.	L.C. tactical knowledge		Selection of info sources reaches for books on shelf again
Int.: Mmhm. Okay. Are there any others that you think will help you?			
S23: Maybe this one [Birds]. Ah...	} }		takes book,basis unknown
Int.: See anything else there that's useful?	}E.C. monitoring }		
S23: There's sparrows but at the moment... I might be lucky or if I can't find it, I'll just go to sparrows	E.C. plans		turns to contents, reads identifies sparrow entry
Int.: When you say you can't find it, are you talking about the fantail again?			Extraction of information
S23: Yes. Well, that's if I can't find it.		confirms basis of previous planning	
Int.: What are you looking for at the moment?			
S23: Sparrows.			reads page numbers to locate relevant page
Int.: Are you looking for pictures or page numbers or ...?			

S23: Page numbers cos they're the ones that tell, that tell you what um, they're going and this one seems to be about their nest. "A tree sparrow is very like the house sparrow but has a chestnut crown, not a grey one like the house sparrow. It always nests in trees, never on houses."		reads aloud
So this, the um, this has given me one of my answers that I needed.	E.C. monitors	
It's the, it, it's been telling, it told me where the sparrow, where the grey sparrow nests, on houses, and where the er, chestnut crown sparrow um, nests in a on a tree, in a tree where it can put leaves and all that.		reports contents in own words, ending with an inference about leaves etc
Int.: Okay, well, you've got some information now. Have you got enough to really get started on your project do you think?		
S23: Maybe enough to, for a certain bird, but I haven't got enough for the other birds.	T criterial task, prompted monitoring implied	

Int.: How will you look for the rest?	
S23: Probably keep um, may, um, I'm not sure. Probably watch birds um, throughout the school or um, see what birds do at home.	L.C. tactical knowledge

Think aloud/concurrent interview with Subject 23 ended at this point.

Subject 23 Retrospective interview	**Metacognition codes**	**Converging evidence and comments**	**Information retrieval phase**
Int.: When you're trying to think up questions, is it easy to come up with questions when you know a bit about the subject, or is it easier to come up with them when you don't know the subject?			
S23: I reckon it's easier to me..er, it's easier to come up with questions when you know quite a bit about the subject	L.C. interaction learner and activity		Analysis of information need
Int.: Do you know quite a bit about birds?			
S23: A wee bit, cos we feed them a lot, we, I look at them. They seem, they seem, when	L.C. knowledge state	Earlier he said he did not know much about the topic	

we first um fed them and all that they did, they were scared of us so they kept on flying away and they still do a wee bit but you can get a lot closer to them than we used to and they don't fly away as much.

Int.: You're quite interested in birds are you?

S23: Yeah, I, I like watching them. I don't watch them occasionally cos now we've got a cat. Now the cat might bring in birds and um....

Int.: Is that what made you think of the question about the dangers to birds?

S23: No, that just came into my mind.

Int.: Okay. What sorts of things do you think about to try and help you make up the questions?

S23: Um,... things that make up questions um... Oh, well, what what I know that they, what I know that comes to my mind

L.C. tactical knowledge, see over

in how they like nests, that came to my mind from birds that I've, that I know that birds nest so I thought of that one, and dangers, I knew that because of all kinds of dangers, like I've heard about it from other classes and other teachers that, that their cat er cats, bring in birds so I was thinking of, not of that but things like.....	*L.C. tactical* knowledge i.e. activate prior knowledge		
Int.: Things a bit like it?			
S23: Yeah, um that's what I did, it just came to my mind.			
Int.: That was good. What helps you decide which books to take off the shelf when you've got a question that needs answering?			
S23: Maybe the cover or um.... cover or just, it's the cover that gets my um, if it says Birds, birds of New Zealand, it's the cover that makes me take it off and			**Selection of info sources**
the, take it off the shelf and then I look through the index to see if it's got the bird I want, like if it	L.C. tactical knowledge	Video shows that he did not use indexes at all, only contents tables	

says fantails I'd take. I'd look through the, if they had the number, I'd look through that like the other book that I took out didn't have any numbers so...

Int.: On the pages?

S23: *Yeah, cos I, I didn't like,* I couldn't understand what page it was trying to show so I just took it out.

Confirms that he had *difficulty with book* with no page numbers but meaning here is not clear

Int.: You said...

S23: I just...

Int.: Go on.

S23: I put it back in because they, I was looking through and it would take too long to look through about 200 pages. It might not have it and then you'd be pretty disappointed to have that er, ...

L.C. interaction his tactic and materials

Int.: You said that you look in, at the index but when we stopped using the camera and started this [interview] you said that you don't like using the index because.... Can you explain that to me again, because I don't think I understood properly?

S23: Yeah, I think I did, because, because sometimes they just have it like um, they don't have A B C D E F G so you can look up, saying you're looking up under birds, you just go to B. They have it in an order where they just go, it might go from A to B but they don't give you that big, um, they don't separate it from the other one.

T materials

Int.: So they don't have a letter showing you where the beginning of the A is and where the beginning of the B is, is that what you're saying?

S23: Yeah, yep.

confirms interpretation of the above code

Int.: Okay, and that's why you don't like indexes?

S23: Well not that much but sometimes they're too long and you're still skimming down through them and

	you try to look for the certain one. You're trying to find where the end of C is and cos you can find so many things that are to do with C and you just keep on going down looking for it. *Sometimes you go ahead* too fast and then you've got to come back so I don't like them that much when I can't find the um, the certain thing that has to do with it, like F and I couldn't find it	L.C. ability	although he refers to 'you', comments reflect his own processing problems
Int.:	Okay.		
S23:	But with that one I could find it a lot easier cos you could just go to F, there it is. You don't have to look through lots of it that they've joined up. Sometimes they're separated at the end of them but most of them, like they're just in long rows all the way through because..., and I can't find them.	reiteration of previous discussion	

Int.: Right, so you prefer an index that's got a letter showing you where each new letter starts or if they haven't done that, you like to see a big gap between the As and Bs?			
S23: Yes.			
Int.: Right, I understand now I think. When, do you use the catalogue very often?			
S23: No.			
Int.: You don't okay.			Location of information sources
S23: Cos that's, I can't, I do use if sometimes but that's if there's a certain book. I normally just look a certain, all kinds of books or else if ...	L.C. ability		
Int.: How do you look for them?			
S23: I some... I just go over to that shelf there normally and I just look through them.	L.C. tactical knowledge	seems to be referring to random shelf scanning	
Int.: Just look along the shelf?			
S23: Yeah and sometimes if I can't find any book I just go to the catalogue and look it up for all kinds of things.			

Int.:	Okay, what happens if you do go to the catalogue and you look up a word and the word's not in there. What do you do then? What does it mean do you think?		
S23:	That means they haven't got the book, ah, that I would have wanted. Some books that I, you would want, you would want, they, they don't have because they can't, well they could, they didn't get them or they can't afford them, but they can normally afford them but they just can't, don't know	T materials	
Int.:	Don't get them.		
S23:	Yeah, don't get them or they don't know.		
Int.:	Have you ever thought that the book might be there but under a different subject word?		
S23:	Yeah, I just haven't thought of that before because... Sometimes I can't understand what the subject mean or cos they've got the big, the big	L.C. ability	rather contradicts earlier statement about looking in the catalogue for all kinds of things

words I can't understand that well but small words I can understand what they're saying.	L.C. interaction learner and materials	
Int.: Where do, you're very aware of when you understand and when you don't understand. What do you do when you don't understand?		
S23: I, I don't know what I do, but I just break them up into syllables sometimes but when I, that's when I can't pronounce the words, but when I don't understand, I just don't understand it and I just leave it.	L.C. tactical knowledge	confirms tactical knowledge revealed in think aloud
Int.: Do you ever think of going to the librarian for some help?		
S23: No, I haven't thought of that (indistinct phrase).	L.C. ability	

The interview session with Subject 23 ended at this point

APPENDIX 5

EXECUTIVE CONTROL PROCESS SUMMARY: SUBJECT 14

COGNITION	EXECUTIVE CONTROL	COMMENTS
Identifies area of interest (Individual birds)		He said he did not want to find out about appearance (in general) because there are so many birds
Narrows area (does not want birds in general	Monitors: Can't think of a particular bird at present	Engages in action to solve this difficulty
	Therefore plans to confine search to NZ bird and identify a specific species among them	Metacognitive knowledge provided information about the sort of questions most easily researched
Narrows interest area further	Plans to find out how big they are and what they look like, limiting search to 2 or 3 birds	
	Moves to location phase	
Moves directly to non-fiction subject headings		
locates multiple entry index card for BIRDS	Monitors: Notes presence of extra numbers saying "I don't need them for the moment	
Selects 598.2 as target		
Rehearses Dewey number		

Moves directly to correct shelf location

Monitors: shifts attention from Dewey numbers to title after reading 598 aloud

Reads title

Rejects as it does not match his assessment of his knowledge state, monitoring implied

Reads title

Metacognitive experience: Ah, that sounds interesting

Predicts content of book

Opens book near front

Monitors: It's got a few of them [NZ birds]

Reads first page

Plans to read to find out which is most interesting

Revises focus of search

Fits information need to information found

i.e. takes first relevant information found but does give impression he is genuinely interested

Identifies species of interest DUCKS

Reads then tightens focus to **grey teal** and identifies search term for use in other books

Prompted **monitoring** of task progress: Hasn't got enough information but sees no difficulty now that name of species is known

Scans shelving

Predicts: Birds of NZ might have information on grey teal

Turns to contents then list of illustrations saying he is looking for grey teal	**Self corrects:** Maybe I should look for DUCK first	
Returns to contents	**Monitors:** There's nothing here	Did not look for an index.
Returns book to shelf	**Plans** to search another book	
Takes book, turns to contents briefly	**Monitors:** structure of book – birds in general	
Rejects book, reads next titles		
Selects one for inspection	**Monitors:** I've got to find some more information cos I want to see where it lives [book in hand is organized by habitat]	
Goes back to read first book	**Regulates:** Stops reading book in hand	
Voices a second focus of interest, grey duck	**Monitors:** Here it is. (reading from 1st book)	
Reads 2nd book contents	Revision:	
Looks for index (not present)	It's not here. I'll look for...	
Thinks of alternative search term, checks contents for it.	**Revision:**	
	Monitors: Only possible entry is Rare Birds. Doesn't know whether teal is rare	
Reads first book again		
Returns 2nd book to shelf	**Monitors:** Nothing here	

Reads titles	**Predicts** usefulness of one with NZ in title	
Takes book, turns to contents	**Monitoring:** There [it is] (Duck)	
Turns to index to see whether chapter on ducks includes teal	**Monitoring:** Not here	Reliance on accuracy of indexing?
Rereads 1st book to identify Maori name	**Prediction:** I could look under that Maori name	
Searches index in present book for Maori name	**Monitoring:** It's here	
Turns to relevant page	**Monitors:** Here;s grey ducks and the grey teal. Now I can find all the information about it.	
	Monitors: Says he would normally move on to writing down information now	
	Monitors (prompted): I still need to find a bit more on them both	
Scans titles as he speaks	**Planning** (prompted) begun but interrupted	
	Monitors: spots relevant title	
Reads aloud "Small Birds"	**Regulates:** I want to see if it's a small bird	
Reads first book to discover size of duck	**Checks** information gained by holding hands 52 cm apart	

Rejects book without inspecting because "that's quite big for a bird"

Reads titles — **Predicts:** Birds won't have anything about NZ birds

Reads title — **Predicts:** Meet the birds might have what he wants

Turns to contents, finds nothing — **Revises**

Turns to index, searches three locations

begins to turn to appropriate page — **Checks:** returns to index to prompt memory

Turns to right page, runs finger down text — **Predicts:** It won't have much about teal

Monitors: Just birds [in general]

Revises: So I'll look for the other one (grey duck)

Returns to index

Monitors: Not under the Maori name

Revises: I'll look under grey duck

Replaces book on shelf — **Monitors:** This [book] won't help me

Reads titles — **Monitors:** I've looked at that one I think

Takes book, looks at back page — **Checks:** Yeah, I did

Replaces book, reads titles	**Monitors:** Oh, these are sea birds
Looks back at book in floor (1st book)	**Checks** whether ducks are sea birds, comments that they are not
Passes on to read next title on shelf	**Prediction:** Birdwatching might be alright
Takes book, examines contents	**Monitors:** Just tells you how to do birdwatching
Rejects book	

Think aloud/concurrent interview ends.

EXECUTIVE CONTROL PROCESS SUMMARY: SUBJECT 23

COGNITION	EXECUTIVE CONTROL	COMMENTS
Identifies area of interest (where birds nest)		
Narrows area, mentions sparrows and fantails	Monitors: That's all I can think of	Has named two varieties, does not try to think of others.
Identifies related area of interest (What are the dangers of living in a nest)		
Refines interest to consider "enemies of birds"		
Identifies interest area (what food do they like best?)	Monitors: Can't think of another question	
	Moves to location phase	
	Planning (prompted) Look up under birds, go through books to see where birds nest or what pictures show of birds nesting and information below [illustrations]	Emphasized pictured and captions, not text searching
Goes directly to non-fiction subject headings	Metacognitive experience: Ah...!	
	Self corrects to examine card before BIBLE	Is not sure whether BIRDS comes before or after BIBLE
Locates index card with single BIRD entry	Monitors: Ah, birds, 598	

Rehearses number incorrectly as 596		
Reads Dewey numbers in bay to left of catalogue	**Monitoring:** I think it was 596 but I don't know whether that will be here	
Locates 590 (Animals)	**Monitors:** I don't know if they've got one [596] at the moment	
	Prediction: I'll have to have another look [in the catalogue]	Does not think the library had 596
Returns to catalogue, locates different card	**Monitors:** Ah, bird 339	Did not comment on finding a different number
Looks casually at shelves on right of catalogue	**Monitors:** Oh, 598!	Location is accidental
Reads titles		
Takes Town Birds, turns to contents		
Reads, locates an entry for fantail		
Looks for page numbers (there were none)	**Regulates:** just have to look at the names	
Looks at each page until fantail if reached	**Monitors:** Fantail	
Inspects pages and reports content	**Monitoring:** It tells me what they eat but not favourite food	
Turns to next page	**Monitoring** (prompted: I need some more information, where they nest and all that.	

Inspects fantail information again

Monitors: Comments that information is about a different bird

Monitors: It tells you a bit here

Reads aloud: They've got 16 centimetres of accessed, excess aleck, alack, whatever they call it. Nest or up to 5 broads in a season

Monitors: I don't understand what they're saying here

As part of secondary task explains usual tactic for dealing with the problem (make up words, syllabify them)

Returns to shelf, rejects one title on basis of prior knowledge

Plans to look at other books

Predicts next volume will be interesting

Turns to contents, locating relevant entry

Monitors: Ah, there!

Turns to that chapter

Monitors: Now I've got to find what a nest is.

Looks at photos

Monitors: Oh, they don't have it.

Turns back to page of text

Predicts: they might have it here

Adds: if I skim read it

Reads in silence

Monitors: I couldn't find anything

Returns book to shelf, reads more titles

Takes one book, flicks through pages, talking about points he's looking for

Monitors: Notes information relevant to his questions

Reports content of that information: This one here seems to like fish

Inspects pages one by one

Monitoring: I haven't found...I have to go back to the contents

The page by page inspection accompanied speech directed at interviewer

Turns to contents, identifies relevant entry

Regulates: Random inspection changes to contents search as speech with interviewer ends

Turns to it, expecting to see sparrows

Monitors: Oh, these are dinosaurs!

Rejects book, returns it to shelf

Mis-reads title of next book as <u>Birds of the country</u>

Predicts: This should have something in it

Prediction expanded in response to interviewer question

Inspects book, repo rting contents based on pictures

Monitoring: Comments some of this information was in a previous book

Turns back to previous page to identify the bird species (prompted)

Checks and monitors: I can't find its name, it's proabably here

Locates name and reports on pictorial information

Monitoring (prompted): That's the food that it likes.

Reports the contents of more pictures while looking through book

Revises: changes from random to more systematic search

Turns to contents

Revises: from contents use to page by page searching

Says this is necessary because "I can't understand what the index is trying to say to me"

Turns pages singly as he reports contents

Monitoring: They're showing seabirds. Continues when prompted: It's not helpful

Rejects book, returns it to shelf

Takes another book, turns to contents, read

Monitors: There"s sparrows

Plans: [It might have fantails] but if not I'll just go to the sparrows

Turns pages singly to find a particular page number

Locates page targeted, reads aloud

Monitors: So this has given me one of my answers that I needed

Reports contents in own words

Think aloud/concurrent interview ends

APPENDIX 6

EXCERPT OF CONTEXTUAL SUMMARY FOR SUBJECT 23

Tactical knowledge

Page	Context and event	Info.retrieval phase
424	Asked what he usually does when he doesn't understand the text. Replied: I sometimes make up words that might go with it, but they never work so I can't understand what it's telling me about, or I syllabify it, break it up into little, like little parts so that I can read it a bit easier.	extraction
425	Identified a relevant chapter heading. "They might have it [in here] if I read a little bit...If I skim read it.	selection
425	What sort of things are you looking for on those books to tell you which one to take off the shelf? Replied: "You really look by the cover or the title of it. What they're trying to show you, like the, like the diagram for infor... all the kinds of birds they've got and they show you what kind it is and how they, what they eat."	selection

428	Had looked at a contents table then started searching every page. Gave reason: "Because I can't I don't I can't understand what the index is trying to say to me so I just skim through by looking at the pictures to see what if that they've got the certain bird that I'm looking for, ot the name of the bird."	extraction
429	Asked how he could find further information. Replied: "I could look in a dictionary.... But if they don't have anything else you probably keep searching from the bird that you reckon might be, well the book that has the birds, like fantails, and how they make nests, or else someone's got it out from the library, that you really want"	selection
431	Asked how he will find answers to other questions. Replied: "Probably watch birds, throughout the school or see what birds do at home."	overall process

432	Asked what sort of things he thinks about to try to help him come up with questions. Replied: "What I know that comes to my mind in how they like nests, that came to my mind from birds that I've, that I know that birds nest, so I thought of that one, and danger, like I've heard about it from other classes and other teachers that their cats abring in birds, so I was thinking of, not of that but things like that."	analysis – tried to activate prior knowledge

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