Modelling the User Education Domain: a Grounded Theory Approach

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Summary

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This thesis reports a research work whose objective was to derive a grounded model of the user education domain, which was identified as pertaining to subject librarians' expertise, using a knowledge elicitation approach in the field of agricultural sciences. The knowledge elicitation framework adopted was that which sees knowledge acquisition as a process of modelling expertise, and the models derived as qualitative in nature. Accordingly, the main methodological approach involved was based on qualitative research and use of grounded theory methods.

The research design was divided into three studies, all based on interview data. The research started by studying the role of subject librarians in academic libraries in the UK (Study One), which identified the area of user education for further study. Study Two proceeded to elicit information seeking practices and user education processes from academics and librarians. Finally, Study Three elicited information seeking practices of students who were engaged in library research. A model of the user education domain in the field of agricultural sciences in a Brazilian university was derived from the combination of the analysis of Study Two and Three.

The model describes the library research process of individuals as happening in discipline specific contexts, influenced by the world at large. The process takes place through a series of information-seeking tasks and task-related strategies, which are employed to search external knowledge sources and satisfy an information need. During this interaction, internal knowledge sources are used and modified according to the tasks and strategies being carried out. If these internal knowledge sources are deficient for effective use of external knowledge sources, mediation strategies by an expert can help readjust the information-seeking process and alter the state of related internal knowledge sources

The model proposed is used to derive recommendations for the design of user education programmes, subject librarians' work, and domain modelling using grounded theory.

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Chapter 1

Introduction

This chapter describes the objectives of the thesis, sets the research into context, and introduces the main topics that are expanded in the subsequent chapters.

1.1 Objectives

The aim of the present thesis is to derive a grounded model of the user education domain in an academic library from Brazil, using a knowledge elicitation approach. Knowledge elicitation, which is part of the knowledge acquisition phase in knowledge-based system development, is understood in the context of this thesis as the process of interpreting domain specialised knowledge for the purpose of conceptually modelling it.

The specific aims of the research are:

- To explore issues related to subject librarians' work in academic libraries in order to select one of their activities for modelling;
- To develop a model, grounded mainly in the personal experience of librarians, academics and students, of library user education for agricultural

sciences in a Brazilian university, by investigating how information-seeking skills are applied, taught, and learned;

- To explore the use of one method of qualitative research from the social science, namely grounded theory, as a knowledge elicitation technique.

Summarising, the research here presented aims at developing a grounded model of user education domain in an academic environment based on both the activities of subject librarians and the information-seeking behaviour of academics and students. At the same time, it also considers methodological issues related to knowledge elicitation and qualitative research.

1.2 Context

The starting point for this thesis was the possibility of applying methods for knowledge-based system development to library and information science studies, particularly through the use of knowledge elicitation methodologies for domain modelling.

The importance of the application of knowledge-based system technology to libraries goes beyond the development of systems themselves; the elicitation of the domain expertise is an enterprise that is of great importance in itself for it can contribute to the understanding of the epistemological foundations of the domain. Dow (1992, p.120) was the first to suggest that the process of developing knowledge-based systems for library and information science "can be a methodological tool that contributes significantly to defining the nature of information expertise as well as clarifying and systematising the theoretical basis of the discipline".

In addition, models of expertise can be an important tool for knowledge management. Knowledge management involves the identification and analysis of available and required knowledge within an organisation, and the subsequent planning and control of actions related to that knowledge (Fisher, 1998). Knowledge to be managed is mainly of an informal, or human, nature and is delivered as solutions rather than products. Modelling expertise as a knowledge elicitation activity within an organisation can represent the way to encapsulate that knowledge for its effective management.

Librarianship is a complex and multifaceted discipline, it is obvious that no single domain model could represent all the aspects related to it. Accepting that condition, the research work started by approaching the work of subject librarians. Subject librarians were considered important sources of human expertise for both the professional work they carry out in libraries and their work in a specialised area of knowledge outside librarianship.

However, subject librarianship is still a broad field of work. Hence, after a preliminary study (Study One), the user education domain, which is one of the areas of expertise of subject librarians, was chosen as target for modelling. Since user education in libraries is mainly concerned with the development of information-seeking skills in students, and since academics are the actual information users in academic environments, the study concentrated on the expertise of librarians, the information-seeking expertise of academics, and the way information-seeking skills are learned and applied by students.

Moreover, since knowledge-based systems in education are known as intelligent computer assisted instruction or intelligent tutoring systems, an understanding of their architecture was brought into the research work to see how it related to domain conceptual modelling. The emphasis on modelling the user education domain as a knowledge elicitation activity persisted, regardless of the specific type of system to which the model could possibly be applied in the future.

Matters related to the terminology adopted in the study and its definition are clarified under the appropriate headings of the two chapters on the literature review (Chapters 2 and 3).

1.2.1 The knowledge elicitation framework

The task of knowledge acquisition for knowledge-based system development has been through several stages over the years. Back in 1993, Gaines (1993) observed advances in the area of knowledge acquisition at two levels: conceptual and theoretical. As a result of those advances, knowledge acquisition was described "as a process of modelling expertise with a view to emulate and extend it" (p.2) and not "...the transfer and transformation of the problem-solving expertise from a knowledge source to a program" (Hayes-Roth et al., 1983) as it had previously been perceived. Transfer to modelling were the keywords that characterised the evolutionary shift. Modelling has since become the dominant view in knowledge elicitation and has influenced methodologies at the same extent it has been influenced by them.

This less positivist perception of human knowledge seems to accompany a trend observed also in other disciplines, including library and information science. In a paper that formulates a domain-analysis approach to information science, Hjørland and Albrechtsen (1995) conclude a section on transdisciplinary tendencies in the understanding of knowledge stating:

> There has been a transdisciplinary development where the view of human individuals, of human knowledge, etc., is seen as less formal, less mechanical, less computer-like, and more organic, contextual, sociocultural, and domain specific. It is not the isolated, abstract individual as much as it is the discourse community and its individuals, which constitute the focus of current research in disciplines allied to IS [information science]. (Hjørland and Albrechtsen, 1995, p.409)

A practical application of the modelling view in knowledge-based system development is the KADS methodology (Schreiber et al., 1993). In KADS

knowledge acquisition is seen as a constructivist process of building implementation-independent models to represent expertise. Following this approach, the designer is aware that the conceptual model generated is an interpretation of the phenomenon. In addition, the designer is not biased towards a computational framework during analysis and the decision about whether or not the model is suitable for implementation comes later, together with a decision on how that is going to be done. Figure 1.1 below represents the role of the conceptual and design models in knowledge acquisition according to KADS.

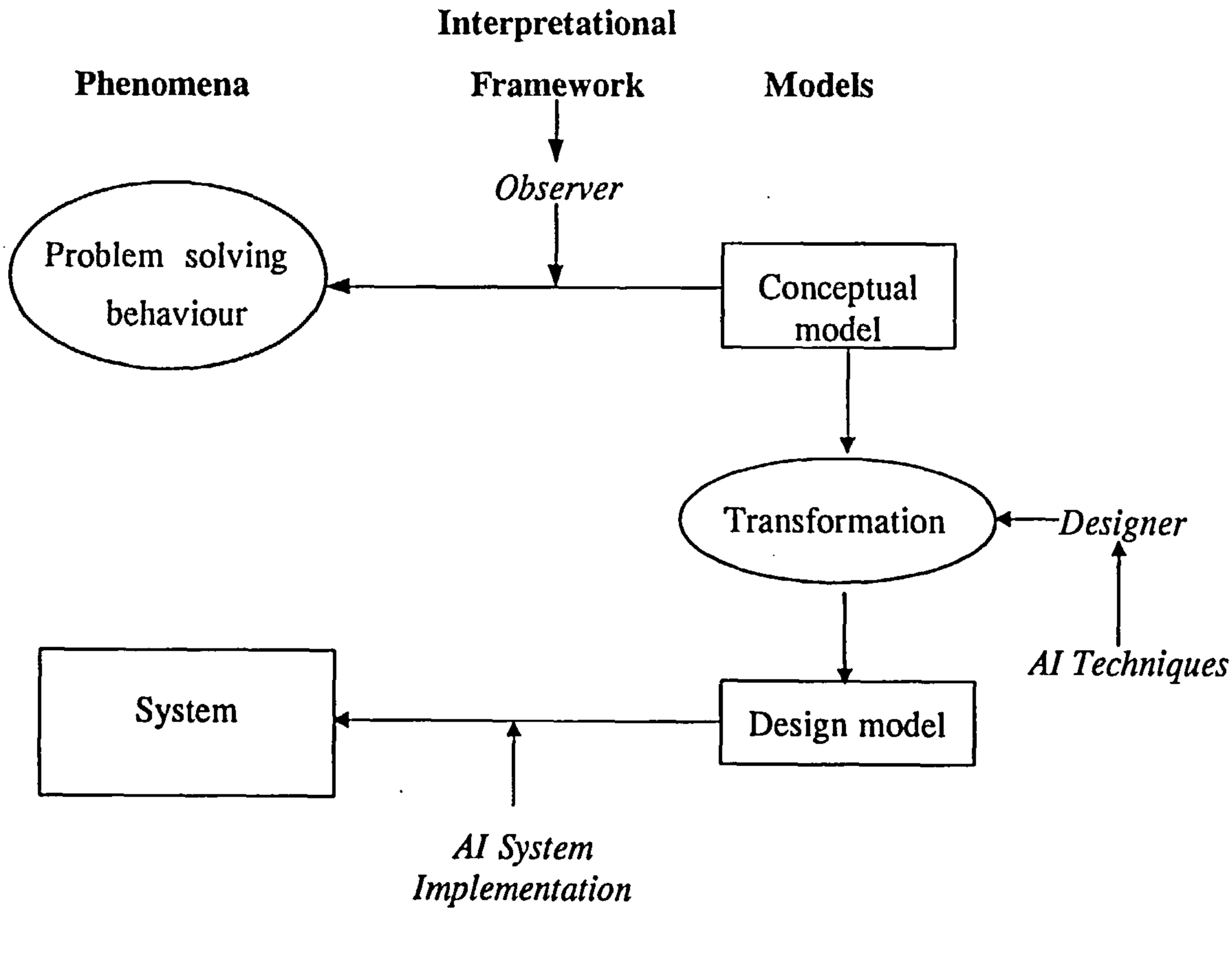

Figure 1.1: Knowledge acquisition in KADS. (Source: Schreiber et al., 1993)

Adopting the view of knowledge elicitation as a modelling activity, the work here presented is concerned exclusively with modelling of the first type in KADS, that

is, conceptual modelling, and for that purpose it uses grounded theory methods and techniques.

Although the KADS methodology is not applied in the present study, it provides a useful framework for the knowledge elicitation process as it is compatible with more general qualitative methods of research, of which grounded theory is an example.

In synthesis, the knowledge elicitation framework adopted in the present study is that which sees knowledge acquisition as a process of modelling expertise and the models derived as qualitative in nature. The derived conceptual models provide mediating representations between human knowledge and design models for implementation of knowledge-based systems.

1.2.2 The user education approach

User education was chosen as the target domain after the study of subject librarians in academic libraries showed it to be one of the major areas of activity for the subject librarians.

Developments in information technology and the growth of scientific and technical literature require a trained user who is able to explore the existing resources. These developments were seen by many authors (for instance, French,1990; Elder and Miller, 1998; Fourie, 1999), as factors that affected the expanding role of librarians in providing end-user education.

As much as these factors have affected the role of subject librarians, they have also affected user education. Martin (1996), on a second round survey on subject specialisation in British university libraries, states that:

> In so far as it has been accepted as one of the functions of the subject librarian, his role in relation to electronic information services will now have largely changed into one of helping staff and students in the use of self-

> service media... This development has transformed the nature of what hitherto has been known as reader education. (Martin, 1996, p.165)

The body of literature on user education is large, consisting mainly of studies of a practical nature which account for local experiences, and some studies concerned with the theoretical basis of the domain. However, there is a need for a theoretical framework based on empirical data explaining which factors are most important in user education process and the relationship between these factors.

The continuous debate in the literature over whose model - librarians' or academics' - is the appropriate one for teaching information skills (Stoan, 1984; Stoan, 1991; Fister, 1992; Pacey, 1995) has shown that an approach which deals with both sides of the problem is beneficial. In addition, a third human component - students - has also to be taken into account if a full picture of the domain is envisaged. Some studies (Fister, 1992; Kulhthau, 1993) contributed to the understanding of information seeking for user instruction but were solely focused on students.

An understanding of the knowledge and processes involved in applying and developing information-seeking skills based on empirical data from librarians, academics and students is necessary, specially when electronic environments are concerned. Librarians and teachers may be available for assistance over networks but, as it was necessary in a non-electronic environment to promote the development of skills that made the user self-sufficient in the use of the library, it is now necessary to create opportunities for information skills to be learned so that users can make the most of the availability of dispersed information.

Electronic information and advances in computer networking have a great impact on scholarship (Blandy & Libutti, 1995). Students at all levels, undergraduates included, are now exposed to vast amounts of information which they must be able to access, select, process and evaluate. Although one cannot disagree that research skills are not synonym to information-seeking and use skills, as Stoan (1984) argued, few people would question the validity of librarians actively

supporting learning of the latter. On the contrary, many authors (for example, Wersig, 1993; McClure, 1994; Fowell and Levy, 1995; Elder and Miller, 1998, Tompkins et al., 1998) see promoting learning of life-long information skills as one of the main roles for librarians, particularly in the networked environment.

Programmes for training users to access and use Internet resources and programmes that work as guided tours to libraries are designed and made available over computer networks. Differently from those approaches, the concern in the present study is not with the development of training programmes or material but with the development of a conceptual model of the user education domain in an agricultural science library which could serve as the basis for building a knowledge base of the expertise involved.

Another aspect that differentiates this work from previous ones is that this is based on data gathered in a Brazilian university and thus reflects the reality of a country where research on the subject is scarce. The bulk of the literature in the subject is produced in English speaking countries and reflects the reality of those countries. Importing pre-established models into a different culture could prove impracticable, for instance, language barriers are commonly ignored in English language literature on the design and evaluation of information systems (Buckland & Florin, 1991).

1.3 Methodological Issues

The theoretical approach adopted in the present study is described in the areas of information needs and use and in information retrieval as "user-centred". According to this approach, the phenomena which should be studied, are those related to individuals' experiences when interacting with information systems. In spite of being user-centred, the social context of the interactions is not ignored

and it is applied in terms of domain and work roles of the members of the domain community.

The research design is based on qualitative research and uses case study approach and grounded theory methodology. The case study approach was considered appropriate for providing an analysis of the phenomenon "in depth and detail, in context, and holistically" (Patton, 1990, p.54), such as is required of a knowledge elicitation approach for domain modelling.

The present study was designed according to grounded theory principles of theory construction, that is, it did not start from a number of hypotheses to test. According to Strauss and Corbin (1990), in a grounded theory study "...one does not begin with a theory, then prove it. Rather, one begins with an area of study and what is relevant in that area is allowed to emerge" (p.22). Following that approach, the study was designed in such a way to allow that relevant findings at one stage informed the context of the subsequent stages.

The work started by the usual literature review and background reading to develop an overview of the topic and proceeded to the design of the preliminary field work. The literature review at that point was concerned with grounded theory, knowledge-based systems, knowledge acquisition and elicitation and subject librarianship.

The field work started focusing on the identification of a specific domain related to subject librarians' expertise in academic libraries. A preliminary study was designed in which subject librarians from three British universities were interviewed for the purpose of understanding the phenomenon from the perspective of the participants without imposing preconceptions and misconceptions. Grounded theory methods were used to analyse the data qualitatively and as a result of this preliminary study the area of teaching emerged as an appropriate area for further studies. This preliminary study was labelled Study One.

Concomitant to the development of the research and according to the findings, literature review progressed to include topics such as user education, user needs, user seeking-behaviour, and knowledge-based systems for instruction, including intelligent tutoring systems, intelligent computer assisted instruction and other variations.

The next stage of the research concentrated on the case study of an academic library in Brazil, the library of the Faculty of Agronomy in the Federal University of Rio Grande do Sul. Data from librarians and academics in a second study (Study Two), and from students in a third study (Study Three), were collected and analysed in an effort to use grounded theory in knowledge elicitation and, thus, derive a conceptual model of the domain. Grounded theory, in the words of two main proponents of the method, is "a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon" (Strauss & Corbin, 1990, p.24). The grounded theory developed is used to analyse implications for user education modelling and knowledge elicitation. Study Two and Three represent the main body of empirical work in the present thesis.

A qualitative approach for the research was desired due to two reasons: first, its appeal in information retrieval research (Fidel, 1993), of which knowledge-based systems can be understood as a subset; second, the similarities between grounded theory and knowledge elicitation (Pidgeon et al., 1991).

The grounded theory procedures adopted in this study were largely based on the writings of a grounded theory founder as present in the books "Qualitative Data Analysis for Social Scientists" by Strauss (1987) and "Basics of Qualitative Research" by Strauss and Corbin (1990). Other researchers who contributed with the understanding of the methodology were Pidgeon et al.(1991), Weingand (1993) and Westbrook (1994). Empirical works describing the way the methodology was employed (for example, Turner, 1983; Bradley, 1993) and the experience on carrying out grounded theory research in the Department of

Information Studies as exemplified by the works of Ellis (1987) and Soto (1992) were also important and illuminated the process adopted in this research work.

Of the three common techniques for data collection in qualitative studies, namely interview, observation, and document examination, interviews were favoured in the research design. However, observation and documents examination were also employed as necessary. The triangulation of methods, as it is known in qualitative research jargon (Patton, 1990), was combined with the triangulation of subjects - or data triangulation according to Patton (1990) - that is, librarians, academics and students. Triangulation helps to ensure integrity of the findings (Westbrook, 1994).

Figure 1.2 illustrates the stages of the study as they progressed, the subjects involved in each stage and the associated studies.

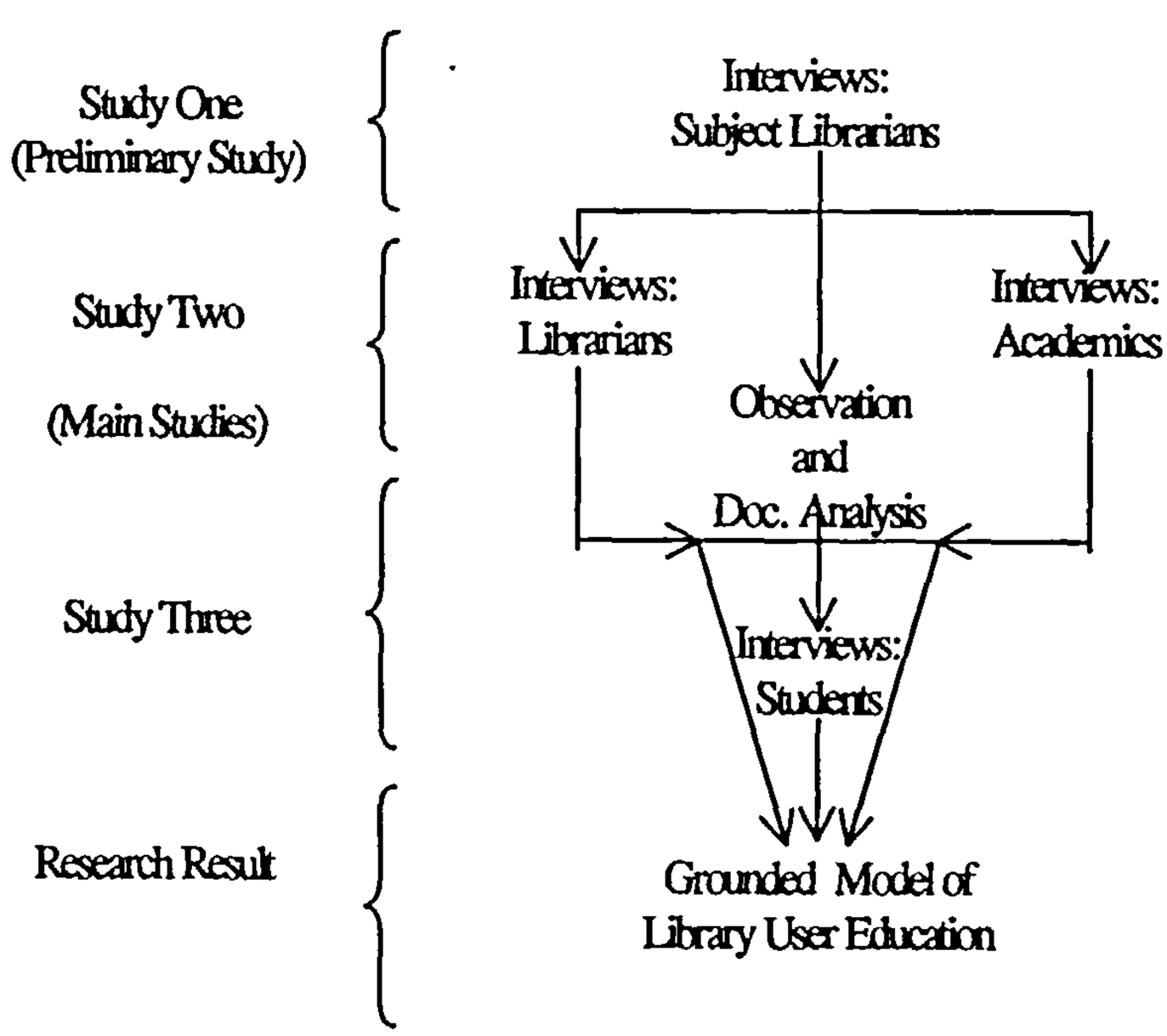

Figure 1.2: The stages of the research study.

1.4 Plan of the Thesis

The information presented in this thesis is organised according to the stages the research went through and divided into 9 chapters:

Introduction, in Chapter 1, puts the research into context, states the objectives of the investigation and presents a plan of the thesis.

Chapter 2 and Chapter 3 cover the literature review and provide a background for the research. Chapter 2 is the result of a literature review carried out in the area of knowledge-based systems and other related software issues. Knowledge elicitation is identified as one phase in knowledge-based system development and is discussed in depth. The last section of the chapter deals with the application of these systems in libraries.

Chapter 3 examines the fields of subject librarianship, user education and information seeking and use. It begins by describing subject specialisation in academic libraries. User education is identified as one of the subject librarian's functions and its implementation in academic libraries is discussed as well as its theoretical foundations. The use of computer systems for information skills development, whether or not they incorporate knowledge-based system techniques, are discussed. Elements of relevant information-seeking and retrieval theories are also covered.

Chapter 4 presents the research methodology and the theoretical framework adopted. It starts with the rationale for the research work, that is, the reasons for employing grounded theory methods as a knowledge elicitation technique in the field of user education of agricultural sciences. That is followed by a presentation of characteristics of qualitative research and its role in information science research. It proceeds to cover the main elements of grounded theory methodology and to examine the use of grounded theory as a knowledge elicitation technique. Finally, it deals with the actual application of grounded theory methodology to

the present research work and discusses the design of the study and the procedures involved. The three studies carried out are presented in terms of objectives, subjects involved and procedures followed for data collection and data analysis.

The results of every one of the three studies are presented and discussed in individual chapters, from Chapter 5 through Chapter 7. Chapter 5 deals with Study One, a preliminary study carried out in three university libraries in England, when the general area of subject librarianship was being considered. It presents and discusses results of Study One whose themes were subject librarians' job, expertise and knowledge as well as assessing the opportunity for domain modelling in the area. Chapter 6 covers the results of the analysis of Study Two, carried out in Brazil with academics and librarians from an agricultural science faculty with the purpose of eliciting expert knowledge related to library research skills. Chapter 7 presents results of Study Three, carried out in the same institution in Brazil, but this time with students for the purpose of eliciting users' views.

In chapters 6 and 7 the emphasis is placed on describing the data collected according to the categories derived. Excerpts from interviews are given to serve as evidences of the categories found in the data.

Chapter 8 combines the results of the three studies together to present a model of the categories and processes involved in user education for the case studied. The emphasis is this chapter is placed on defining the categories and their relationship in a conceptual and integrated level It compares the derived grounded model to related studies presented in the literature.

Chapter 9 concludes the study by highlighting strength and limitations of the model and suggesting further developments. It also analyses implications of the study for subject librarians and for the use of grounded theory as a knowledge elicitation method for domain modelling.

Chapter 2

Knowledge Elicitation for Knowledge-Based Systems

This chapter reviews the literature on knowledge acquisition and knowledge elicitation for knowledge-based systems development. Apart from a discussion on knowledge, expertise, and knowledge elicitation and acquisition, it also discusses knowledge-based systems for learning and knowledge-based systems applications.

2.1 Knowledge-Based System Development

The terms knowledge-based systems and expert systems have been used almost as synonyms throughout the literature, that is, they have both been used to identify computer systems that "aim to codify the knowledge of human experts in specific problem domains, thus making that knowledge available for others to use" (Alberico and Micco, 1990, p.31). Some authors, however, emphasise differences between these two terms. Ford (1991), for instance, differentiates knowledge-based systems from expert systems by stressing the use of heuristic knowledge in expert systems. Knowledge-based systems, according to him, do not necessarily require artificial intelligence techniques to be built. Bell and

Hardiman (1989), on the other hand, seem to think that the difference is the degree of expertise:

> We feel that the terms 'experts' and 'expert systems' lay too much emphasis on expertise, when many useful and profitable systems have been developed using a combination of the appropriate computer technology and simple, heuristic knowledge that is certainly not 'expert'. (p.49)

What perhaps better characterise these systems are their constituent parts. Knowledge-based systems and expert systems are often described as having at least three main components: (1) a knowledge base; (2) an inference engine; and (3) the interface (McGraw and Harbison-Briggs, 1989). The knowledge base is where human expert knowledge is coded and represented, the interface engine is the reasoning part which co-ordinates the manipulation of that knowledge, and the interface is the bridge between the computer system and the user. In summary, these systems embody specialised human knowledge. Because the term knowledge-based systems is broader and encompasses both types of systems, it has been adopted throughout this thesis since the concern here is not with a specific type of system but with the phase of knowledge elicitation.

Hayes-Roth et al. (1983), in a seminal work on expert systems development, demonstrated that most knowledge engineering applications, expert systems or not, fall into a few generic categories, which are:

- Interpretation systems which infer situation descriptions from observed data;
- Prediction systems which infer likely consequences from given situations;
- Diagnosis systems which infer system malfunction from observed behaviour;
- Design systems which develop configurations of objects according to the constraints of the design problem;
- Planning systems which design actions for objects that perform functions;

- Monitoring systems which compare observation of system behaviour to desired outcomes;
- Debugging systems which prescribe remedies for malfunctions;
- Repair systems which develop and execute plans for solving diagnosed problems;
- Instruction systems which diagnose and adjust students' behaviour;
- Control systems which govern the overall behaviour of a system.

Although those applications are depicted as distinct systems, they can more appropriately be described as a generic set of problem-solving activities within a domain that are performed by an expert in the subject. Thus, one of these generic problem-solving activities can be implemented as a type of system on its own or by combination with others activities. For example, Hayes-Roth et al. (1983, p.15) explain that instructional systems incorporate diagnosis and debugging sub-systems and that debugging systems "rely on *planning*, *design*, and *prediction* capabilities to create specifications or recommendations for correcting a *diagnosed* problem" [emphasis added].

A knowledge-based system development model, despite the type of system, is often described as progressing through phases similar to the ones found in conventional software engineering approaches. Hayes-Roth (1992, p.25) specifies the "evolutionary process of knowledge system development" as follows:

- Identification: identify the characteristics of the problem;
- Conceptualisation: find concepts to represent knowledge;
- Formalisation: design structures to organise knowledge;
- Implementation: formulate rules to embody knowledge;

- Testing: validate rules that organise knowledge.

In a similar approach and drawing from the works of other authors, Hart (1986) specified the following stages in expert system development:

- Identification: select a task and define objectives;
- Knowledge acquisition: extract and represent expert knowledge in a conceptual model;
- Design: define knowledge representation and interface mechanisms;
- Development and testing: implementation and testing of aspects of the system;
- Use: continue to review and evaluate.

The stages she specified differs little from the ones Hayes-Roth dealt with; she only explicitly recognises knowledge acquisition and introduces a use phase. Hayes-Roth (1992) interprets knowledge acquisition as one of the knowledge engineering activities, together with knowledge system design, knowledge programming, and knowledge refinement. He does not make it clear how these activities relate to the stages in knowledge system development.

A slightly different set of stages in expert systems and knowledge-based system design was described by Diaper (1989) who specified in more detail the five stages already presented. The stages he arrived at are: a) pre-project feasibility study; b) organisational modelling; c) personnel identification; d) knowledge elicitation; e) knowledge representation; f) knowledge encoding; g) user interface design; h) prototype testing; i) delivery system implementation; j) delivery system installation; k) delivery system evaluation. Knowledge elicitation, knowledge representation and knowledge encoding when combined together, according to the authors, represent knowledge acquisition.

One opinion that seems to be generally accepted, however, is that because knowledge-based systems deal with knowledge rather than data, that is, they contain more than isolated facts and include structured information (Weckert, 1991) derived from human expertise, knowledge acquisition is more complex and difficult than conventional systems analysis (Hart, 1986).

Soft Systems Methodology (Checkland and Scholes, 1990), a systemic, versatile and human centred methodology which represents an alternative to traditional system analysis and design, has been suggested as a framework for knowledge-based systems development (Gregory, 1995). This paper argues that the models derived from the application of Soft Systems Methodology can be developed into logico-linguistic models that represent the language used in the domain. As such, they can be used as a framework for knowledge elicitation.

One structured methodology developed specifically for knowledge-based systems design is known as KADS, which originally stood for Knowledge Analysis and Documentation Systems but which is currently used as a proper noun (Schreiber et al. 1993). KADS originated in a ESPRIT program and started as a project aiming at developing a knowledge acquisition methodology; however, that emphasis "was replaced by a broader view in which issues such as life-cycle models, system-user interaction and system design and implementation had their appropriate place" (Schreiber et al. 1993, p.xi). KADS was followed by CommonKADS, the result of the ESPRIT-II project KADS-II, which is also a methodology for development of knowledge based systems but qualified to become a commercial standard. "CommonKADS supports most aspects of a knowledge-based system development project, including project management, organisational analysis, knowledge acquisition, conceptual modelling, user interaction, system integration, and design." (WWW010).

In KADS and CommonKADS, system development is seen as a modelling activity which generates multiple models of the problem and the environment. The problem has first to be completely analysed before solution methods are

selected and applied. An intermediate step is required between identification and the selection of solution methods. KADS modelling view of knowledge-based systems development and, consequently, knowledge acquisition, are further explored in the sub-section 2.3 on Knowledge Elicitation.

Other modelling frameworks, some derived from KADS, have also been proposed. Brazier and Wijngaards (1998), in a study which compares some of those modelling frameworks, including CommonKADS, cited:

- Desire. A modelling framework for modelling, specification and operationalisation of tasks.

- Protégé-II. A knowledge-acquisition shell that permits the construction of problem-solving methods.

- Mike. The MIKE (Model-based and Incremental Knowledge Engineering) approach integrates semiformal and formal specification techniques, and prototyping into a coherent framework.

- Vital. An approach to structured knowledge-based system development which includes a knowledge engineering and a project management methodology.

- TASK. A modelling framework designed to support system development from conceptual specification to operationalisation.

Before structured methodologies for knowledge-based systems development were available, the rapid prototype approach prevailed. Rapid prototyping "entails the selection and rapid development of a section of the expert system, testing on the partial system, iterative refinement, and further development" (McGraw & Harbison-Briggs, 1989, p.11). While being useful as a tool for further discussion with the expert and for overcoming time constraints, it may result in a commitment to a specific model that does not represent the expertise in question (Johnson et al, 1987). In addition, it requires continued revisions, updates or even

complete redevelopment (McGraw and Harbison-Briggs, 1989; Firlej & Hellens, 1991). Rapid prototyping is still used as a method for knowledge-based system development. Some authors (Firlej & Hellens, 1991; Kidd, 1987), however, argue that before trying to develop any system there is a need for a thorough investigation of the problem area, which is not the case with the rapid prototyping approach. Notwithstanding, it should be noted that rapid prototyping can be useful for testing the feasibility of a system, that is, "it can assist with validating or refining of some of the technical decisions made in Phase 1 [Feasibility study]" (Morris, 1992, p.28).

2.2 Knowledge and Expertise

Knowledge-based and expert systems deal with knowledge rather than simply with data. Knowledge as a subject has been studied by such diverse disciplines as philosophy, computer science, psychology, sociology of science, information science, etc. It is necessary, then, to clarify the different meanings attached to the concepts of knowledge and expertise before exploring issues related to how to elicit expert knowledge.

Most frequently, knowledge is described as one of two types: procedural knowledge, which is represented by rules, heuristics, algorithms; and declarative knowledge or assertive knowledge (for example Chernyi, 1997). These two types correspond, respectively, to content and process knowledge in Garg-Janardan and Salvendy (1987). Evans (1988) further subdivides declarative knowledge into factual knowledge, which is defined as simple assertions about the subject, and conceptual knowledge or the relationship between those assertions. Hale et al. (1996), on the other hand, subdivide procedural knowledge into general and application.

Declarative and procedural knowledge are also the categories distinguished in KADS, only that they are named domain and control knowledge instead. Domain knowledge is "static knowledge describing a declarative theory of the application domain" and "embodies the conceptualization of a domain for a particular application in the form of a domain theory" (Wielinga et al., 1993, p.22). Control knowledge is further specified by the same authors at three levels: knowledge of different types of inferences, knowledge of elementary tasks, and strategic knowledge.

Other ways of looking at knowledge are proposed by different authors. For example, McGraw & Harbison-Briggs (1991) and Moody et al. (1996) identify the following categories of knowledge that are relevant for knowledge system development: 1) declarative knowledge, which is defined as "knowing that"; 2) procedural knowledge or "knowing how"; 3) semantic knowledge, which has a cognitive structure and is organisational or representational; and, finally, 4) episodic or autobiographical knowledge. Perhaps a better description of the last two is given by La France (1989) who defines semantic knowledge as facts hierarchically arranged and episodic knowledge as situations compiled from experience.

Different ways of describing knowledge can be useful for practical purposes, such as the subdivision of public and private knowledge suggested by Hayes-Roth et al. (1983). Public knowledge, they explain, is the sort of knowledge that is encountered in the literature whereas private knowledge belongs to an individual and comprises rule of thumb and heuristics. A slightly different view is that of Weckert (1991) who specifies implicit, or tacit, and explicit knowledge. Tacit knowledge is not easily articulated for it may even not be conscious knowledge; in contrast, explicit knowledge can be articulated even if not made public already.

Tacit knowledge adds difficulties to system development because it is almost unreachable, particularly in view of reports (Bloomfield, 1988) that say that much of the human knowledge is held on a tacit basis. That is "the paradox of

expertise" (Wooten and Rowley, 1995); the more one knows the more difficult it is to articulate how one thinks and reasons.

Expertise is intrinsically related to knowledge yet clearly distinct from it. According to Jonhson et al. (1987, p.163), expertise is applied knowledge or "the kind of knowledge that is used to perform a task". That is, expertise is "the demonstration of the application of knowledge" (McGraw & Harbison-Briggs, 1989, p.15).

Expertise is very often explained by contrasting it to its reverse, that is, it is explained by contrasting expert versus novice characteristics. Some examples of this distinction is the assertion that "experts not only know more quantitatively than those with less expertise but that they know what they know in qualitatively different ways from those possessing less knowledge" (LaFrance, 1989, p.6). As one gains more experience, knowledge is compiled in such a way to speed up performance thus decreasing step-by-step processing and making one less aware of what he or she knows.

Owing to its sophisticated characteristics expertise presents several problems for knowledge acquisition. Some of the problems already identified in the literature (McGraw & Harbison-Briggs,1989; Evans,1988; Bainbridge, 1986) can be summarised as follows:

- metaknowledge (knowledge about how knowledge is used) is difficult to access;
- human experts are not exact, or accurate, when expressing their knowledge;
- humans tend to become selectively focused or directed, e.g. they tend to use strategies which have succeeded in the past;
- working memory capacity is limited;

- perceptual-motor skills, such as swimming, and high level skills used in cognitive tasks are used automatically;
- images and movements may not be accurately represented verbally;
- reporting at the same time as doing a task may interfere with it;
- techniques for knowledge acquisition do not always match knowledge types to be extracted.

The aspects of knowledge and expertise highlighted help to clarify the reasons why elicitation of knowledge of experts is complex to the point of being considered the "bottleneck" in knowledge-based system design. The stage of knowledge-based system development that deals directly with expert knowledge is known as knowledge acquisition or knowledge elicitation. The specification of what it entails and of the slight differences between the two concepts are given in the next section.

2.3 Knowledge Acquisition and Knowledge Elicitation

Until quite recently, the idea of capturing knowledge to transfer it from domain experts into the computer was the dominant view in knowledge acquisition for knowledge-based systems development. According to this view, knowledge is seen as a objective thing that can be extracted from the expert's mind, albeit not without problems, and implemented as a computer system. Mining was the prevailing metaphor in this context.

The transfer view, however, did not seem to generate satisfactory results and some researchers began to look for alternatives, proposing that a solution to the

knowledge elicitation problems may be achieved through the design of conceptual models before any implementation activity (Ramoni et al., 1992). Steels (1990) argues:

> [Textbooks] assume that knowledge can be translated more or less directly into computational structures from observations of the expert's problem solving or from verbal reports about this knowledge. It is true that at some point in the process of developing a working application, we have to face decisions on which implementation medium to use; however, the computational answer is only partly satisfactory. The gap between the implementation level and the knowledge and problem solving that we observe in the human expertise is too wide. What is needed is another level of discourse that talks about knowledge and problem solving independent of their implementation. (p.29)

Gaines (1993, p.2) also observed the phenomenon in which knowledge acquisition is described "as a process of modelling expertise with a view to emulate and extend it", and classified it as an advance in the knowledge acquisition area. Clancey (1993, p.33), on a similar approach, added that "knowledge acquisition is a process of developing qualitative models of systems in the world - physical, social, technological".

The modelling view of knowledge acquisition had its origins, according to Schreiber et al. (1993) and Steel (1990), back in the 80' when Newell, a prominent AI researcher, proposed a "knowledge-level" approach to AI as a way of providing a description of system rational behaviour, independently of its computational representation. Schreiber et al. (1993) explain the purpose of the model as one which makes the organisation of knowledge in the system explicit and provides an implementation-independent description of the phenomenon.

As a result of taking such view, several researchers propose a naturalistic or constructivist approach to knowledge acquisition, for example, Adams-Webber (1995), Bell and Hardiman (1989), Hale at al. (1996), Moody et al. (1996), Wooten and Rowley (1995).

Going a step further, more recently, Sierhuis and Clancey (1997) showed dissatisfaction with that perspective of modelling knowledge in Artificial Intelligence which equates models to the knowledge itself. They argue in favour of the notion of "situatedness" in cognition, action and learning as knowledge cannot be disembodied from the people and the situation. They state that "We cannot disembody knowledge, we can only make a representation of the knowledge of a person who has evolved his or her knowledge in practice" (Sierhuis and Clancey, 1997). Thus, "situatedness" implies that we should understand about people and the actions they are engaged in within an environment before we can understand and manage knowledge.

The modelling view in knowledge-based systems development in general, and in knowledge acquisition and elicitation in particular, is best described in the KADS methodology. The following are the models distinguished in KADS (Schreiber et al., 1993):

- Organisation model: Describes the organisation in which the knowledge-based system will function and how the introduction of the system will affect the organisation.

- Application model: Defines what problems the system should solve, its functions in the organisation, and the external constrains that are relevant to the development of the application.

- Task model: Specifies the tasks the system will perform to achieved the function assigned to the knowledge-based system.

- Model of cooperation: Describes the interaction between the agents while accomplishing the tasks and sub-tasks assigned to them.

- Model of expertise: Describes the knowledge used by the knowledge-based system to solve its task.

- Conceptual model: Results from the combination of the model of cooperation and model of expertise. Conceptual models are abstract descriptions of the objects and operations that a system should know about and are implementation independent.

- Design model: Links the conceptual model and the computer implementation. Describes the computational and representational techniques that the knowledge-based system should use.

The main advantage of the modelling approach in KADS is that it clearly separates conceptual models from design models allowing for a knowledge level approach to the development of knowledge-based systems.

So far knowledge acquisition and knowledge elicitation have been used in a more or less interchangeable way throughout this work. This is because there are not consistently clear differences between the two concepts throughout the literature. Two main views about the type of difference were identified. In one, knowledge elicitation is but one stage in knowledge acquisition. The following definitions of knowledge acquisition serve as an example of this approach:

> It involves eliciting, analysing, and interpreting the knowledge that a human expert uses when solving a particular problem and then transforming it into suitable machine representation (Kidd, 1987, p.1).
>
> Knowledge acquisition involves, in our view, at least the following activities: *eliciting* the knowledge in an informal - usually verbal - form, *interpreting* the elicited data using some conceptual framework, and *formalizing* the conceptualizations in such way that the program can use the knowledge. (Schreiber et al., 1993, p.2)

In this view, knowledge acquisition is almost synonym to the complete process of knowledge-based systems construction, although Schreiber et al. (1993) label that as knowledge engineering for it includes the construction of all the models specified in KADS. Knowledge elicitation seems to be particularly related, in these cases, to the contact with the "sources of knowledge", either human or non-human (Diaper, 1989).

In the other slightly different view:

> Knowledge "acquisition" will refer to the broader activity of gathering information from a variety of sources, one of which is a domain expert, and interpreting and organising it. The activities involving direct interactions with an expert will be referred as knowledge "elicitation". (Wood & Ford, 1993, p.72)

If knowledge elicitation is solely concerned with human sources, then "knowledge acquisition can proceed without elicitation in cases in which machine learning algorithms are used to induce knowledge instead" (Cooke, 1994, p.802).

In this thesis the concept of knowledge elicitation is used when referring to the empirical study carried out in the understanding that knowledge elicitation is not only limited to the direct contact with "sources of knowledge" - mainly human but supplemented by non-human sources - and involves also the interpretation of the knowledge into a mediation model. Knowledge elicitation, within this understanding, does not include the implementation of the mediation model as a design model or an actual system. Perhaps a more complete definition is that given by Johnson et al. (1990, p.88):

> Elicitation involves creating an environment where an expert, and others, can generate some kind of description of their activities which the knowledge engineer comments upon, analyses and moulds into a body of "knowledge". Thus knowledge elicitation is not the discovery of heaps of mature, internalised cognitive structures; nor is the mapping of ideas into a formal system. It is closer to a learning or research activity where one, usually a knowledge engineer, comes to understand something of the concerns of the other (the expert). With varying degrees of appropriateness, the knowledge engineer actively creates the knowledge from a sea of qualitative data produced during their meetings. The two stages of elicitation, raw elicitation (interview, problem-solving, etc.) and knowledge analysis (getting it down on paper) are distinct but do co-occur and knowledge engineers need skills in both.

Although that is the understanding of knowledge elicitation adopted and used in this research work, other authors may use the terminology differently than it is

used here. When citing those authors, the terms employed in their papers are maintained in order to avoid misrepresentation of the original ideas.

2.3.1 Approaches

The two main views in knowledge acquisition, namely transfer and modelling, have been discussed in the previous section. Despite the philosophical underpinning, practical approaches to knowledge acquisition and, consequently, knowledge elicitation are noteworthy. Modelling has already been considered at the pragmatic level elsewhere in this thesis, so it is not going to be considered again in this section. Two other practical approaches which have not been dealt with previously are considered here, namely machine induction and structured approaches.

2.3.1.1 Machine Induction

Machine induction is a method which the computer program uses to induce rules for a training set. The quality of the rules will depend on both the algorithm used and the quality of the examples used. The advantage of this method is that it almost suppresses the elicitation process and is useful when experts find it easier to describe examples than describe their knowledge. However, it is not possible in all domains to identify a documented training set and when it is possible the examples may not be representative of the real situations. The rules produced that are correct for the training set may not be correct in general (Hart, 1987). If no documented training set for the domain exists, the system developer and the expert will have to work together to produce one and this process can bring about some of the same problems encountered in knowledge elicitation.

2.3.1.2 Structured approach

McGraw & Harbison-Briggs (1989) propose a system-oriented methodology specifically for knowledge acquisition. Because it deals mainly with the elicitation of knowledge through several techniques, it cannot be considered a methodology for the development of knowledge-based systems as a whole. The authors propose that the technique in each phase of the design match the knowledge type to be extracted. The phases they identified and the corresponding techniques are:

- Identification. Identification of the domain knowledge, knowledge subsets, and vocabulary.

  Techniques: unstructured interviews .

- Concept analysis. Conceptualisation of the domain to understand and graphically represent the organisation of concepts within the domain, also to determine knowledge acquisition structure.

  Techniques for concept identification: generating concepts definitions, comparing and contrasting, generalisation, using prediction.

  Techniques for concept organisation and analysis: concept dictionary, concept framework, cognitive maps, models, taxonomies, concept sorting, scaling techniques, repertory grid analysis.

- Domain analysis (structural analysis). Involves analysing the domain to set boundaries and impose an initial structure to it. There are two types of analysis procedures:

  Identifying the major functions of the expert systems. Techniques: functional analysis (to identify declarative knowledge), information flow analysis (to identify declarative knowledge), interaction analysis, operational sequences analysis (to identify procedural knowledge).

Structuring the domain to derive knowledge acquisition goals and plans. Techniques: task analysis (to identify episodical knowledge), job analysis , timeline analysis (to identify procedural knowledge), extend decisions/action analysis.

- Structured interviews. Interview goals are to obtain enough information about task performance to increase foundational knowledge and/or to structure and refine already-acquired information. While this process is portrayed sequentially in the model it may be used in combination with other techniques at any stage.

- Solution analysis. The knowledge engineer analyses the expert solution strategies. The goal is to identify the priorities, heuristics, alternatives, attributes, and critical values that the domain expert uses. The focus is on decision making and problem-solving knowledge.

Techniques for process tracing: environmental observation, constrained information, constrained solution, simulated scenarios, episodic analogies, Analysis of difficult cases.

Techniques for verbal reports: think aloud, discussions, retrospective verbalisations, cued recall.

According to the authors, during the knowledge acquisition, record-keeping procedures should be maintained to guarantee documentation throughout each phase. The appeal of McGraw and Harbinson-Briggs' (1989) model is that it relates stages in the acquisition to techniques for eliciting knowledge. The authors emphasise, though, that the appropriateness of the techniques depends on the specific situation under investigation.

2.3.2 Techniques

Several techniques are explored and used in research and operational settings as ways of eliciting expert knowledge. Their application seems to be based on the stage in which the elicitation process is and on the type of knowledge elicited. Nevertheless, a taxonomy of these techniques can be based on the mechanics of the techniques themselves, as suggested by Cooke (1994). Some of the most common techniques are presented according to the organisation proposed by that author: observation and interviewing, process tracing and conceptual techniques.

2.3.2.1 Observation

The system builder observes the expert while he or she performs a domain-related task or solves a problem and identifies the knowledge the expert is using. It is a powerful technique for it can help identify knowledge that is not consciously accessible through interviewing (Welbank, 1990; Cooke, 1994). It is a naturalistic technique (Bell and Hardiman, 1989) and, as such, interpretation of the observed data is a straightforward task.

2.3.2.2 Unstructured interview

This takes the form of a free-flowing dialogue in which general, open-ended questions are asked and neither the content nor the sequencing of the questions is predetermined (Welbank, 1990; Cooke, 1994). The disadvantage is that it produces lots of information from which little is of use because of the lack of focus (Welbank, 1990).

2.3.2.3 Structured Interview

Structured interviews are goal-oriented, they follow a structure or plan (McGraw and Harbinson-Briggs, 1989), present questions that range from highly-structured to semi-structured whose "content is predetermined, although the sequencing

may vary" (Cooke, 1994, p.808). A number of variations of the structured interview are mentioned in the literature. A few of these variations are:

- Questionnaires: not a frequently cited technique for knowledge elicitation, but sometimes used to provide a validity check on the data obtained by other means.

- The teachback interview: the expert teaches a procedure to the system builder and the system builder teaches it back to the expert until there is agreement between them (Johnson and Johnson, 1987)

- Goal related tasks: aims at focusing interviews on goals. Hart (1986) proposes goals and reclassification as two of these techniques.

- Imposing constraints: subdivides further into two other techniques, namely limited information (the problem to be solved or the amount of information available to the domain expert is limited), and limited time (the expert has to do a task in a limited time which does not correspond to a real life situation) (McGraw and Harbinson-Briggs, 1989).

- Case analysis: involves the discussion of past cases dealt with by the expert (Bell and Hardiman, 1989).

- Cognitive interview: aims to enhance the expert retrieval of information via memory stimuli (Moody et al., 1996).

A series of guidelines on how to formulate questions and carry out interviews are given by authors such as Wood and Ford (1993) and Wooten and Rowley (1995), for example.

2.3.2.4 Task Analysis

Task analysis is used to describe the functions a human expert performs and to determine the relation of each task to the overall job (McGraw and Harbinson-

Briggs, 1989). Task analysis also involves the specification of the sub-tasks associated with it and "the focus is on what the expert does as opposed to what the expert knows" (Cooke, 1994, p.813).

2.3.2.5 Think-Aloud Technique and Protocol Analysis

The expert is required to think aloud while performing a task and his report is recorded. McGraw and Harbison-Briggs (1989) use the term protocol analysis for the method used to analyse protocols, or verbal reports, including the ones produced using think-aloud techniques. Cooke (1994) regards think-aloud verbal reports and protocol analysis as process tracing techniques because they are associated to specific tasks and the performance of the tasks. She also includes grounded theory as a method for protocol analysis.

2.3.2.6 Conceptual Techniques

Under this notion are a number of techniques for eliciting domain concepts, their interrelations, attributes and values. They are more structured and "tend to be indirect, requiring less introspection and verbalization than interview and verbal report techniques" (Cooke, 1994, p.821). Examples of the most often cited of these techniques, apart from interviews for concept elicitation, are:

- Repertory grid technique, which is a method for eliciting and analysing the expert's personal model of a problem. A grid consists of elements, or concepts, ranked according to dichotomous distinctions (Shaw and Gaines, 1987). More recently, Gaines (1993) explained that the repertory grid is but one technique derived from the personal construct psychology.

- Card Sorting (or Concept Sorting). This technique is used to elicit the expert's organisation of concepts in the domain. Concepts are written to cards and the expert is asked to group them into meaningful categories and explain why they belong in certain categories (McGraw and Harbison-Briggs, 1989).

- Multidimensional Scaling. The expert is asked to judge the similarity of items in the domain (Welbank, 1990). The results obtained using these techniques can be analysed using a variety of techniques, e.g. cluster analysis (McGraw and Harbison-Briggs, 1989).

This section has described a number of approaches and techniques for knowledge elicitation as observed in the literature. It is clear from it that knowledge elicitation is a complex task and the techniques employed have to match the results expected. Apart from that, Cooke (1994) shows that the elicitor role (ranging from active to passive), the expert response (ranging from direct to indirect), the time available for elicitation, and the type of data obtained (from qualitative to quantitative) have to be considered when applying the techniques available.

In addition, some of the techniques have been more frequently applied, described and studied and, as a consequence, are already well established as standard techniques whereas others still need assessing before being considered effective for knowledge elicitation.

2.4 Knowledge-Based Systems for Learning

The generic name given to computer systems designed to facilitate learning is computer-assisted learning (CAL), or computer-assisted instruction (CAI). CAL is comprised of a number of approaches to using computers in education and training, but not necessarily at the level of knowledge-based systems.

Hypertext and multimedia technologies have been extensively used to implement CAL systems and, although to a lesser extend, expert system and knowledge-based system techniques have also been applied. The integration of artificial intelligence techniques aims at the creation of a second generation of computer-

assisted learning systems, that is, Intelligent Computer-Assisted Instruction (ICAI) or, as others prefer to call it, Intelligent Tutoring Systems (ITS).

A number of benefits derived from the application of CAL to learning have been highlighted in the literature by, for example, Cleary (1992) and Dowell and Crews (1990). These include: a) students work at their own pace; b) one-to-one instruction allows for individuals needs to be met; c) instruction is more accessible; d) instruction is more standardised and formalised; e) instruction is interactive and students receive feedback; and f) it can be designed to accommodate different skill levels.

Traditional CAL systems, in spite of the benefits they can bring to learning/training situations, are still not yet true representations of the student/tutor interaction. Yazdani (1987, p.185) argues that they "do not have human-like knowledge of the domain they are teaching and they cannot answer serious questions of the students as to 'why' and 'how' the task is performed". In ICAI systems those problems are addressed by making use of techniques for knowledge acquisition and representation derived from knowledge engineering to represent complex knowledge of the domain, of teaching, and of the student.

Cleary (1992), however, contends that CAL packages exhibit some 'intelligence' although not created from an artificial intelligence or expert system programs because they embrace the two key elements in intelligent and expert systems, which are: (a) embodiment of an intelligent/expert skill within a computer, and (b) the system can offer intelligent advice or make an intelligent decision. The author acknowledges that those systems do not display the adaptability of a human instructor but says that even so many library-based CAL systems would fit a broad definition of 'intelligent library systems'.

It is doubtful that such a view of CAL is shared by many other researchers. Self (1988, p.xv), for example, state that "intelligent computer-aided instruction is

concerned with developing computer system which interacts knowledgeably with learners"

Perhaps a more practical way of describing the differences between CAL and ICAI systems is to use Dowell and Crews (1990, p.78) words:

> ICAI systems try to imbue the traditional CAI course development and delivery process with the codified intelligence of subject matter experts, instructional designers, and courseware developments with the intent of modelling the student/tutor interaction.

That description corresponds to the classical architecture for an intelligent computer-assisted instruction system, as described by Clancey et al (1982), who have specified three main components that characterise the operation of an application as it delivers instructional material to a student:

- Expertise module: Contains the domain knowledge or subject matter to be taught in the form of factual and procedural knowledge.

- Student module: Contains information about the student: assumptions about the current state of his/her understanding of the material being taught and historical information about his/her aptitudes, background and interests.

- Tutoring module: This is where instructional strategies, that is, decisions about what training material to present to the student and how to do it best are defined. It integrates its own information with information from the student profile with information from the expertise module.

The combination of those components should provide the system with intelligent capabilities and mimic the tutor/student interaction closer than CAL systems. When applied to user education in libraries, ICAI systems could represent an effective means of enhancing the instructional program and improving services for users. However, as Dowell and Crews (1990, p.95) warned, "...when addressing the bibliographic instructional needs of libraries one should accept the potential of ICAI systems but be realistic and moderate current expectations"

because most of the applications are still of a research nature and very few are commercially available.

A number of different concepts have been used to indicate instructional systems which embody and uses human expert knowledge in an adaptive way. The term expert systems rather than intelligent tutoring systems or intelligent computer assisted instruction systems is used by some authors (Gisolfi et al., 1993; Dabke and Thomas, 1992; Feinman, 1993) to identify application of knowledge-based and artificial intelligence techniques to instruction. Others, for example Duchastel (1991), prefer the term knowledge-based instructional systems to mean instructional applications that are based on artificial intelligence and hypermedia technologies. In addition, instructional system is one type of knowledge-based systems described by Hayes-Roth et al. (1983), as discussed in Chapter 2 of this thesis.

Gisolfi et al. (1993, p.25) note that "there is an overlap between the construction of expert systems and intelligent tutoring systems in that an expert system may serve as a module for an ITS". More specifically, both Duchastel (1991) and Orey and Nelson (1993), when discussing the implementation of instructional system, cite the modelling of expertise as one of its phases. van Joolingen and Jong (1992) propose a conceptual domain modelling for their Intelligent simulation Learning Environment (ISLE) which is very similar to KADS methodology (fact acknowledged by the authors).

The point to be made here is that domain modelling for knowledge-based systems and for instructional systems are basically the same. In knowledge-based systems, domain conceptual models, if implemented, are part of the knowledge base and in instructional systems they are part of the experts module.

2.5 Knowledge-Based Systems for Learning in Libraries

Knowledge-based systems for education in academic libraries could represent an effective means of improving and facilitating the delivery of library research instruction as suggested by Dowell and Crews (1990) and Feinman (1993). However, few such applications have been documented in the literature. The reasons for that are probably related to the fact that these systems are expensive and time-consuming to develop. At the same time, expert systems and knowledge-based systems in library applications failed to deliver what was expected of them a few years back. For example, Su and Lancaster (1995), in an evaluation of expert systems for reference applications concluded their research paper by stating "The results of this research generally do not offer strong support for the belief that present expert systems can greatly increase the accuracy of question answering in reference services" (p.227).

Several knowledge-based systems for library and information services have been developed over the years (Lancaster et al., 1996). Alberico and Micco (1990), Ford (1991) and Morris (1992), among others, review many of those applications. Reference and information retrieval seem to be the main target areas for such systems, whereas user education is subject to very little research.

Some of the reference knowledge-based systems proposed can also deliver library instruction. In fact, some authors, for example, Binkley and Parrott (1987), explicitly acknowledge incorporating both functions: reference service and user education. Their program, which was built from CAL authoring software supplemented by expert systems, is able to perform query negotiation, to present instruction, to provide referral and simple information and to perform specific tasks rather that to teach the general rules to perform.

Another somehow similar system is the one proposed by Dabke and Thomas (1992). The instructional expert system they designed focuses on a subject area and its relevant bibliographic sources to provide instruction and advice within that scope. In addition, Cleary (1992) suggested that CAL packages, although not built from AI technology, are intelligent system for they provide intelligence advice and embody expert skill within a program. Following this rationale, the author developed such a system for online search instruction.

User education and reference work both require knowledge of the field and knowledge of the literature within it. One difference is that reference work is a question negotiation task, whereas user education is an instructional task (Richardson, 1995). Alberico and Micco (1990) discuss expert systems for reference work and propose an experimental system which is developed from expert knowledge acquired from in-house publications such as handouts used for library user education. The system is both an advisory system and a program for library instruction. Richardson (1995) also considers knowledge-based systems in reference work in depth, he presents a system which recognises thirteen reference formats and their characteristics. By classifying the user's question into one of those formats, the system can select the best sources for answering a question. His system is based on the traditional reference work paradigm which sees reference as consisting of classifying user's questions to match the question to a known source. Reference work may be more than that, involving a complex communication process between librarian and users.

Few reports on the application of knowledge-based technologies to user education were found in the literature. In addition, the number of reports of implementation of systems in that area in particular, and on knowledge-based systems for libraries in general, are decreasing over the years. However, if expert and knowledge-based systems have been criticised for not providing the results expected few years back, similar technology is now being used for the design of intelligent agents (Nardi and O'Day, 1996) which, for example, can provide

assistance on online searching (Haverkamp and Gauch, 1998) or over the Internet (Walker, 1998) and thus helping to design intelligent digital libraries (Fox, 1994) and knowledge-based systems for libraries applications which are truly user-centred (Brazier and Treur, 1994) and "self-explanatory" (Pacey, 1995) and in which information skills are not taught but learned.

Chapter 3

Subject Librarianship and User Education

This chapter examines the fields of subject librarianship and user education. It also considers models of library research, information searching and information seeking and use and establishes their relation to user education. The use of computer systems for developing information skills in library contexts, both incorporating and not incorporating techniques for knowledge based systems, are also examined.

3.1 Subject Librarianship in University Libraries

In trying to identify the actual situation of subject specialist librarians in today's academic libraries one realises how little has been published about the subject. There have been limited reports added to the literature since a survey on subject specialisation in UK university libraries in 1981, which forecasted: "With university income diminishing, subject specialisation may become increasingly less feasible in future as indeed several of the replies in our survey indicated would happen" (Woodhead and Martin, 1982, p.94). In a similar vein, Bundy (1984) during a comparative study of the role of subject librarians in British

polytechnics and Australian Institutes of Technology also foresaw a change, or development, in the role of the subject librarian due to financial constraints in academic libraries and increasing levels of automation. These predictions have been confirmed; however, the changes were not only due to financial constraints but also to changes in the academic environment. The Follett Report (1993) on library and related provisions for the academia in the next decade describes the changes:

> Changes in the organisation of teaching and learning have also led to changes in what is required of library staff. Subject librarians, enquiry desk staff, and others need to be able to play an active role in supporting students in their teaching and learning, including providing guidance in how to use the facilities provided by a library, through to subject-specific advice on project work and source materials. (Follett, 1993, p. 121)

Similarly, Martin (1996) found that there had been significant developments in university libraries since 1982 to justify a second round of the Woodhead and Martin's survey. According to him, these developments related to advances in electronic media and information technology, and financial pressure had profound implications for the role of librarians in those institutions.

The implications of changes and developments related to subject librarians, in particular, and library staff, in general, resulted in a commission for a supplement to the Follett report which came to be known as the Fielden report. The Follett report implied the findings that would be specified by the consultancy:

> The work undertaken by the consultants confirmed that a range of developments were changing the demands placed on university librarians, requiring a broader range of skills from them. The principal area where the study expected further major change was "learner support" - the activities within a library/information service which support individual learners. This includes education and training for library users, training in information management, and other forms of support in the use and manipulation of information. (Follett, 1993, p.125)

Of importance to this chapter are the implications of these changes in terms of functions of the specialist within the library; the effect of their educational

background and the relevance of their education to their job; the organisation of subject librarianship within libraries; and possible advantages and drawbacks of the approach. First, however, it is necessary to clarify the definition of subject librarianship.

A number of writers have attempted to define the concept of subject specialist librarian. Humphreys (1967) traditional definition is: "...a member of a library staff appointed to develop one or more aspects of a library's technical or reference service in a particular subject field" (quoted in Ogundipe, 1990, p.52). Holbrook (1972) clarified this definition in the Polytechnic library environment:

> A subject specialist is a member of the library staff appointed to organise library services in a particular subject field. This subject field may be fairly narrow, or, more typically, be broad enough to cover an umbrella of related disciplines contained in a faculty/school/department structure. (quoted in Hay, 1990)

Hay (1990) himself argued that in North America the definition tended to be vague and lacking consensus, as opposed to the situation in Europe. However, both of the UK university libraries surveys (Woodhead and Martin, 1982 and Martin, 1996) showed that a standard concept was far from being reached. Reservations concerning the term subject specialist were particularly stressed by many respondents who felt it lacked the subject knowledge equivalent to that of academic staff. Several other terms are being used in academic libraries but subject librarian was preferred in UK by the time of Martin's survey. In North American literature the term bibliographer seems to be favoured.

Having dealt with subject librarianship in general, the following sections deal with particular aspects related to it.

3.1.1 Background

The ancient libraries at Oxford and Cambridge universities have a tradition on subject specialisation which goes as far back as the Renaissance when universities had learned librarians who were scholars in some subject (Hay, 1990) even though today, according to Martin (1996), their modern counterparts have adopted a distinct organisational structure.

However, subject specialisation as it is seen today started to spread much later. Woodhead and Martin (1982) explain:

> In the late 1940s University College London, faced with the need to rebuild collections destroyed during the war, developed a system of delegating detailed work on the subject libraries to assistant librarians. (p. 95)

The post-war period experienced an unprecedented growth in the university sector: the number of students increased and new universities were created. The development of the libraries in these universities paralleled the experience of University College London (Woodhead and Martin, 1982). In 1964, the University Grants Committee Report (the Parry Report) of the Committee on Libraries recommended the appointment of subject specialist to libraries as a way of maintaining liaisons with departments. This report was influential on a national scale and specifically to university libraries (Bastiampillai & Havard-Williams, 1987). Woodhead and Martin (1982) noticed the development of the scheme:

> As university libraries grew rapidly in size and moved from a custodial to an exploitive role, subject specialisation schemes of various types became common, often involving a complete remodelling of an existing staff organisation. (p. 95)

In 1982, in the aforementioned survey on subject specialisation in UK university libraries, Woodhead and Martin (1982) found that 48 out of 61 university libraries surveyed presented some kind of subject specialisation. The other 13 either presented no subject specialisation at all or the degree of specialisation that

was imposed on the functional structure was so small that the libraries were in essence characterised as functional.

Two years later another study on subject specialisation in academic libraries, but at this time on British polytechnic libraries and Institutes of Technology in Australia, revealed that 21 Polytechnics responding to the questionnaire had a total of 223 subject specialist staff (Bundy, 1984). However, the survey had as its principal aim to access the subject librarians' view of their role and the degree of their job satisfaction and not to analyse the degree of commitment to subject librarianship in these institutions. It appears that 21 polytechnics that answered the questionnaire had staff appointed as subject specialists, but the commitment of these libraries to subject specialisation as a whole and whether the respondents were aware of the author's definition of subject specialisation, which did not include specialisation by type of material or according to linguistic ability, were not clear.

In his more recent survey, Martin (1996) found that 38 out of the 45 university libraries surveyed presented some kind of subject specialisation. The number of libraries which did not present subject specialisation in their structure had also dropped, from 13 to 6. The difference in numbers from the previous survey was due to both the reduction of existing institutions and the number of respondents.

3.1.2 Functions

Traditionally, the activities of subject librarians within their subject fields could be enumerated as liaison between the relevant subject departments and the library; user education; reference and information work; collection development; literature searching; provision of current awareness services: bibliographies, reading lists, guides, etc.; and, in fewer cases, classification and cataloguing of material (Crossley, 1974; Duino, 1979; Harris, 1974; Ogundipe, 1990).

The functions listed, however, are a summary of the description of the role in different studies and substantial differences were observed amongst them. A clearer distinction is found in the Fielden (1993) report's assessment of "subject or information librarians" that found three different approaches to the role of subject librarians:

> In some places the title described someone who worked in the library with responsibility for the ordering, classification and cataloguing of books in a group of subjects, but who had little interaction with academic staff, except on the topic of ordering books. A second interpretation of the role involved close working with academic colleagues in a wide range of support activities and therefore tended to the 'academic convergence' model we have described above. A third interpretation of the role was the recognised researcher in a subject area who had virtual equivalence with academic peers. This tended to be found in larger research institutions with special collections. As we believe that the second interpretation is the direction in which the role will develop further... (Fielden Consultancy, 1993, p.3.26)

The report also specifies the elements that in their opinion constitute the role of subject librarians:

- Attending course planning committees;
- Providing tuition on study skills programmes run by departments or faculties/schools, on issues related to resources available and the means to access them;
- Participating in academic audit and quality assurance initiatives to review the library and information science contribution to particular courses and to suggest ways in which a university's resources could contribute more to the quality of learning;
- Helping academic staff to understand the resources that are available, physically and electronically, as well as the teaching/learning approaches to adopt to make the best use of them;

- Providing technical support for staff and students on how to access and use the electronic text and databases that are most relevant to the subject;

- Assisting students with any technical or access problems when they are in the Library or Resource Centre;

- Producing educational material, in a range of formats, for staff and students about resources in their subject area.

It is clear from the report that the educational aspect of the subject librarians' role is a major area of change, with an emphasis on helping students and staff in using the resources available through their technical and pedagogical support. Fowell and Levy (1995, p.274) also stress that "...information and subject professionals are becoming increasingly involved in educational, facilitative, design, navigation and problem-solving activities".

In the networked environment, where information sources are available away from the library, the educational role of librarians - both subject specialist librarians and other librarians -seems to be ever more important. McClure (1994) sees this happening in the United States and predicts that in the networked society of the future "...librarians and educators would serve as electronic intermediaries, navigators, and instructors - actively involved in helping people best use the network" (p.123).

Heseltine (1995) emphasises the educational role of the librarian in the networked electronic environment - the cyberspace. However, he does not believe that the role is for subject librarians as he sees too many managerial problems linked to the subject librarianship type of library organisation. According to Martin (1996, p.167), however, Heseltine "considers it important to have expertise among staff across as wide a range of subjects as possible, to be called upon as required".

That a major change which affects academic libraries is under way there seems to be no disagreement; that this change is reinforcing the educational side of what

has traditionally been perceived as the role of subject librarians is also not in dispute. The only doubt, however, is if subject specialisation is still going to be an important component of the job specification. Martin (1996) concludes his paper by stating that the relevance of subject qualifications is less apparent in this new environment.

It is not a concern of this thesis either to support or to question the organisation of libraries on the basis of subject librarianship. However, it is concerned with the approach of "subject" in more general terms within library and information science, that is, it is in agreement with the understanding that "the best way to understand information in IS [Information Science] is to study the knowledge-domain as thought or discourse communities, which are parts of society's division of labour" (Hjørland and Albrechtsen, 1995, p.400).

3.1.3 Qualifications

There is almost a consensus in the literature that subject librarians should have an academic background in the subject of their speciality plus a postgraduate qualification in librarianship.

Nevertheless, Humphreys (1967) adds that "Although he would normally already have some experience in his field and would commonly have obtained a first or research degree it is not essential that he should have qualifications in the subject when he is appointed" (quoted in Ogundipe, 1990, p.52). Crossley (1974, p.39) believes that formal academic qualification in the subject is not essential and that "the trained librarian is, or can become, a specialist in the literature and librarianship of a particular subject, which is what subject specialist librarianship is all about".

Ogundipe (1990, p.52) goes one step further: "The normal minimal qualification for a subject specialist would be a good degree in a subject plus postgraduate

professional training in librarianship. An additional higher degree in either a subject field or in librarianship would be useful, if not essential for further career advancement".

However, with the proliferation and specialisation of the literature and the growth of the number of courses offered by universities it is increasingly difficult to have a subject specialist for each one of the subject areas offered by a university. In addition it seems that science and engineering subject librarians are more difficult to recruit than humanities and social science librarians. Holbrook (quoted in Crossley, 1974, p.41) believes that "the subject field of a specialist librarian may be broad enough to cover an umbrella of related disciplines in a faculty/school/department structure".

Thus, a post-graduate course on a subject area does not guarantee academic preparation in the other subject areas he or she will be most likely to be responsible for. Williams' article (1991) addresses this problem and tries to determine the extent to which subject knowledge is necessary to perform the required activities adequately, particularly in relation to the selection of materials.

For the same reasons that it is impossible to have academic qualifications in each of the subjects the librarian is responsible for, unless the library can have one dedicated specialist for each subject, it is not possible to call the subject librarian a subject specialist, in the opinion of some authors. Woodhead and Martin (1982), in their survey, pointed out that many subject librarians avoid the term subject specialist because they believe that the real specialists in the subject are the library users. Library staff specialisation, in the opinion of those subject librarians, does not impress the specialised users and is often limited to specialisation in the literature of the subject.

As a consequence of this and to avoid misinterpretation, the term subject specialist has frequently been substituted by subject librarian. Other names used to define the same professional are faculty or school librarian, liaison officer or

librarian, subject consultant, information officer, bibliographer, area specialists, etc.

3.1.4 Organisational Patterns

According to Bastiampillai and Havard-Williams (1987), traditional staffing structures in university libraries are hierarchical, and specialisation is by function or process. They emphasise that the functional approach has reflected the rather conservative and custodial role of libraries, that it works well administratively but the users gain very little benefit from subject knowledge the library staff may have. Apart from these two types of organisational patterns in university libraries - functional and subject oriented - the authors describe a third type that is formed by a combination of the two other and where staff have a functional and subject role.

Woodhead and Martin (1982), based on a classification first proposed by Scrivener (1974), identified five types of organisational pattern in the university libraries surveyed. The categories were described as follows:

> (1) Functional: all functions are performed on a centralised basis (i.e. non-subject) basis rather than some of them being subdivided among several senior members of staff (i.e. assistant librarians and above) by subject.
> (2) Dual: some members of the senior staff perform certain functions of the library which have been subdivided among them by subject. Other members of the senior staff perform the remaining functions (i.e., those which are run on a centralized basis).
> (3) Hybrid: some or all members of the senior staff perform certain functions of the library which have been subdivided among them by subject. Each of those who has such 'subject' duties is also responsible for one or more of the remaining functions (i.e., those which are run on a centralized basis).
> (4) Three-tier: all or most members of the senior staff perform functions which have been assigned to them on a subject basis. The remaining functions (i.e., those performed on a centralized basis) are the responsibility of a middle grade of staff, commonly senior library assistants, supported by junior assistants and clerical staff.

> (5) Subject division: there are subject teams consisting of both senior and supporting staff, each team being located in, and responsible for, a physically separate portion of the central library collection. Underlying this arrangement there will normally be a supporting structure performing those functions which are centralized. (Woodhead and Martin 1982, p.98)

Independently of the structure adopted, there are advantages and disadvantages in following one or other of the approaches. According to the literature, the advantages of applying the subject specialisation approach to academic libraries are that it improves relations with library users (Woodhead & Martin, 1982); job satisfaction is augmented (Woodhead & Martin, 1982; Bundy, 1984; Bastiampillai & Havard-Williams, 1987); academic status of librarians is raised (Williams, 1991); subject specialisation brings to readers' services considerable specialised knowledge and a strong clientele orientation (Ogundipe, 1990); and it improves the image of the librarian via relationship with users (Ogundipe, 1990).

In addition, as library systems become more complex and more extensive, the break-down into subjects allow for a more competent and knowledgeable exploitation of the library sources.

However, there are obviously some disadvantages in a subject-oriented organisational approach; for example, Ogundipe (1990) found that subject specialisation systems are more expensive to run. In addition, the changing nature of the curriculum and the growth of interdisciplinary degrees mean that the subject specialist with a first degree cannot really be called a specialist. There may be resistance to the idea of subject librarians in some institutions and among some professionals because it may be felt that they constitute a library elite that is not responsible for the ordinary and rather mundane matters of the library (Hay, 1990). Finally, there may be practical difficulties in implementing subject specialisation in a meaningful way due to traditional division by functions (Woodhead & Martin, 1982; Bundy, 1984).

Future trends in subject librarianship are difficult to foresee. Apart from the increased emphasis on the educational role of librarians, it is not clear if subject

functions are still going to be considered relevant in networked environments. Perhaps the distinction between librarians and educators is starting to blur and in such case the term subject librarian would be meaningless.

3.2 User Education

Academic libraries play a central role in the educational process. In addition to supporting research, teaching and learning by providing access to information, they also have to help students on the use of information and the exploitation of information resources to the full both for course-related activities and for life-long requirements.

Concepts such as information skills teaching, library instruction, user education and bibliographic instruction are used extensively across the literature and in practice. In an attempt to clarify matters for the purpose of this work, some of the terms have been outlined.

User education has been formally and widely defined by Fleming (1990, p.ix) as

> ...various programmes of instruction, education and exploration provided by libraries to users to enable them to make more effective, efficient and independent use of the information sources, resources and services to which these libraries provide access. Fleming (1990, p.ix)

Library instruction, on the one hand, involves the teaching of the use of the library, its services and resources, and the use of information sources accessed through the library. Bibliographic instruction, on the other hand, relates more specifically to teaching how to use specific information sources, particularly bibliographic ones.

In practice, however, these concepts do not differ significantly from each other and their adoption seems to be more closely associated to author's affiliation and

trends in terminology than to real conceptual differences. For example, according to Pacey (1995), library instruction and bibliographic instruction are pedagogic labels used mainly in North America, which has witnessed the rise of the concept of information literacy. User education is an expression adopted in British literature which is giving way to the idea of information skills development. User education, according to Rogers (1994), relates to library use and has been used since the 1970's. Some authors, however, still favour the user education concept because it places the user at the centre of the process (Watson, 1999).

Information skills and information literacy, which are concepts specially tailored for the information society, are not synonyms for library skills. Information skills denotes a wider range of skills which include, as Morrison and Markless (1992) point out: library skills, study skills (e.g. note-taking, essay writing), cognitive skills needed to handle information (e.g. analysis, synthesis), and additional skills needed for independent study (e.g. planning, prioritising). Malley (1984) describes information skills as a set of skills which include library skills, communication skills, study skills, reading skills, and a mixture of skills which he conveniently describes as learning skills.

The teaching/learning of these skills in programmes are not without difficulties. Hopkins (1987) argues that:

> There is an unresolved dichotomy and confusion between the notion of information skills as (a) the retrieval and location of information, and (b) the analysis and synthesis of information. The former aspect of the term is most commonly the focus of information skills programmes, but the latter is arguably the more important. The distinction between the two aspects of information is not clearly articulated in the literature. (quoted in Rogers, 1994)

Information literacy, in turn, comprises three broad areas of activity: the ability to access information, the ability to evaluate information, the ability to synthesise information (Pacey, 1995). McClure (1994), expanding on a definition by the North American Association for Supervision and Curriculum Development, states

that information literacy "includes the ability to locate, process, and use information effectively regardless of delivery mechanisms and the type of format in which that information appears" (p.117). More recently, this understanding of information literacy has been reaffirmed and the relationship between information literacy and information technology skills stressed (Association of College and Research Libraries, 1999).

The reasons for the evolutionary change, it seems, are related to the ever-increasing complexity of the information world, particularly fomented by the advances in electronic media and networked information services. Blandy and Libutti (1995) argue that "the electronic dissemination of information is changing our culture, changing our definition of what culture is" (p.281).

As can be seen from the definitions, the scope of the information skills development area is much broader than what traditionally is done in most libraries, even after the introduction of the newer terminology. As such, the term user education is favoured throughout this thesis since it better describes the sort of support provided by librarians, particularly subject librarians, which is not limited to the use of bibliographic tools or the location of material within the library building, but which comprises support for seeking and using information for academic purposes, in other words, support for library research.

Traditionally, most libraries give some form of instruction to their users, from guided tours and workshops, through lectures, formal courses, distribution of handouts and exhibition of videos to the one-to-one situation at the reference desk. The application of such methods has been extensively discussed in the literature.

Malley (1984) differentiates between modes and methods of instruction. According to him, methods are forms or procedures for teaching, for example, formal courses, course-related instruction, course-integrated instruction, and point-of-use instruction. Modes, on the other hand, are manners of executing the

methods, for instance, lectures, printed materials, audiovisual presentations, and computer-assisted instruction.

Guided tours are probably one of the most basic forms of orientation in academic libraries; they aim at orienting new students to the library physical layout, facilities and organisation but are not considered to be effective in instructing students on the use of basic library research tools and methods (Lawson, 1989). Workshops and lectures are more sophisticated forms of instruction and involve extensive preparation and planning. A combination of exercises and presentations may be used to instruct students in the use of the library and the bibliographic information they will need for a particular non-library course; that appears to be one of most popular modes of instruction. Handouts, videos, audio, etc., may be used in combination with other methods or on their own both for orientation in the use of the library and for instruction on research tools and methods.

Since the 1980s, the widespread availability of microcomputer technology has meant that new modes for user education delivery have been introduced. Firstly in the form of hypertext and computer-assisted learning (CAL) programs made available in stand-alone computers; and, subsequently, as Web-based instruction. These modes are discussed later in section 3.2.4.

Having dealt with the concepts related to user education, its modes and methods, the following two sections deal respectively with models of library research and models of information seeking and searching which can serve as the basis for the development of user education programmes. The final section of this chapter deals with the use of computer technology in user education.

3.2.1 Library Research Models

Research in academic settings seems to be understood in different ways by librarians and academics. Traditionally, librarians emphasise the gathering of information in their research model whereas academics emphasise the use of the information gathered.

Several years ago Stoan (1984) started a polemical debate about the "form over function" approach to library research. He argued that research skills and library skills are thought to be the same thing by librarians who insist on teaching the reference search strategy - a series of steps for gathering information in the library using tools from the reference collection - in their bibliographic instruction classes. According to him, academics see research as a far more complex activity; for them research is discipline-oriented and involves the mastering of knowledge, methodologies and tools from the discipline. He had a strong argument in that academics seldom use the library in the way librarians think they should, still they are the ones who do research.

Library skills, still according to him, are only useful for students involved in undergraduate library projects who can learn library research as a set of mechanical skills, independent from a discipline and which enable one to find information on almost any topic. Reference tools could also be useful for faculty members who are venturing outside their fields, though in this case they are more likely to seek advice from a colleague who is a specialist in the area in question. In addition, librarians should recognise the role of citations as a way of locating information and should emphasise browsing in libraries.

In a later paper, Stoan (1991), based on the literature of scholarly communication, argues that faculty are successful and logical in their information seeking and that education has not contributed to changing researchers' behaviour. He emphasises that faculty rely on a wide variety of information-retrieval techniques, particularly informal ones, that they only occasionally need

to carry out structured literature searches, and that they do not seem to be convinced that more formalised methods would benefit their research.

His findings about faculty behaviour seem to be corroborated by a study of attitudes towards, and skills in, conducting library research among undergraduate students. Valentine (1993, p.304) concluded that "...students use research strategies that they perceive will reap the greatest benefits with the least cost in terms of time or social effort".

Similarly, Kenney and McArthur (1984) also expressed their dissatisfaction with the "form over function" approach to library research instruction as they explained:

> This approach presupposes both that the professional librarian's paradigm for organising information is an appropriate one for the undergraduate student and that a junior majoring in marketing has the same motivation to memorise this artificial structure as does the aspiring future reference librarian. (p.36)

These authors decided that none of the existing models were appropriate and set about designing their own, implemented as a programmed instruction text. The instruction emphasised function over form and presented problems in context. The programmed instruction starts with a chapter on using encyclopaedias to help focus on a term-paper topic and continues by outlining "a search strategy through the standard bibliographic access tools, emphasising that finding information is a logical process that can be applied, in whole or in part, to any topic" (p.37) . It is clear from the quotation that the librarians' view of the research process was being applied to the programmed text; the only difference was a shift on delivery method; no new model for library research was proposed. Nevertheless, the authors state that the textbook was extremely popular with students and they decided to determine its effectiveness as a teaching instrument by using pre- and post-tests as measurement tools. Acknowledging the limitations of such methods, however, they believed that the findings and the result of their own experience

indicate that "programmed texts can be used for teaching basic skills more effectively and less tediously than a librarian with a truckfull of books" (p.41).

Keeping on the polemic, Stoan (1984) also argued that research from the faculty point of view is a very sophisticated process which starts being mastered at the post-graduate level. Undergraduate education "frequently involves no independent literature-searching in the library" (p.104) thus library instruction has a limited role for undergraduate students.

According to Hubbard (1995), a reductionist, modernist conception of the scientific method has characterised bibliographic instruction, imposing a structuralist model which does not correspond to the way research and learning takes place. The author suggests a postmodern pedagogy to user education to overcome the problem.

Electronic information and advances in computer networking are having a great impact on scholarship (Blandy & Libutti, 1995). Students at all levels, undergraduates included, are now exposed to vast amounts of information which they must be able to access, select, process and evaluate. Although one cannot disagree with the view that research skills is not a synonym for information seeking and use skills, few people these days would question the validity of librarians' actively supporting learning of the latter. On the contrary, many see promoting learning of life-long information skills as one of the main roles for librarians (for example, Wersig, 1993), particularly in the networked environment (for example, McClure, 1994; Tompkins et al., 1998, Elder and Miller, 1998)

Similarly to Stoan, Pacey (1995), states that "User education is dead" (p.95). He proceeds to explain that he is referring to the "library and bibliographic skills, *taught*, by librarians, and at its worst resembling 'a micro course in librarianship'" (p.95). However, he agrees that information skills should be reintegrated with the curriculum and that subject librarians, where appropriate,

should be encouraged to continue to provide subject-oriented information skills training. Consideration should be given, he says, to "transforming *teaching* (offered at given times) into vehicles of *learning* (available at all times)" (p.101). This is in accordance with his vision of the self-explanatory library.Fister (1992) agrees that the librarians' traditional model of "making a systematic, tool-based series of searches that takes the student from a general background source through monographic and periodical literature" (p.163) is not a true representation of the research process. However, she adds that the faculty's model is also not completely appropriate because it assumes a thorough knowledge of the discipline. She concludes that it is necessary to teach skills that integrate library use into the research process and to do so proposes to analyse the problems encountered by novices to disciplines, that is, undergraduates.

To uncover the process students go through when doing research (library research) Fister interviewed in-depth 14 high achiever students. As she describes:

> The goal was to compare the process described in the classroom as research - either the library model, with its emphasis on tools, or the expert model described by Stoan, with its emphasis on familiarity with the literature - with the research students actually do. (Fister,1992, p.164)

Although she produced an interesting piece of work, she did not propose a model of bibliographic instruction or the students' information searching process. She found that the students under study had a sophisticated understanding of the nature of research and presented sophisticated strategies to deal with it; finding a focus is a major and critical phase and the librarian's recipe for narrowing a subject by mechanical means does not help; reference books (dictionaries and encyclopaedias) were used for filling gaps in their information and not for starting the research; citation and browsing of shelves were used extensively; and generating of ideas, finding information and writing were parts of a single process. She finished by stating "...we need to re-examine our tool-based, 'systematic' search model - and develop a new model that better addresses the special needs of undergraduate researchers" (p.169).

Kuhlthau (1991) also studied the information search process of students doing a term-paper. She elicited feelings, thoughts and actions students experienced when engaged in specific information tasks. The formulation of her search process was based on empirical data on the information seeking of students who were assigned a research paper. The search process presented six stages: initiation, selection, exploration, formulation, collection, and presentation. Initiation relates to students' recognising an information need; selection concerns the identification and selection of a general topic to be investigated or the approach to be pursued; exploration relates to seeking relevant information; formulation has to do with the focus of the search; collection concerns the selection and gathering of information; presentation is related to writing or presentation of the information. At all these stages, the author emphasised feelings, thoughts, actions and appropriate tasks.

Kuhlthau (1993) gives some advice, based on the model she developed, to reference librarians. Her model is concerned only with the user component of library search and is not intended to be a full understanding of the user education domain. Nevertheless, she states, "within reference services, five levels of mediation have been identified: organiser, locator, identifier, advisor, and counsellor" (p.137). Educational roles match those levels as follows: organiser, locator/lecturer, identifier/instructor, advisor/tutor, and counsellor. She also identified five zones of intervention, which parallel those mediation/education roles: self-diagnosis, right source, relevant sources, sequence of sources and process. Within their organiser role, librarians expect the user to conduct a self-diagnosis of his information problem; as locator/lecturer, librarians are prepared to intervene offering the right source; as identifier/instructor, they can offer relevant sources; as advisor/tutor they can offer help on a sequence of sources; finally, in their counsellor role, librarians are able to apply the process approach developed by the author to reference/education situations.

An important model for library research was suggested and applied to user education by Mellon (1984). Although not based on empirical data, Mellon proposed a process approach to instruction which is in opposition to the traditional product-oriented model applied by librarians and which focuses on tools use or search strategy. Starting with the recurring stages in the writing process - pre-writing, writing and editing - she and her colleagues developed a "generic model of library research" the aim of which was "to identify general principles with lifelong application rather than the simple acquisition of facts for immediate use" (p.472). The model is conceptualised in three stages: pre-library (generating the need to know), library awareness (conscious recognition of the need to know), and library competence (need to know is internalised). In the first stage the student is assigned or selects a topic, explores existing knowledge related to it and starts formulating a focus for the research. The second stage is concerned with seeking information, notetaking and evaluation of initial sources. Finally, in the third stage, the need for more specific information is generated, more information is sought and a recursive process of search, retrieval, and evaluation takes place until information is viewed as sufficiently adequate for the student to begin writing the paper. Library instruction activities derived from the application of the model are emphasised:

> ...attitudes toward the library and librarians, limitation of research topics to provide positive experiences rather than frustration for students, and the development of print materials to supplement instruction in the use of specific library tools. (Mellon, 1984, p.474)

Kuhlthau's and Mellon's models are quite similar although they do not present the same number of stages, that is so because Mellon's model presents several specifications within each stage. When superimposed, the models show that initiation and selection stages of the information search process (Kuhlthau, 1991) are included in the pre-library stage of the generic model of library research (Mellon, 1984), that exploration is part of the library awareness stage; and formulation and collection are part of the library competence stage. Presentation

does not find an equivalent because Mellon's model stops just before the writing starts.

Eisenberg and Berkowitz (1990) introduced the concept of the "big six skills approach to library and information skills instruction" which "represents a general approach to information problem-solving consisting of six logical steps or stages" (p.5). The steps specified are:

- task definition includes identifying and stating an information need;
- information seeking strategies involves deciding about the appropriate information sources that meet the defined task;
- location and access is the implementation of the information seeking strategy through the use of libraries, access tools, electronic databases, etc.;
- use of information is the interaction of the student with each single information source;
- synthesis is the application of the information to the task through a process of restructuring it;
- evaluation is the examination and assessment of how effectively and efficiently the task was carried out.

The emphasis of the big six skills is on general information problem-solving rather than specifically on information seeking It is in this particular point that the approach differs from several other models described in the literature. In addition, it clearly separates information seeking from locating and access to information. The big six skills approach had a positive impact when introduced and has continued to be debated in the literature for almost a decade (Eisenberg, 1998).

The focus of the model proposed by Ackerson (1996) is on promoting effective reference services for post-graduate students, but in the words of the author:

> ...because reference and bibliographic instruction (BI) transactions often occur at the reference desk, it is plausible that the approach utilized for these library instruction sessions represents the same model librarians actually use to guide their reference interactions (p.250).

The model was based on a review of the literature on scientific communication and bibliographic instruction and proposes the following steps: (1) searching subject indexes; (2) identifying reviews; (3) searching for ancestors; (4) searching for descendants; (5) identifying key documents; and (6) current awareness.

In an extensive work on library research models, Mann (1993) identified several of what he labelled models of library research. His work, although not particularly enlightening to this research, is of relevance for two reasons: firstly, it is one of the few pieces of work which deal explicitly with library research models; and, secondly, it is still referred to and studied in American schools. The first of the library research models he identified is the "subject or discipline model", in which library research is confined to the boundaries of a discipline. Another of the models is the "traditional library science model", that was subdivided into three schemes: the "classification scheme", which is based on the arrangement of books on the shelves; the "vocabulary-controlled scheme", which is based on the subject cataloguing of books; and the "published bibliographies and indexes scheme", which is based on the identification of sources not covered by the two other schemes, particularly journal articles. A third model is the "type-of-literature model" which is particularly useful for teaching undergraduate students and is concerned with general types of literature that are expected to be found in all subject areas, for example, almanacs, bibliographies, catalogues, computer databases, dictionaries, handbooks and manuals, indexes and abstracts, etc. The "actual-practice model" is based on the behaviour demonstrated by scholars in all areas and stresses browsing, footnote chasing and talking to colleagues, for example. Finally, Mann (1993) describes the "computer

workstation model", which is based on the use of computers to retrieve both bibliographic information from databases and full-text documents from electronic sources. Mann made no mention of the role of the Internet in library research.

Mann (1993) shows dissatisfaction with the use of any single model, although for his background he seems particularly keen on the vocabulary controlled model. He asserts that "what is required of a new model, then, is a balance of the existing models against one another so that a weakness in any one may be compensated for by a strength in another" (p.156) and proposes the "methods-of-searching model" as a comprehensive model to overcome the fragmentation. His "methods-of-searching model" presents eight different methods of searching the universe of knowledge records, all of them based on one actual way of searching, they are:

- controlled-vocabulary searches in manual or printed sources;
- key word searches in manual or printed sources;
- citation searches in printed sources;
- searches through published bibliographies;
- searches through people sources;
- computer searches;
- related-record searches (or citation searches);
- systematic browsing of full-text sources arranged according to subject.

The model proposed by Mann separates entirely searching on printed sources from searching on electronic sources, which is peculiar since the boundaries of both media seem to be blurring and thus changing research in the academic context.

Arising from the apprentice-journeyman-master craft tradition, a model of scholarship in this new electronic environment has been proposed by Blandy and Libutti (1995). The model describes four layers of learning required of undergraduates in a electronic environment: the inquiry layer, the library layer, the technology layer, and the scholarly layer. The authors explain that, traditionally, instruction aimed at teaching students to navigate the library layer (bibliographic skills) to reach a scholarly layer. Today, undergraduates need to master the four layers to become truly information-literate.

Apart from these studies, several others have introduced new approaches to user education or concentrated on issues related to library research modelling. Amongst these there are studies on conceptual frameworks for user education; for instance, Ercegovac (1995) proposes the Information Access Instruction, a framework for instruction which includes design principles related to the user, active learning, conceptual model of teaching, and modularity. She later reported a programme for information literacy implemented from the framework (Ercegovac, 1998). Other practical application is suggested by Diamond and McGee (1995), who designed a conceptual framework for bibliographic instruction for business students. Active learning methods have been applied in library instruction by Dabbour (1997) who observed positive results in the use of the method to teach online searching to undergraduates.

Based on cognitive science research and its understanding of conceptual models as external representations of a system, Devlin (1997) proposes the use of a broad conceptual model of information retrieval, including a model of the Internet, to facilitate learning of information skills in a networked environment.

Learning theories for user education have been addressed in such works as McNeer (1991, p.296), who proposes cognitive development theory "for planning successful library interactions with students"; Tuckett and Stoffle (1984) whose paper revised pedagogical models applied to instruction, including the reference-tool approach, the conceptual frameworks approach and the theory-based

approach; and Prorak et al. (1994), who related the achievement of students taught in a small-group method with their learning style. More recently, active learning theories for user education have been suggested (Dewald, 1999).

Finally, a group of related studies concentrated on instructional systems design. Cottam and Dowel (1981) developed an instructional design model for academic libraries which consisted of seven phases. Miller and Bratton (1988) described a five key elements model; the elements are the learners, the learning objective, the subject content, the teaching methods, and the evaluation of learning. Neuman (1991) applied a naturalistic paradigm to evaluate her CAL system which was developed from an instructional systems design perspective. After the evaluation, revisions were incorporated to improve problems highlighted during qualitative analysis of the data collected. Dewald (1999) asserts that "This traditional Instructional Systems Design can be effective for simple, well-structured learning on the Web" (McManus, 1996 apud Dewal, 1999, p.29). She suggests the application of the Hypermedia Design Model, which is based on cognitive theory, to the development of Web-based instruction.

Several models of library research and related studies have been identified and examined within the scope of this thesis. It was found that many of them present a close relation to models of information seeking and searching. The next section deals with the findings of some of these studies.

3.2.2 Related Information Seeking and Searching Models

Studies on academics and their use of information abound in the literature of information science and other disciplines, falling within the scope of "user studies". However, most of them are related to how people use specific systems rather than aspects of their information-seeking behaviour (Wilson, 1994). However, there are a few models and theories of information behaviour which

have been adopted in other studies (Wilson, 1999). These and a few others are revised in the present chapter.

Aspects of information seeking and the models derived are applicable to user education in a direct way since the latter is concerned with appropriate ways of teaching and learning those information seeking skills.

A model of information needs and information-seeking behaviour was proposed by Wilson (1983) in a seminal paper on user studies and information needs. Wilson (1994) refined the original version of the model to include Ellis's (1993) specification of information-seeking patterns. The amended model shows information seeking deriving from a person's physiological, affective and cognitive needs, which, in turn, arise out of the roles of this individual in social life.

Kuhlthau (1993), as mentioned earlier, derived a six stage model of the search process: initiation, selection, exploration, formulation, collection, presentation and the feelings, thoughts, actions and tasks associated with those stages. The formulation of her model was based, initially, on a study of students searching for information for a term paper.

Ellis (1989; 1993) developed a model of the information-seeking behaviour of academic social scientists. The categories he found are: starting, chaining, browsing, differentiating, monitoring and extracting. Later he added the categories verifying and ending, after studying the behaviour of academics in other fields (Ellis et al., 1993). The aim of his study was the derivation of a model for information retrieval system design.

In assessing the information seeking of professionals from a review of the literature, Leckie et al. (1996) proposed a model which describes work roles and associated tasks as prompting information needs. Information needs are characterised by variables such as individual demographics and complexity.

Information seeking is affected by two main factors: sources of information and awareness of information, that is, the actual sources and the way the professional perceives the use of these sources. The results of the seeking process are the outcomes that satisfy or not the originating needs. The authors argue that the model is useful for providing an alternative to models of scholarly communication which are problematic when applied to groups outside the academic environment. Differently from many other models, this one integrates a feedback loop in it that is activated when a need is not satisfied and further information is sought.

Cole (1997) derived a five stage model of the information process of history PhD students which included the following stages: a) opening of information process b) representational (cognitive) activity c) corroborating evidence sought and found d) closing of process e) effect of process: knowledge structure is modified. His model differs significantly from others because his emphasis was on the cognitive activity and how information changes the cognitive structure of those students rather than behaviour in information seeking.

In a study of communication patterns in dentistry, Soto (1992) investigated professionals, academics and students, using a grounded theory approach and the coding paradigm in particular. Amongst other results she found that information-seeking activities could be described as six basic strategies: reading, talking, enquiring, attending/organising continuing education events, watching, and using the library. Strategies could be deployed on their own (simple patterns), with another strategy (combined patterns), or with several others (complex patterns).

User needs in agricultural sciences have been examined by French (1990) who accounted for users' information-seeking habits, information needs and response to library services. Her paper characterised the distinct features of agriculture, for example, that information is "open" and that "governments play a pivotal role in information transfer" (p.417); presented a taxonomy of users: scientists, farmers, extension agents, or any individual involved in agriculture or its products; and described patterns behaviour, such as the importance they place on personal

communication for the transfer of information, the intensive use of grey literature, the habit of following citations and the inability of some users to make use of information systems (user ignorance). The review condensed the literature in the area in a very systematic and thorough way.

Also in a survey on the agriculture domain, Palmer (1991) investigated personality, discipline and organisational structure in relation to the information behaviour of researchers. Statistical analysis revealed five categories of users: non-seekers; lone, wide rangers; unsettled, self-conscious seekers; confident collectors; and hunters.

Westbrook (1993) examined and synthesised several grounded theory studies on user needs. Considering information seeking, she derived a set of interlocking actions, namely, needing, starting, working, deciding and closing. She states: "More than a sequence, model, or process, information seeking might best be described as the interconnection of these activities". (p.546)

Information searching and retrieval have also been modelled by researchers. Ingwersen (1982) derived a model of the information retrieval process of user/librarians in public libraries. The steps he identified are:

1. Information need of user(deriving from a problem situation)
2. The formulated information need of user
3. User-librarian negotiation
4. Developing the search profile - topic analysis
5. Choice of tools
6. Looking up systematically or alphabetically
7. Judgement based on terms of index (terms)
8. Judgement based on descriptions, abstracts, titles
9. Evaluation of the documents themselves(Ingwersen 1982, p.167)

Ingwersen is one of the proponents of a cognitive theory in information retrieval (Ingwersen, 1996). His research is concerned with retrieval in computer systems and approaches the problem from a cognitive perspective.

Saracevic et al. (1988) also proposed a general model of information seeking and retrieval which focuses on users and includes seven events: user needs, question statement and the start of interaction with information system, presearch interaction with an intermediary (human or computer), searching activities, delivery of response to users and evaluation by the user. Each event can present several classes of variables, for example, the "user needs" event has two classes of variables: user characteristics and problem statement.

The studies considered here are just a few of the most relevant in terms of describing the behaviour of humans in their process of seeking and retrieving information.

Understanding students', academics' and librarians' behaviour for modelling information skills as taught and learned in libraries is a very important element of the study of library user education. Even if we agree that the librarian tool-based model is limited to teaching information skills and that the academic model can be extremely sophisticated, still we cannot base the practice of user education only on what the students do or perceive. Since learning is the objective, we must also look into the expertise that, one way or another, academics and librarians developed when searching and using information. After all, they are the experienced and successful users of information.

Since comprehensive models are already available, one could argue that they could be used as basis for the development of a model for user education. However, they were not developed from the perspective employed in this research: some of them did not approach the problem for user education purposes, others looked into the problem from the perspective of the user and not from the expert, others yet were based on theoretical approaches rather than empirical data. In addition, the study here presented was carried out in a Brazilian university and as such should reflect the reality and culture of that environment where no work of this nature has been carried out. Finally, it ought to be useful

to compare the model of information-seeking behaviour presented here to those presented in previous studies.

3.2.3 User Education in Brazil

User education in Brazilian libraries has never been a fertile field of study to judge by the scarcity of literature on the subject. The most intense period for user education studies in academic libraries seems to have been the 1980s, when financial support and professional staff were widely available. In the 1990s the situation has changed substantially.

Academic libraries are under constant pressure to improve the quality of the services they offer to users and to cope with staff reductions and financial constraints. At the same time, the overwhelming explosion of information resources of all sorts, and electronic ones in particular, requires that the human and financial efforts be directed to organising and making available these information sources.

One of the services provided by academic libraries that has not received sufficient attention in the past decade, when the resources seemed to have been drawn towards mastering and applying the new technologies, is user education.

Many of the identified studies of user education in academic libraries in Brazil are based on international literature reviews: for example Araujo (1980), Cunha (1986), Nocetti (1983) (on a review of user education for agriculture), and Ota (1990). Papers of a pragmatic nature have also been identified, for example Costa (1987) and, of particular interest to this thesis, Schreiner (1980), who describes user education as it was implemented in the library system of the Federal University of Rio Grande do Sul.

Schreiner (1980) listed the user education methods being implemented at that time: library printed guide, audiovisual library guide, library orientation tour,

programmed instruction and curriculum integrated courses as well as non-integrated ones. The approach she described was a general one, aimed at the main and branch libraries.

Judging by the literature, it appears that the main concern in the library and information science community is networked and electronic information services, and how to use and apply them from the technical point of view. Education and training of users in these environments have not yet been shown to be widespread, as is already the case in the developed world with such projects as the DEDICATE (Distance Education Information Courses with Access Through nEtworks) (Fjaellbrant and Levy, 1998).

3.2.4 Computers in User Education

Computers have commonly been applied to user education in the form of computer-assisted learning programs (CAL). A number of CAL systems have been built for user education over the years, for example, Creanor & Durndell (1994), Ottaviani (1995), Robertson & Williams (1993), Schoolbred (1990), Son et al. (1993), Wood et al. (1996). Many of them were designed as hypertext or hypermedia systems using the Apple Macintosh HyperCard program or authoring software such as *Guide* or *ToolBook*. Most of these CAL systems were substitutes for the library guided tours and are what the name describes: guides to specific libraries and its resources. Others, however, offer subject-specific instruction and incorporate tutorial characteristics and are intended for non-institution-specific user education.

CAL systems have being applied especially to library user education in academic environments, but they are still primarily aimed at orientating users around the library instead of true user education. Other systems make more extensive use of the technology behind CAL and present students with material usually taught in bibliographic instruction sessions, give examples and prompt with exercises.

However, yet other types of systems integrate AI techniques or expert systems technology (Dabke & Thomas, 1992; Feinman, 1993; Waters, 1986) for knowledgeable interaction with students. ICAI systems focus on integrating knowledge of the subject matter and pedagogical knowledge with an individual model of the student for a closer match of the human instructional process.

More recently, computers have been applied to user education both as an instrument for learning and as information access devices. Particularly in the networked electronic environment, skills are needed that allow the user to search for information independently and efficiently. Several libraries, particularly academic ones, have prepared Web-based guides to the library or to the literature of specific subjects and made them available over the Internet. User education on the Web has been discussed in several papers (for example, Legge and Reid, 1998; Dewald, 1999; Simoneaux et al., 1999) and implemented in many libraries. One example of implementation is available in the site of the University of Houston libraries which makes available a series of tools for library instruction such as a Library Research Guide that teaches how to find information on specific subjects, a Reference Expert that helps to identify information sources to answer a specific question and a Research Strategy Advisor that helps to plan and research information for a paper (WWW011).

Several other examples could be provided as can be seen by inspection of a number of quality sites that function as gateways to such web-based library guides and identify and describe the different sites available. PICK: User education (WWW012) is such site; it lists Library Guides, Library Tours, User Education Programmes, and Networked Learner Support sites. The page of the Library Instruction Round Table of the American Library Association is also a useful resource for identifying web-based library instruction material (WWW013). The Computers in Teaching Initiative Centre for Library and Information Studies (CTILIS), at the Department of Information Science at Loughborough University, provides a Resources Guide that lists computer-based teaching materials (CBT) of

interest to the academic library community (WWW014). The items listed are not exclusively user education or web-based material, on the contrary, many of the materials cited are CBT packages for use in stand-alone microcomputers. The Centre stands as a rare source for that type of information, and is particularly useful for the value it adds in compiling and evaluating that type of material.

Legge and Reid (1998) highlighted both the advantages of and constraints on web-based user education. As advantages, they cite the possibility of creating links to other relevant sources and sites, which is a capability that differentiates this form of instruction from traditional CAL systems. However, like other forms of CAL, the Internet makes instruction available all the time, without an instructor, and allows users to progress at their own pace, with repetition where necessary. In addition, "it provides access decoupled from a particular location" (Legge and Reid, 1998, p.414). The main disadvantages, according to the authors, are related to reliance on computer networks which can bring technical problems, difficulties of access to some, and problems related to personal difficulties with the technology.

The shortcomings of web-based user education, however, clearly tend to be minimised with the advances and adaptations that happen as the medium becomes more "mature". On the other hand, advantages tend to grow with the increased emphasis on distance education in universities.

The approach taken in this study, that is, domain elicitation of user education for the development of a model which could be used to design knowledge-based systems is not dismissed in this new context of the ever more widespread web-based approach to user education. On the contrary, so far most library instruction programmes on the web are based on traditional print versions of instruction. A grounded model designed from a knowledge elicitation approach which can inform the development of programmes oriented to the exploitation of the technology for the benefit of researchers in a domain specific discipline is still highly desirable.

It has been pointed out that, more than user education, what people really need is self-explanatory, friendly systems that make instruction superfluous (Pacey, 1995). Research on the Internet in general, and the web in particular, tries to achieve just that. However, the poor results achieved when searching for information in the Internet due to its diversity of tools, software, and technologies show that true self-explanatory systems, that can eliminate any type of instruction, particularly to novices, are still a long way off.

Chapter 4

Methodology

The aim of this chapter is to present the methodology approach used in the research work, discussing both principles and practice related to the method.

In the first section it presents the rationale for the methodology used. It then considers the changing nature of research in the social sciences, in particular in the library and information sciences, its adoption of qualitative research methods, and the characteristics of such methods, which are similar in nature to the characteristics of the modelling view in knowledge acquisition. That is followed by a detailed account of the elements, techniques and procedures of the particular method for qualitative research used, namely, grounded theory. Those elements, techniques and procedures are discussed in general terms in that section, the description of the way they were applied to this research work is found in the design section of each study.

This chapter also describes the research design for the thesis, specifying each stage of the study, its objectives, subjects, sampling techniques used, and procedures for data collection and data analysis. In section 4.4 examples of the application of the method to the analysis of the data are given. Finally, an overview of the derived model is presented.

4.1 Rationale

The aim of this thesis is to derive a grounded model of the user education domain in an academic library in Brazil using a knowledge elicitation approach. The results are expected to contribute to the understanding of the knowledge and skills that are relevant to the user education domain. This understanding is important both for theory and practice in library and information science; theory benefits from attempts to clarify the epistemological basis of library and information sciences so that they can be really recognised as science, whereas practice benefits from the elicitation of knowledge and skills that constitute the work in library and information science. The elicited knowledge and skills, when formalisation is appropriate, can become part of a knowledge base.

Knowledge elicitation has traditionally been understood as part of the knowledge engineering process of developing knowledge-based systems, and as such it is discussed in Chapter 2. It is described there as the "process of modelling expertise with a view to emulate and extend it" (Gaines, 1993, p.2). However, even if its origins are found in knowledge-based systems development and expert systems development, knowledge elicitation cannot be perceived as a process solely applied to the development of computer systems. For instance, it is possible to envisage the importance of knowledge elicitation in knowledge management programmes in organisations.

It was observed from the beginning of the research that there had been a shift in the conceptual and theoretical understanding of knowledge elicitation in knowledge engineering: from a view of knowledge as something objective and transmitted during elicitation from one medium - human - to another medium - computer, to a view of knowledge elicitation as a constructivist process of building implementation-independent models to represent expertise. This shift is referred to in Chapter 1 and discussed in Chapter 2.

One of the main difficulties in knowledge elicitation is related to the subjective nature of knowledge and information which does not allow for easy generalisations, simplifications and control. This problem affects also many fields of study and research, notably library and information sciences (Wersig, 1993). In these areas, a holistic, constructivist and cognitive paradigm has been evoked to deal with the problems related to the subjectivity of information and human knowledge and qualitative methods suggested for the study of those problems.

Therefore, while there was a shift in the knowledge elicitation understanding, another, of a similar nature, was also happening in the social sciences as a whole, and in library and information science in particular: a shift away from the scientific objectivism as the only way to study and interpret human and social phenomena towards a phenomenological view of those phenomena which are approached through the use of qualitative methods of research (the nature and characteristics of this shift and of qualitative research are discussed in the next section).

The observation of the two similar paradigmatic changes intensified the argument that knowledge elicitation presents characteristics that are similar to characteristics of qualitative research, as previously suggested, for instance, by Johnson et al. (1990), Pidgeon et al. (1991), and Fidel (1993).

A comparison between the characteristics of knowledge elicitation and the characteristics of qualitative research was clearly elaborated by Pidgeon et al. (1991). They observed that the data collected in both tasks are qualitative in nature; that behaviour (which is analysed in qualitative enquires) and expertise (which is studied in knowledge elicitation) are contextual and domain specific; that both tasks are oriented to the human subjects that contribute data; that human and social phenomena and expert knowledge are complex; that tacit knowledge plays a critical role in both tasks; that both emphasise the discovery of theory, or generation of models and that these models are derived inductively from data; that analysis in both tasks is based on interpretation; that the researcher and the

knowledge engineer are research tools, that is, they interpret data using their personal qualities; that the researcher's interpretation has to fit the data collected; and that the outcomes of qualitative enquiry should reflect the social reality of the participants as the outcomes of knowledge elicitation should reflect the experts' understanding of the problem.

Owing to these similarities, to the understanding that knowledge elicitation is a modelling activity and the models created are qualitative in nature, and to the new approach in library and information science research, which claims that qualitative methods can and should be applied to its studies, it was proposed that a qualitative research method from the social sciences, which is widely applied in information and library science, namely grounded theory, should be used for conceptual modelling of the field of user education in academic libraries from a knowledge elicitation perspective.

The area of user education was selected after a preliminary study of subject librarians in academic libraries. That preliminary study aimed at analysing the work of subject librarians and was justified by the fact that the tasks related to their work require specialised knowledge to be carried out, thus implying that they are important sources of human expertise for a knowledge elicitation approach.

The selection of one specific area within subject librarianship was necessary because it was found in this preliminary study that the work of subject librarians can be divided into three main parts: teaching work, inquiry and reference work, and administrative work. Because all of them are broad areas of study, knowledge elicitation would have to be carried out exclusively in one of those areas. The teaching work of subject librarians, that is, user education, was thus selected as the target area for the knowledge elicitation presented here.

User education is an area of subject librarians' activities that has been traditionally taught at university libraries. Nevertheless, it cannot be said that

subject librarians are the only experts in this area; on the contrary, it has been argued (e.g. Stoan, 1984) that academics are the ones who do research and thus are the real experts on information searching and use (see discussion in Chapter 3). Information skills, particularly in the form of information searching and use skills, are traditionally the focus of user education programmes.

Taking the broader view, that argued by Wilson (1991), which identifies cognitive authorities on a field as those who possess knowledge of the literature and/or knowledge of the subject matter and assuming that subject librarians have primarily knowledge of the literature and academics primarily knowledge of the subject matter, thus accepting that information skills development depends on both to be effective, the research set out to investigate the phenomenon from this combined perspective, that is, from the perspective of librarians and academics. Therefore, the information-seeking behaviour of the experts on the "subject matter", that is, the academics, became a matter of concern to this research work.

Finally, to accommodate a third human element that appeared as of great importance for user education, and following the principles of theory construction as supported by grounded theory, the perspective of the students seeking for information was brought into the work.

Thus, a comprehensive representation of the user education domain in an agricultural science library, modelled using a knowledge elicitation approach and grounded theory methods, emerged and is presented in this thesis.

4.2 Qualitative Research

Qualitative methods are being increasingly applied to library and information science research. In 1993, in a review article on the use of qualitative methods in information retrieval research, Fidel (1993) observes that the application is a relatively new phenomenon and one that is "steadily on the rise" (p.219). At the same time, another phenomenon in the study of information, although of a more philosophical nature, has been observed by a number of authors: what has been described as a paradigm shift from a system-centred approach to a user-centred approach (Morris, 1994; Savolainen, 1993; Sugar, 1995), or, from system-centred studies to person-centred studies (Wilson, 1994), or, from a traditional framework to an alternative one (Dervin and Nilan, 1986; Itoga, 1992).

It is not a mere coincidence, however, that principles and methods in library and information science are changing. The social sciences as a whole have been considering their epistemological basis, moving towards a subjectivist approach which is characterised by an emphasis on the individual and on the subjective nature of the social phenomenon. This happens in opposition to the objectivist approach which is positivist in nature and aims to employ in the social sciences the same methods used in the natural sciences (Ellis, 1993).

Budd (1995) identifies three main aspects of positivism in the social sciences which are being criticised today. These are:

- instrumental positivism: instrumental because it limits research to questions that can be answered by current research instruments and positivist because it constrains the social sciences methods to those used in the natural sciences

- excessive quantification of phenomena: statistics is not equal to empirical research because it is not a form of observation - although there is a place for quantification. In a survey method it is only possible to ask questions that were thought in advance, thus eliminating observation of phenomena

- objectivism in excess: human and physical phenomena are distinctive and what sets them apart is the "intention" component of the human phenomena. The complexity of social life cannot be easily reduced.

In library and information science, this shift away from scientific objectivism as the only way to describe and understand the phenomenon under study has its roots in the dissatisfaction with the results achieved through the application of traditional methods and was initiated in the 1980s by people such as Belkin, Dervin and Wilson, as pointed out by Wilson (1994). Usually, those authors and the alternative framework they support are identified with the cognitive approach in information needs and use. However, some of them contest such classification; for instance, Wilson (1994) asserts that his views of information needs and information-seeking behaviour are phenomenological in character, thus social interactions are crucial to him.

In an attempt to clarify matters, Sugar (1995) explains that the cognitive approach is just one of two main approaches to user-centred design in studies of information needs and information retrieval and not the only approach. According to him, the cognitive approach is concerned with modelling the information processing of users whereas the holistic approach - the second of the main approaches - considers also affective and psychomotor aspects in information searching. This classification, however, does not seem totally appropriate, studies such as the one by Ellis (1989) who developed a behavioural model for information retrieval system design, are neither rigorously cognitive nor holistic in nature; nevertheless, they break away from traditional, or system-centred, studies on information seeking.

Itoga (1992) describes the traditional framework in information needs and uses as having the following basic premises (the information needs and uses area is defined as comprising user studies, information-seeking behaviour studies, and information retrieval and information system design studies):

- De-personalization of information: information exists independently of human action or consciousness;

- Sharability of information needs: personal information needs can be objectified and verbalised or observed through scientific methods;

- Objectivity of information provision: information can be delivered objectively and impersonally independent of its context, that is, the relevance of a piece of information can be pre-determined regardless of the context in which the need arises.

The alternative framework challenges these assumptions about information and information provision. Still according to Itoga, this alternative framework suggests a number of new assumptions. Firstly, information does not exist independently of people; it is only when someone is conscious of a physical entity as sign, symbol, letter, data, etc. that it can be termed information. Moreover, information is subjective, it varies from person to person and has different meanings for each person. Finally, information is context-dependent; a person extracts particular meaning from information in a specific context.

Brenda Dervin, an influential theoretician of the alternative approach, contrasts the traditional paradigm with the "sense-making" paradigm (Dervin and Nilan, 1986). In her alternative paradigm information is seen as subjective, situation-specific, holistic and cognitive and the user is not a passive receiver of this information but an active force which is at the centre of the process of change, that is, the process of sense-making (Morris, 1994). The sense-making model presents the information need as arising from a *gap* in the knowledge, which happens at certain space and time, or *situation*, and which is dealt with by *uses* or *helps*.

In this emerging theoretical background there has been an opportunity for less restrictive research methods. The relevance of qualitative methods for

information use studies was brought up by Wilson (1983) when he suggested the use of those methods for studying user needs. The reasons presented were:

> "- our concern is with uncovering the facts of everyday life of the people being investigated;"
>
> "- by uncovering these facts we aim to understand the needs that exist which press the individual towards information-seeking behaviour;"
>
> "- by better understanding of those needs we are able better to understand what meaning information has in the everyday life of the people;"
>
> "- and by all of the foregoing we should have a better understanding of the user and be able to design more effective information systems." (Wilson, 1983, p.11)

Various approaches can be identified as qualitative methods: ethnography, anthropological methods, interpretative research, field research, grounded theory research, naturalistic inquiry, observation, participant-observer method, and case-study method (Fidel, 1993). They share a number of similarities, though Bradley (1993) presents four issues that underlie much qualitative research practice as follows:

The Researcher as Interpreter

The researcher has an active role in qualitative research in the sense that he or she is viewed as the interpreter of the phenomenon. Distancing from the phenomenon is not possible or desirable.

Emergent Nature of Qualitative Research

Structure and strategies that shape the research process should not be rigidly pre-defined at the beginning of the research since understanding is expected to emerge as the research progresses and thus modify those structures and strategies.

Understanding the Experience of Others

Qualitative research aims to understand the experience of others from their point of views.

Trustworthiness in Qualitative Research

Many of the criteria for evaluating quantitative research are not appropriate for judging qualitative research which is based on a set of different assumptions. Still, trustworthiness has to be achieved and criteria for qualitative research are suggested.

Patton (1990) also acknowledges a number of theoretical orientations in qualitative research and emphasises that "qualitative inquiry is not a single thing with a singular subject matter" (p.65). However, he presents a list of themes which qualitative inquiry strategy emphasises and is built on (Table 4.1).

1. Naturalistic inquiry	Studying real-world situations as they unfold naturally; non-manipulative, unobtrusive, and non-controlling; openness to what emerges - lack of predetermined constraints on outcomes
2. Inductive analysis	Immersion in the details and specifics of the data to discover important categories, dimensions, and interrelationships; begin by exploring genuinely open questions rather than testing the theoretically derived (deductive) hypotheses
3. Holistic perspective	The whole phenomenon under study is understood as a complex system that is more that the sum of its parts, focus on complex interdependencies not meaningfully reduced to a few discrete variables and linear, cause-effect relationships
4. Qualitative data	Detailed, thick description; inquiry in depth; direct quotations capturing people's personal perspective and experiences

5. Personal contact and insight	The researcher has direct contact with and gets close to the people, situation, and phenomenon under study; researcher's personal experience and insights are an important part of the inquiry and critical to understanding the phenomenon
6. Dynamic systems	Attention to process; assumes change is constant and ongoing whether the focus is on an individual or an entire culture
7. Unique case orientation	Assumes each case is special and unique; the first level of inquiry is being true to, respecting, and capturing the details of the individual cases being studied; cross-case analysis follows from and depends on the quality of individual case studies
8. Context sensitivity	Places findings in a social, historical, and temporal context; dubious of the possibility or meaningfulness of generalizations across time and space
9. Emphatic neutrality	Complete objectivity is impossible, pure subjectivity undermines credibility; the researcher's passion is understanding the world in all its complexity - not proving something, not advocating, not advancing personal agendas, but understanding; the researcher includes personal experience and emphatic insight as part of the relevant data, while taking a neutral nonjudgemental stance towards whatever content may emerge
10. Design flexibility	Open to adapting inquiry as understanding deepens and/or situations changes, avoids getting locked into rigid designs that eliminate responsiveness; pursues new paths of discovery as they emerge.

Table 4.1: Themes of qualitative inquiry (from Patton, 1990).

The themes represent the characteristics of qualitative research as a whole. Patton observes that different theoretical and philosophical traditions in social sciences influence how qualitative studies are conducted. For instance, the ethnography perspective, which has its roots in anthropology, is concerned with questions of the type: "What is the culture of this group of people?" Whereas phenomenology study, which originated from the discipline of Philosophy, would formulate

question as "What is the structure and essence of experience of this phenomenon for these people?" (p.88).

After these considerations it is possible to describe the research work presented here as adopting the perspective of people-centred studies rather than systems-centred and being concerned with the application of one specific qualitative method, namely grounded theory, for domain modelling.

4.3 Grounded Theory

The qualitative approach known as grounded theory was originally developed by sociologists Barney Glasser and Anselm Strauss in the early 1960's. Their 1967 book, "The Discovery of Grounded Theory" (Glaser and Strauss, 1967), is still a much-cited source. Naturally, the approach has undergone improvements and refinements during the years, culminating with the proposition of a coding paradigm for data analysis (Strauss, 1987). It is this later development in the grounded theory approach, specifically presented in Strauss and Corbin (1990), that is used in this thesis.

Grounded theory is "a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon" (Strauss and Corbin, 1990, p.24) or, as defined more recently, "a general methodology for developing theory that is grounded in data systematically gathered and analysed" (Strauss and Corbin, 1994, p.273). Simultaneously applying stages of data collection and data analysis the researcher creates from a set of unstructured material a theory or model for describing the data. This theory or model comprises the identification and description of a set of categories and their relationships.

Strauss (1987) describes grounded theory as a style of doing qualitative research rather than a specific method or technique. The style aims at the development of theory that is grounded in the data, in other words, that is inductively derived from the phenomenon under study. The induction component is what differentiates grounded theory from other forms of theory construction that are based, for example, on logical deduction from previously held assumptions. Grounded theory is built from data and is conceptually dense, that is, concepts are thoroughly generated and linked.

Grounded theory also differentiates itself from some types of qualitative research which are concerned only with the description of phenomena. Moreover, grounded theory aims at building rather than only testing theory. Theory construction differs from description because it develops concepts through interpretation of data and relates the concepts generated by statements of relationship to form conceptual schemes (Strauss and Corbin, 1990). These conceptual schemes can also be referred to as models.

Grounded theory is built on a number of distinct features. They are discussed separately in the next subsection but in practice there may not be such a clear distinction between their application.

4.3.1 Techniques and procedures of grounded theory

The main techniques and procedures applied in grounded theory inquiries are described here. An account of the procedures and techniques as they apply to data collection and analysis in the present study is given in the section on Research Design (section 4.4).

Theoretical Sampling

Sampling in grounded theory, and in qualitative research as a whole, is not based on statistical principles of randomness; on the contrary, cases which are thought to be appropriate are purposefully chosen. Still, this does not mean that data collection does not conform to criteria or that it is done carelessly. In theoretical sampling "the analyst decides *on analytical grounds* what data to collect next and where to find them" (Strauss, 1987, p.38). What should control data collection are the conceptual requirements of the emerging theory, that is, the researcher starts with a general subject or problem area and as the analysis develops through coding he or she "...decides what data to collect next and where to find them, in order to develop his theory as it emerges". (Glaser and Strauss, 1967, p.45)

Coding

Coding procedures lie at the heart of grounded theory analysis. Strauss and Corbin (1990) explain:

> Coding represents the operations by which data are broken down, conceptualised, and put together in new ways. It is the central process by which theories are built from data. (p.57)

Three types of coding are specified: open coding, axial coding and selective coding. They are not, however, necessarily stages in the coding procedure, all of them may happen in one single coding session without clear boundaries marking the end of one and the beginning of another.

During open coding, data are closely examined, broken down into small units (one single incident, idea, or event) and labelled to create concepts. Concepts are then compared to each other and grouped according to similarities. Groups of concepts that pertain to a similar phenomenon are called categories. During the discovery of categories, their properties and dimensions should also start to emerge. Open coding can be done in a number of ways: line-by-line, by sentence

or paragraph, or in an entire document. Strauss and Corbin (1990) recommend the line-by-line approach at the beginning of data analysis; as the concepts start to emerge, however, and one wants to code around them, the other approaches can be used.

Axial coding focuses on specific categories, one at a time. It is the procedure in which connections are made between one category and its sub-categories. It is when the discovery of the main categories and their relationship with sub-categories and other categories is achieved.

Selective coding is when the final integration of categories to form a theory is completed. It involves the process of selecting the core category, or core categories, and relating them to the other categories. Validating these relationships against data and filling in gaps through refinement of specific, less developed, categories is also part of this stage.

The coding paradigm

A coding paradigm was suggested by Strauss (1987) to help the process of associating categories to sub-categories. It was claimed to be particularly helpful to beginning analysts but central to coding procedures, even if used only implicitly by more experienced minds. At that point, he defined the coding paradigm in terms of conditions, interaction among the actors, strategies and tactics and consequences. By the time the book by Strauss and Corbin (1990) was published, the coding paradigm had clearly been refined and was presented as a means of enabling one "to think systematically about data and to relate them in very complex ways" (p.99). The model was represented as involving:

(A) CAUSAL CONDITIONS ⇨ (B) PHENOMENON ⇨
(C) CONTEXT ⇨ (D) INTERVENING CONDITIONS ⇨
(E) ACTIONS/INTERACTIONS STRATEGIES ⇨
(F) CONSEQUENCES.

Causal conditions "refers to the events or incidents that lead to the occurrence or development of a phenomenon" (p.100). Normally several conditions are expected for every phenomenon.

Phenomenon is the central idea, or the category, to which the coding paradigm is being applied.

Context are the properties of the phenomenon and the location of this phenomenon along a dimensional range which started being specified during open coding. Context also covers "the particular set of conditions within which the action/interaction strategies are taken to manage, handle, carry out, and respond to a specific phenomenon" (p.101).

Intervening conditions are also conditions that affect action/interaction strategies but differently from context they are broad and general and represent concepts such as time, space, culture, history, etc.

Action/Interaction strategies are "devised to manage, handle, carry out, respond to a phenomenon under a specific set of perceived conditions" (p.97).

Consequences are the results of action/interaction over a phenomenon.

The significance of the application of the coding paradigm is not yet clear; many grounded theories have been produced without the help of such a device and its absence does not seem to have devalued the work produced. One drawback, as pointed out by Ellis (1993), could arise if such an organising structure hindered the analyst in the open approach to theory generation. However, as Strauss and Corbin remarked, it is helpful for thinking systematically about data, so it appears to be particularly appropriate for an approach such as the one presented in this thesis.

Comparisons and Questions

Making comparisons and asking questions are two analytical procedures central to grounded theory. They pervade all the coding and sampling activities and involve the continual comparison of events for similarities and differences in the data that will limit categories and uncover dimensions and will break through assumptions. The asking of questions leads to comparisons and formulation of a hypothesis.

Theoretical Saturation

Theoretical saturation refers to the point reached during category analysis in which no new or relevant information seems to emerge for that category. Also, at this point, the category has been thoroughly examined from the paradigm perspective and its connection to other categories has been established. Theoretical saturation in grounded theory is intended to create conceptually dense theory.

Code Notes, Memos and Diagrams

During all the analysis process the researcher is writing down thoughts, ideas and category labels with their respective dimensions and definitions. The written material takes various forms:

Code notes: The code notes are where labels or concepts - even temporary ones - are registered. As concepts gradually become categories during analysis (through comparison and grouping of similar concepts), they too, along with their dimensions and paradigm features, are written down on notes.

Memos: Almost at the same time as code notes, writing of memos starts taking place. These are more theoretical notes and the product of the analytic thinking process the research is engaged on. Typically, they will record ideas about categories, provisional relationships recognised in the data, problems encountered

during the processes, and suggestions for further data collection (theoretical sampling).

Diagrams: Whereas memos and code notes are written records of analysis, diagrams are their graphic counterparts. They represent concepts and their relationships in a visual and compact format.

Presenting the Theory

Code notes, memos and diagrams begin with the research project and continue until the final writing of the theory. The ones produced first are normally very basic but they improve in sophistication and quantity as analysis progresses and by the end of the project represent an "integrated model or set of model for describing the data" (Pidgeon et al., 1991).

4.3.2 Similarities Between Grounded Theory and Knowledge Elicitation

The modelling aspect of knowledge acquisition is very similar in nature to what in grounded theory is described as "building theory". Schreiber et al. (1993) explain the purpose of the model as one which makes the organisation of knowledge in the system explicit and provides an implementation-independent description of the phenomenon. Clancey (1993) adds that "knowledge acquisition is a process of developing qualitative models of systems in the world - physical, social, technological - often for the first time" (p.33). Likewise, in grounded theory the emphasis is on building models, or theory, from data gathered from real-world situations without imposing constraints on outcomes.

Similarities between grounded theory as a qualitative method and knowledge acquisition for knowledge-based systems were highlighted by Pidgeon et al. (1991) in an early work arguing for the use of qualitative methods of research in

knowledge elicitation. The similarities between qualitative research and knowledge elicitation they highlighted are presented in the first part of this chapter.

Particularly in terms of grounded theory there are a number of procedures in it that stress the appropriateness of using the method in knowledge acquisition. The coding paradigm, as explained earlier, define categories in terms of conditions, context, action/interaction strategies and consequences. It can be seen that specifying those parameters for a category can clearly lead to the creation of production rules. Strauss and Corbin (1990) explain that after having elaborated categories in those terms, the analyst is ready to make statements of relationship and validate them with data. These statements are explicit IF...THEN rules as can be seen by the example of a study on pregnant women given by the authors:

> **Under conditions** that a woman perceives her pregnancy to be of lower risk and on course, and if she is highly motivated to have a healthy baby, then she will use a form of joint management that can be described as Adjunctive Management. **If** adjunctive management is successful, and the risks are contained, **then** the women will deliver healthy babies. (Strauss and Corbin, 1990, p.139; original emphasis)

It is not being argued here that the domain model should be presented in the format of production rules, that is, a representation structure for computational purposes. On the contrary, as has been said before, domain modelling during knowledge elicitation is conceptualisation of the domain and aims to describe the domain structure in a implementation-independent format. However, as production rules have traditionally been used to represent knowledge in knowledge-based systems and the similarities between them and possible outcomes from grounded theory application are noticeable, the appropriateness of the use of the method in knowledge acquisition is accentuated.

Another example of similarities between the outcomes of the application of the coding paradigm and knowledge acquisition is present in KADS (Wielinga et al., 1993). There, domain knowledge is described in terms of the "primitives":

concepts, properties, relationship between concepts, relationship between property expressions and structure. Domain knowledge, the authors explain, "can be viewed as a declarative theory of the domain" (Wielinga et al., 1993, p.24), that is, as static knowledge. Adding to it the notion of process as embodied in the combination of conditions, action/interaction strategies and conclusion, inferential knowledge should also be represented.

Finally, another benefit in grounded theory for knowledge acquisition is the amount of documentation that is produced during analysis in the form of memos, code notes and diagrams. This documentation gives the opportunity to keep track of the progress of analysis and provides history and context for every concept and relationship elaborated.

4.4 Research Design

According to the qualitative tradition, the research started from a broad aim, more specific objectives were determined as the work progressed and the picture of the domain became clearer. The broad aim which started the work was that of studying a subset of subject librarians' job and modelling it for possible application in knowledge-based systems. The actual implementation of a system was not a concern in the present study. Rather, the concern was with conceptually modelling the domain through knowledge elicitation from experts and then, if appropriate, attempting to derive recommendations for implementation.

Because of the characteristics of the research, an inductive, naturalistic and qualitative approach which permitted theory to be built from data was adopted. The methodology adopted was grounded theory, as described previously.

The research was designed so that each key stage determined the context of the next one, as supported by grounded theory principle of theory construction. The

first stage of the research work was interviews with four subject librarians about their jobs and expertise, which has been labelled Study One. The study had an exploratory character and was intended to open up the subject for further investigations.

After analysis of those interviews, user education was chosen as an appropriate subset of subject librarians' activities for the knowledge elicitation. However, user education is perceived as an activity that involves librarians and academics from a specialised field of knowledge, as demonstrated in the section "Rationale", of this chapter. At the same time, it became clear that, differently from the first study, it would be necessary from there on to concentrate on studying user education within one discipline. Consequently, a decision was made to study librarians and faculty in one academic field of a Brazilian university to identify their domain-related concepts and relationships. This exercise was named Study Two.

Results of these studies were analysed using the grounded theory method to derive a model for describing the data. However, as the modelling process progressed it was realised that one side, or one human component, in information skills development was missing: the students. So, a new field study was designed to incorporate that. This final stage of the research work was Study Three.

Research instruments used on each of the three studies are presented below. First, however, some considerations about the choice of research method for the main part of the research, that is, Studies 2 and 3, have to be made.

A qualitative and naturalistic approach to the research subject implies collecting data in the natural setting, as they evolve and without manipulation of the conditions in which the activities occur. Two methods were appropriate for collecting data: observation and interviewing. Interviewing as the main method was preferred because it would be difficult to determine in advance all the activities where user education was present, thus making observation impractical.

At the same time, expertise in the area is not necessarily explicit and is more likely to be found underlying information-seeking activities rather than be in meta-knowledge format. For this reason, the interviews aimed at understanding those information-seeking activities and the processes involved. That accords with Ellis (1989) who found that interviews were more appropriate to obtain detailed accounts of people's information-seeking activities, which are likely to be too diffuse for observation.

Observation was not completely ruled out, however. Some opportunities for observing user education sessions occurred during field study and were exploited. Observation notes, along with written material collected in these sessions, supplemented the main data collection method.

4.4.1 Study One

The feasibility study on the application of knowledge elicitation methods to the knowledge and skills of subject librarians in academic libraries started with a small scale study of subject librarians' activities in British universities.

4.4.1.1 Objectives

The objectives of this exploratory study were to identify the main topics in the subject librarianship domain, from the point of view of subject librarians, to assess possible areas of modelling. Also, as the study had an exploratory character, it represented an opportunity for practising interviewing and analysis skills before they were applied to the main data collection.

The intention was to reveal information on:

- the roles and functions of the expert;
- the nature of their knowledge;

- the relationship with the users;
- a possible area for modelling;
- problems or special requirements in any particular case.

4.4.1.2 Subjects

Four interviews were conducted with subject librarians from three different universities whose subject responsibilities ranged from Arts and Humanities to Science and Engineering. The subjects were two members of Sheffield University library, a member of Sheffield Hallam University library, and a member of the University of York.

4.4.1.3 Procedures for Data Collection

The choice of subjects was based on accessibility and subjects' willingness to participate and there were no specifications on subject knowledge. Librarians were contacted over the phone for an interview; all four of them agreed to participate when contacted. The interviews were carried out between June and December 1993. At the beginning of the interview the research project was explained to them and their permission for tape-recording was solicited. A semi-structured and flexible interview schedule with open questions was used for data collection (Appendix I). Interviews lasted from 40 minutes to one hour each. Soon after each interview the tapes were transcribed in full and any additional relevant information which had not been recorded was added.

4.4.1.4 Analysis

Analysis was carried out following the main grounded theory guidelines, although at this point the analysis did not aim at building theory from this specific phenomenon. The analysis had the purpose of opening up the subject for future

questioning and identifying main themes in the data. Results of Study One are reported in Chapter 5.

4.4.2 Study Two

Based on the results of Study One, the area of user education was chosen as an appropriate sub-set of subject librarians activities for the knowledge elicitation approach. Apart from subject librarians, the study involved also academics who are experts in information seeking and use in their subject areas, and consequently, should represent an important source of knowledge for information skills development. At the same time the study concentrated on one specific discipline, agricultural sciences and was carried out in Brazil. The options of area and field were based on the necessity of academic research in Brazil and also the interest of the researcher and of the institutions involved.

4.4.2.1 Objectives

The purpose of the study was to investigate the domain of user education from the perspective of subject librarians and academics from a Faculty of Agronomy ("Faculdade de Agronomia" of the "Universidade Federal do Rio Grande do Sul" in Brazil, in order to identify elements, characteristics, factors and processes involved. The perspective was that of the subject librarian when educating students and of the academics when seeking information and advising students on information searching and use. Specifically in relation to academics, the objective was to reveal data on their:

- personal information including educational background, work characteristics, and areas of interest in teaching and research;
- information-seeking behaviour and knowledge employed;

- perceptions in relation user education, the environment where it takes place, and students' information skills.

Regarding librarians, data collection and analysis focused on:

- personal data;
- perceptions on students and academics' use of information and the environment where it takes place;
- roles and activities;
- user education.

4.4.2.2 Subjects

Subjects in this second study were seven subject librarians and thirty-four academics from the Faculty of Agronomy in the Universidade Federal do Rio Grande do Sul (UFRGS) in Brazil, representing a total of forty-one interviewees. Subjects for the study were chosen based on sampling principles from qualitative studies: theoretical sampling (Strauss and Corbin, 1990) and maximum variation sampling (Patton, 1990).

Theoretical sampling was applied as defined in the section about grounded theory procedures and techniques. The choice of the two groups to interview was based on the perceived theoretical requirements of the study. After Study One, it was decided that user education would be the area to concentrate on. Since the experts in the area of user education were seen as being both librarians and academics and user education in academic libraries was seen as happening in a subject context, a decision was made to interview librarians and academics of an agricultural science library in Brazil (the reasons for choosing agricultural sciences and Brazil have already been given in Chapter 1).

Maximum variation sampling is a strategy for purposeful sampling that aims at identifying a sample that cuts across a great variation of subjects and experiences. In this study, variation was achieved by interviewing all subject librarians involved and academics from all the departments of the Faculty and from a variety of subjects and backgrounds. The four librarians working in the library of the Faculty of Agronomy were interviewed, plus the head librarian of the university system and two other librarians from the same university who were widely involved with user education. Teaching staff from the six departments within the Faculty - Soil, Zootechnics, Horticulture and Silviculture, Agrometeorology, Crop Production, and Phytopathology - were contacted for interviews. Each department contributed five to seven subjects, depending on the size of the department and availability.

UFRGS is a federal university located in southern Brazil, in the Rio Grande do Sul state. It is the largest university in the region and one of the top ten in Brazil. The Faculty of Agronomy is one of its twenty-two units and is constituted of six departments. In 1994, when the field work took place from June throughout December, the Faculty offered one graduation course and four Master's programs and three doctorate. The teaching staff was composed of 81 faculties and there were 357 undergraduate students, 126 Master's students and 69 doctoral students.

The Faculty library is administratively subordinated to the Dean of the Faculty but at the technical level follows the instructions emanating from the "UFRGS library system" which is the co-ordination element of all branch libraries of the University. UFRGS library system has its own staff who are also responsible for the running of the central library and is co-ordinated by a librarian who reports directly to one of the Pro-Chancellors. Several task groups on different aspects of library work whose members are subject librarians meet regularly to discuss and suggest lines of action which are presented to the system co-ordination. Although librarians are not appointed explicitly as subject librarians, they work in specific fields of knowledge and, consequently, do subject related work.

4.4.2.3 Procedures for Data Collection

The activities in Brazil started with a meeting with the head librarian and the three other librarians of the Faculty of Agronomy. In this meeting the research work was described and their collaboration was requested; they also had the opportunity to clarify details and suggest forms of action. They demonstrated great interest in the research and the head librarian granted full support to the project. The researcher was assigned a place at one library office and was introduced to members of the administrative and teaching staff including the Dean and Vice-Dean of the Faculty and co-ordinators of the post-graduate programmes.

Interviews with Academics

The names and corresponding departments of all eighty-one members of the teaching staff were obtained from a list provided by the Faculty. From that list five to eight names from each department were randomly chosen for interviews, adding up to thirty-seven people, who represented more than a third of the total number of academics. That number was not yet definite; however, qualitative studies of information seeking and use have used small samples and there were no reasons to believe that in this case it needed to be different. In addition, there also were no reasons to believe that the experience of the subjects chosen for the interviews would drastically differ from those not selected since variation sampling was achieved by selecting a proportion of academics from each department. If after the interviews more interviewing seemed necessary, then the study would adapt accordingly.

A letter requesting the interview and briefly explaining the research, accompanied by a presentation letter from the Faculty head librarian was sent to those academics. The interviews were arranged by telephone or personal contact and were distributed over a five-week period. The subjects started being interviewed on the basis of willingness to participate and availability. A total of 34 interviews with teaching staff of that Faculty were actually carried out.

A semi-structured, in-depth interview guide with chiefly open-ended questions was used (Appendix II). The interviews would start with general questions and, depending on the replies, the interviewer would prompt with more specific questions or bring the conversation back to the main points. The interview guide approach, as presented by Patton (1990), was used. According to him "An interview guide is a list of questions or issues that are to be explored in the course of the interview" (p.283). The interview guide should guarantee that the focus of the interview is maintained, giving the interviewer flexibility to word questions spontaneously.

The interview guide took themes from other studies. For example, the section related to information search and use benefited from works developed on information needs and use such as Ellis (1987) and Soto (1992).

The interviews were tape-recorded with the consent of the interviewees. The interviews normally took place at the subject's office, apart from six of them which took place in a reserved room in the library. Interviews lasted for about an hour, with a minimum of 40 minutes and a maximum of one hour and a half. For practical reasons, interviews were not transcribed immediately after they took place, but the notes taken during interviews and soon after their conclusion helped to focus on important topics and to improve the interview guide where needed; for example, the order in which issues were raised during interviews was changed to become more natural and probing questions were noted down

Interviews with Librarians

In addition to the meeting with the four librarians of the Faculty of Agronomy, individual interviews with each one of them were carried out. Interviews with three other librarians of the University were also sought for specific reasons: an interview with the co-ordinator of the UFRGS library system was considered vital to understand user education in the context of the university as a whole; another with the librarian responsible for user education in the Central Library was

thought to be necessary to give insight into the practical side of the activity in the system; and, finally, one with the librarian who is the co-ordinator of the task group in user education was also highly desirable for her views on the subject. As a result of these decisions a total of seven librarians were interviewed. The interview guide used is presented in Appendix III.

The interviews with librarians were similar in structure to the ones with academics. They were carried out in private, tape recorded and transcribed after the field work period. The interviews lasted slightly longer than with faculty, from one hour to one hour and 45 minutes.

Alternative Data Collection

The actual process of instructing in the use of the information sources for a specific discipline was observed when a group of undergraduate students were brought to the library by the faculty responsible for the discipline. The instruction was delivered by one of the librarians and involved the demonstration of, and practice in, the use of indexes, abstracts and a CD-ROM database. It should be pointed out that the students were already familiar with the basic structure of the library. The session lasted one hour and was fully observed by the researcher.

Printed material was also collected and included leaflets about the university, the courses offered by the Faculty, the library and course notes used during user education situations.

Access to alternative media utilised in user education sessions was granted. These included two videos produced by the institution and a tape recorded self-instruction. One of the videos presented general information on the university library system and the other provided instruction in information sources in the biological sciences. The tape recording introduced the Citation Index. Access to, and observation of, the library facilities, activities and materials (CD-ROM, catalogue, abstracts and indexes, etc.) were also granted.

4.4.2.4 Analysis

It was intended that the tape recordings of the interviews would be transcribed soon after they had taken place so that findings could be used to guide subsequent data collection, allowing for focusing on the more important aspects of the phenomenon. However, owing to the nature of the second data collection process, which took place in Brazil during a two-month period, and the amount of information recorded it was not possible. Rough written notes taken during the interviews helped to improve the interview guide as the process of interviewing went along and also helped the research to focus on the most interesting points which were emerging. The contents of the interviews were transcribed in full at the end of the fieldwork period, back in Sheffield. The transcription amounted to 418 single-spaced pages.

Analysis started with the interview transcripts of academics. Each transcript was analysed separately from the others in a case analysis fashion. Analysis started with open coding which was based on looking at the smallest significant bits of information from each paragraph of every interview. Labels assigned to those bits of information were written down in cards specially designed in an Idealist database (Idealist is a text retrieval software) together with the text occurrence pasted from the interview transcript. Each sentence or paragraph received one or more labels to describe meaningful pieces of data, unless no meaningful data could be identified in that segment of text. Examples of data which were not considered meaningful were tangential comments about academic life in general or, for example, specific details of their research work.

At the end of the analysis of the first interview more than a hundred labels, or concepts, had been produced but many of them represented only factual, or demographic, data about, for example, the frequency of use of different types of information sources. Thus, another Idealist database was created for recording factual information obtained from interviews and printed material which were not appropriately described as concepts. Fields in this database were used to store

information about each academic, their departments, the number of publications they had, journals titles cited, whether or not they used specific information sources, etc.

Strauss and Corbin (1990) point out that beginning researchers may end up with too many labels at this point of analysis. As this actually happened here, analytical procedures and results were assessed and revised to ensure the concepts represented the nature of the segment of text and did not simply repeat the content of it. Asking questions proved extremely relevant to avoid labels which simply summarised data and were not of a conceptual nature. For example, questions such as: What incident is described in this bit of data? and Is this a relevant piece of information? helped to keep open coding focused. The number of concepts diminished significantly for the first three interviews.

The first Idealist database was revised and helped to organise concepts that emerged during analysis and keep track of the process of analysis. Records in the databases were called cards and contained fields for adding card number (Card), concept labels (Concept), text from the transcripts that relates to that concept with identification of interview number and paragraph (Reference), connection to other concepts (Links) and concept description/ definition (Definition). Records style was adapted from the paper cards suggested by Pidgeon et al. (1991). The printed version of the interview transcripts was used for marking concepts next to the incidents they described.

Subsequently, the concepts were compared and similar ones grouped under a broader label, that is, a category. Categories thus represented groups of concepts at a higher, or more abstract, level. Comparison and questions were extensively used before any category was created or any concept was incorporated into an existing category. Questions were of the type: Are these two concepts similar or different? In what ways are they similar or different? What more general label can be used to describe both concepts? Is it possible to accommodate this concept inside this category?

An example of the type of analysis procedure at this stage in open coding is given when considering the follows data labels arrived at: "practice-oriented nature of agricultural sciences", "applied nature of agricultural sciences", "regional characteristics impacting agriculture information", "role of international literature in agricultural science", "multidisciplinary approach", "countryside as a work place", "Faculties of Agronomy as places for transforming basic knowledge into applied knowledge". These labels were compared and they all seemed to pertain to the same category, one which represented the characteristics of the agricultural sciences. Thus, the category "discipline specificity" was created . Later, when a new category for describing concepts related to the institutional structure was created through similar process of coding and comparison, the concepts for "discipline specificity" were again compared among themselves and with others. The process resulted in the data concept "Faculties of Agronomy as places for transforming basic knowledge into applied knowledge" being moved to the new category "institutional structure". The particular concepts mentioned above have since been seen as properties, or characteristics, of the two categories as applied to the agricultural sciences.

It is impossible to clearly differentiate when each of the three types of grounded theory coding is actually being employed for they do not happen in a strict, consecutive fashion. However, there is a point when categories are compared among themselves and analysed for higher-order categories, thus originating a category and its sub-categories. That is called axial coding and can be observed in the example above where the categories "discipline specificity", "institutional structure", and "social-economic-cultural environment" were grouped to create a higher-level category labelled "domain context". The lower-level categories were from then on called sub-categories. Third level concepts were also identified for some sub-categories.

Actual selective coding started when all the interviews with academics, librarians, and students had been analysed individually and as part of their group. It only

ended when the core category was selected and the other categories and sub-categories were related to it through the use of the coding paradigm.

The relationship between the core category, other main categories and sub-categories emerged when they where integrated with the help of the coding paradigm during selective coding. Those relationships were written down in memos or graphically. The existing categories did not always fit neatly the elements of the coding paradigm, namely, causal conditions, context, intervening conditions, actions/interactions strategies and consequences. For example, causal conditions were purposefully identified only after the coding paradigm was employed to integrate the theory. At that point it was realised that categories that corresponded to causal conditions had not been identified, so it was necessary to return to the raw data in order to identify the causes and consequences of the phenomenon under study. The categories "information needs" and "outcomes" were thus described.

Analysis was carried out in Portuguese, but instead of labelling the phenomena using words in Portuguese, it was decided to simultaneously discover concepts and categories from the data and translate them into English language in order to avoid misinterpretations that might be caused by a later translation of such concepts and categories. Results of Study Two are presented in Chapter 6.

4.4.3 Study Three

After Studies One and Two, it became clear that a picture of the library user education domain would not be complete without looking into the third human element in it: students. Study Three was designed to complete the picture.

4.4.3.1 Objectives

The purpose of Study Three was to develop a set of grounded concepts about the nature of students' search for and use of information and the relationship between these concepts and the ones identified in the previous study to form a full picture of the information skills development. Collection of data concentrated on eliciting students' perceptions, behaviour and opinions.

4.4.3.2 Subjects

The sampling for the present study followed the principles of the previous studies: theoretical sampling and maximum variation sampling.

After analysis of data in Study Two, it became clear that to complement the picture of the emerging theory it was essential that students should be incorporated into the research work (theoretical sampling). The choice of the groups of students to interview was influenced by the characteristics of the Faculty of Agronomy which had three types of students enrolled in its programmes: undergraduate, Master's and doctoral students.

From the interviews with academics and librarians it became clear that undergraduates used the library less frequently and often solely for the purpose of borrowing books; for that reason it was realised that post-graduate students would represent richer cases for study. Nevertheless, adopting maximum variation sampling meant it was also necessary to understand the purpose and use of the library made by all three types of students. Therefore, a decision was made to

interview all three types of students but with a larger number of post-graduate than undergraduate students. It was also decided that the number of Master's students should be approximately double that of doctoral students, for that is roughly the way they are distributed (126 Master's and 69 doctoral students) and that the number of undergraduates should be smaller than the number of post-graduates even though their group was larger (357 undergraduates) for they would not represent rich cases for study. Finally, it was believed that the specific programme on which post-graduate students were enrolled, for example, Horticulture or Crop Production, would not particularly impact on the way those same students sought and used information so no effort was made to select students from the different programmes. Thus, the assessment and the previous studies suggested that about twenty students should be interviewed and so distributed: eight undergraduates, eight Master's students and four doctoral students.

The researcher was purposefully looking for students who would contribute rich cases of information seeking and library use, therefore the library was an appropriate place to locate these cases. Thus, Master's and undergraduate students were approached as they came into the library to look for and use information. This type of procedure is supported by principles of theoretical sampling, as suggested by Glaser and Strauss (1967).

Students were approached without the researcher knowing if they were undergraduate or post-graduate students. Therefore, the first step was to ask the student approached about his/her status and then explain briefly the work being carried out and request his/her collaboration. This procedure was repeated until eight undergraduate students and eight Master's students were approached successfully. Sixteen out of a total of nineteen undergraduate and Master's students approached were actually interviewed. All four of the doctoral students approached were interviewed.

Along the interviews it became cleat that the number and types of students selected had been appropriate to the representation of diversity and, at the same time, consistency in the data, for the experiences reported seemed to repeat across types of students and became "saturated".

4.4.3.3 Procedures

Semi-structured, in-depth interviews were carried out with undergraduate and postgraduate students from the Faculty. Undergraduate and Master's students were interviewed in the library because there were no special rooms in the building for the use of those two types of students. Doctoral students, being a smaller group and having a special room in the Faculty, were interviewed in their offices or laboratories.

A total of twenty interviews with students were carried out which lasted from 25 to 45 minutes each, the average being 35 minutes. Interviews were tape recorded and took place over a period of ten days during March and April 1996.

The interview schedule (Appendix IV) for students contained mainly open-ended questions and was divided into three parts:

- Identification. To identify the student's course, age group, period at the University and academic background;
- Information behaviour. To specify when, why and where the student looks for information related to discipline, how he or she does it and the use he or she makes of information sources;
- User education. To identify situations when the student received library research training and the perceptions the student has about them.

Similarly to Study Two, simple notes were taken during interviews to reveal themes and to guide subsequent interviews due to the impossibility of transcribing them during field work.

In addition to the interviews with students, an introductory session given by the library to first year students was observed. Also, the answers to the questionnaire prepared by the library and used with the students who attended the session were collected.

4.4.3.4 Analysis

Similarly to Study Two, interviews were transcribed only after the field work took place. This time, however, a different approach was chosen: instead of transcribing the interviews in full, only the relevant parts were written down. This decision was made after the previous experience, where transcription was word-by-word, which proved to be very time consuming both for transcription and analysis, and deemed unnecessary at the point in the research when the researcher had already developed skills from the two previous studies at identifying the relevant pieces of information. To ensure that no important aspect was being missed, however, the tapes were repeatedly listened to by the researcher.

Data analysis proceeded in a similar way to Study Two. Idealist software was again used for helping to structure concepts. At this time, however, coding was not initiated from scratch but was guided by the concepts and categories discovered in Study Two. That is, coding was purposefully done in order to discover instances of domain context, information-seeking tasks, knowledge sources, and mediation strategies. Using the analytical procedure of making comparisons academics' experiences were systematically compared and contrasted to students' experiences. That did not mean, however, that the inductive component of grounded theory was dismissed: data that did not fit into those

categories were purposefully looked for to allow new concepts to emerge. Nevertheless, no instances of new concepts were identified in Study Two. On the other hand, concepts derived during analysis of data in Study One that were not applicable to data in Study Two were clearly identified and, thus, not included in the students' model. For example, the "surrogating" concept from the "tracing task" category, which was evident in academics' data, did not have a corresponding concept in students' data.

Studying the phenomenon from the perspective of the students led to the elaboration and clarification of the emerging model and allowed the making of comparisons between information seeking of experts and novices. Instances of data and how they fit the categories derived are given in the chapters that show the results of the main studies. They are in the form of citation to specific interviews.

4.5 The Proposed Model

The model derived from the analysis and integration of the results of Study One and Two is introduced here as a means of providing an overview of the conceptual scheme which forms the basis for the presentation of results in the subsequent chapters. The model represents the phenomenon studied and is depicted in terms of a core category, a set of related categories and subcategories, and the relationship between them. It shows how library research and user education correlate in the academic environment studied. A major theoretical statement of the model thus proposed is as follows:

The library research process of an individual (student/lecturer) happens in an organisation, discipline specific context, influenced by the world at large. This context creates the conditions (roles and associated information needs) necessary

to initiate the process. The process takes place through information-seeking tasks and task-related strategies (tracing, selecting, locating, obtaining and using),which are used to both search information sources (public and private external knowledge-sources) and satisfy an information need. During this interaction, the cognitive states of the user (internal knowledge sources of the types: domain subject knowledge, domain literature knowledge, system concept-function-content knowledge, system procedural knowledge, topic searched knowledge, and general scholarly skills) are used and modified according to the tasks and strategies being carried out. Occasionally these internal knowledge sources are insufficiently developed for effective searching of external knowledge sources. In such cases, education (mediation strategies of the types directing, expanding, elaborating and exploring) provided by an expert (librarian/academic) can improve the process by helping individuals in the selection and use of tasks and strategies, thus altering the state of related internal knowledge sources and affecting subsequent information-seeking tasks and strategies (learning library research skills).

This statement can be depicted as in Figure 4.1 which summarises the main components of the model and their relationships.

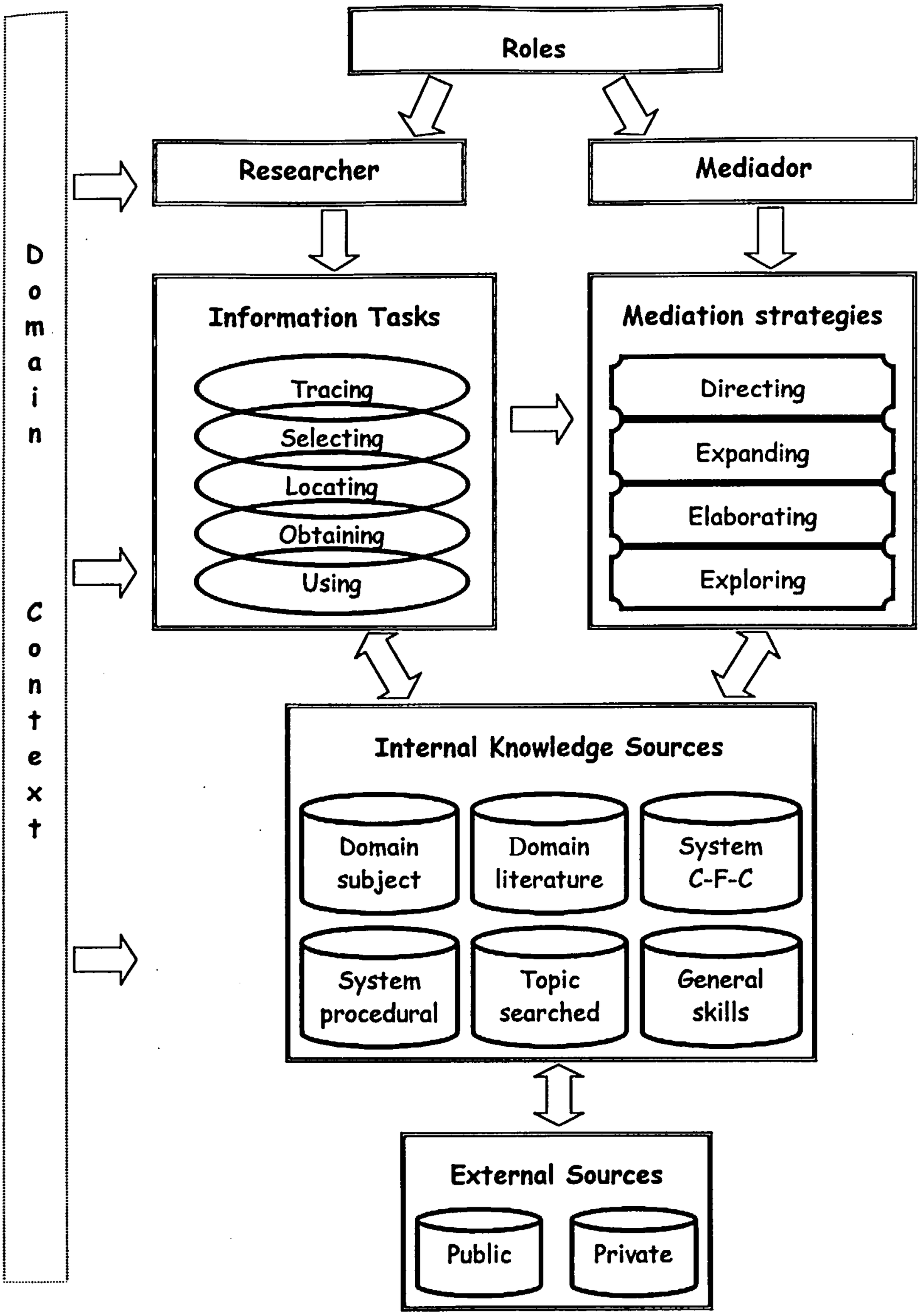

Figure 4.1: The model of user education and library research.

A full description of the model, definition of its categories and sub-categories, and the nature of their relationship are given in Chapter 8, along with a discussion of it.

Chapter 5

Subject Librarians Expertise: Results of Study One

An exploratory study on subject librarians' expertise was carried out to identify a potential area for modelling from the perspective of knowledge elicitation methods. The study was qualitative in nature and involved interviews with subject librarians from British Universities.

The specific objectives of the study were to describe the main topics in the subject librarianship domain from subject librarians' perspective and identify areas where grounded theory modelling could be applied.

The aim of the qualitative analysis of the data was not to build a grounded theory but instead to identify main themes in the data to opening up the area for future studies. Qualitative analysis was also an opportunity to develop the skills necessary to apply the methods from grounded theory. The coding paradigm suggested by Strauss and Corbin (1990) was not applied at this point, however.

The aim of the present chapter is to show and discuss the findings of this preliminary study.

5.1 Experts' Roles and Tasks

The role of a subject librarian in an academic library context is given by Holbrook (1972):

> A subject specialist is a member of the library staff appointed to organise library services in a particular subject field. This subject field may be fairly narrow, or, more typically, be broad enough to cover an umbrella of related disciplines contained in a faculty/school/department structure (quoted by Hay, 1990)

This definition is still considered appropriate despite all the changes the have affected the profession over the years, but the general characteristics of "to organise library services" needed to be spelt out.

Data from interviews suggested that there were three main areas of professional activity associated with subject librarians:

- inquiry and reference work;
- teaching the use of information resources;
- administration area (including collection management and liaison with teaching departments).

In the past decades there has been an increasing application of information technology in libraries, and this, as would be expected, affected the role of the subject librarian. Bundy (1984), in a comparative study of the role of subject librarians in British Polytechnics and Australian Institutes of Technology, foresaw a change, or development, in the role of subject librarians due to financial constraints in academic libraries and increasing levels of automation. At that time it was expected that the performance of online searches by subject librarians would change the work of these professionals. However, some years later the situation had changed even more dramatically than expected: carrying out online

searches for clients was a comparatively small task in the job of subject librarians interviewed.

There had been a shift in libraries from doing the searches for the users to teaching them to do it, a fact mainly possible because of the widespread introduction of databases available in CD-ROM and/or online. In the cases studied, the users were doing their own searches and the role that was supposed to emerge had already been superseded. Furthermore, this shift meant that the teaching side of the subject librarian's work was being widening. All four interviewees mentioned this happening.

In addition, as Bundy foresaw, financial constraints in the universities changed the work of those professionals as more planning efforts and management of the resources allocation had to be put forward. This was also confirmed in the data collected.

The duties a subject librarian carried out varied according to the policy of the institution and, to a much smaller degree, according to the personal interest of the professional librarian. The differences found in interviewees data are shown below.

The duties of Interviewee 1 ranged from dealing with informal and unstructured inquiries and participating in committee work to giving lectures/seminars on information skills. He also dealt with departments over collection development matters - such as resources allocation and priorities - and ordered book and journals. Finally, he dealt with official publications, provided consultancy for the library and prepared research papers for the library information co-operation committee.

Interviewee 2 spent most of her time on administration, "a very wide definition of administration" which included managing systems for allocation of resources

and financial control. Liaison with departments and teaching activities, such as giving instruction and preparing handouts was also highly valued.

Interviewee 3 was responsible for managing his team, whose work included cataloguing and classification of material, ordering of material and inquiry work, amongst others. He also controlled the budget for the subjects under his responsibility and was responsible for organising the information desk, a project advice and user education. The emphasis being placed on enquiry work.

These three interviewees were responsible for collection development in their subjects but that was not an activity to which they were able to dedicate much of their time. Basically, it was based upon the department's and lecturers' suggestions. The main reason apparently being the financial constrains that did not allow for diversification in buying.

Interviewee 4 main responsibilities were liaison with academic departments and collection management. User education was also stressed, although it was mainly done on demand from teaching staff. However, teaching staff, according to the interviewee's account, resented giving much of their classes' time to the library, thus user education did not take much of the librarian's job. Collection development seemed to require more effort and time than the other subject librarians interviewed.

> In music I do most of it on my own, I have done it for many years. In that, I go through all the journals; follow books, abstracts, catalogues and so on; prepare a list of the works which I then consider with the departmental library representative which I find a better way of proceeding.

It became clear from the data analysed that the job of the subject librarians was divided into the three main areas already mentioned, with no identifiable overall function. Duties seemed to encompass aspects of planning and managing, instruction and problem solving.

5.2 The Knowledge

The four subject librarians interviewed were not specialists in all the subjects they were responsible for, at least not in terms of their formal education. Interviewee 1 had a first degree in one of his subjects. Interviewee 2 had a Ph.D. in Sciences, which is her subject area, but she acknowledged the difficulties that could arise from having to deal with a variety of scientific disciplines for which she had no specialisation. However, she thought background knowledge was an important component of the job because it made her think in the same way scientists do. The subjects for which interviewee 3 was responsible were completely different from his background. Although he thought it would be useful to have a background on his subject areas, the fact that he did not have was not an obstacle. Interviewee 4 had a first degree on one of his subjects and a Ph.D. on the combination of the two subjects – history and music.

From the various realities in terms of background knowledge reported, it seemed to be valid to infer that these subject librarians' expertise did not come directly from their subject knowledge, although it appeared to be an important addition. In fact, expertise seemed to be a combination of subject knowledge and knowledge of information sources and the way to exploit these sources.

An important point about subject librarians' expertise was stressed by the professionals interviewed: experience. They all agreed that learning by experience was a crucial factor in the development of their knowledge. "Every day I'm here I learn something new" (Interviewee 2). In addition, and to some extend related to this, was the fact that he believed a good memory also played an important role. But, undoubtedly, experience was pointed out as a key factor.

Another important aspect of the expertise seemed to be related to developing good personal skills in dealing with the users during inquiries and teaching. One of the interviewees said that the expertise came from experience, but it was

necessary "to have a gift for it" (Interviewee 3) as well. This "gift", which is a characteristic of an individual's personality, seemed to be very important in the work, particularly inquiry work, as stated by another interviewee:

> ...inquiry work is not something that can be taught anyway. You can't teach somebody how to be a good reference librarian. You can only teach them techniques and methods and hope that they will understand what they are doing and be able to devise their own approach to, for instance, listening. You can't teach someone to listen, which is an important element in inquiries. You can't teach someone to question successfully, you can teach the principles of what they are trying to do. You can't teach someone to remember...(Interviewee 1)

Other personal characteristics was pointed out by one of the interviewees when asked about her expertise: she says that the fact that she is good at analysing problems, looking at things from different points of views, saying what would and what would not work is good for online searching (Interviewee 2).

5.3 The Users

For its own nature, the subject librarian's role is closely related to the users of the library. The teaching and information areas being the functions directly involved in the provision of services to these users.

Particularly in one interview it was quite clear that the expertise a subject librarian had was, to some extent, related to knowing about the users and the way to interact with them:

> ...But there is the other side of the equation, there is the user who is important as well. How you interact with the user, how you find out what they really want, how you know and give them what they want, when to stop, what is the right level, because people are surprisingly bad at asking questions. (Interviewee 4)

Users in academic libraries were using information technology extensively. As the same interviewee remarked, the users of index and abstract services in the library prefer to use them in electronic format rather than using them in paper format: "even if they find that sometimes in some cases the electronic ones are just as difficult to use as the paper ones. But because it's on the computer..." (Interviewee 4).

5.4 General Requirements and Problems

Some problems were found that could interfere with the implementation of knowledge-based systems for assisting subject librarians in their activities. Thus, representing also problems for knowledge elicitation.

There seemed to be some resistance from professionals to the idea of system executing some of their functions. The professionals interviewed were all committed to using information technology but in relation to their activity they seemed to think that there was not much room for automation, even if systems were built to assist them rather than substitute them. This is a feeling present in many professionals, as attested in the literature, and was not connected to subject librarians in particular. It was, however, a very relevant point if knowledge-based systems for supporting their functions were ever to be built.

Other point that was found should be carefully considered in any modelling: a prospective knowledge-based system would have to concentrate on a small set of the expert's work because their activities were complex and involved several sub-sets and tasks. It would be impossible to elicit the overall expert's domain due to the diversity of work involved. In addition, if knowledge from different experts was to be studied, it needed to be taken into account that subject librarians'

activities varied according to institution, library policies, personal experience, background, and even personal inclinations.

5.5 Possible Areas for Domain Modelling

The main areas into which the subject librarians' job was divided were identified as the teaching area, inquiry and information work area, and administrative area. Several tasks or sub-sets of activities inside each of these areas were identified in which the elicitation of domain knowledge were considered potentially useful . These are discussed below.

5.5.1 Teaching Area

From the knowledge elicitation of the teaching area of subject librarians' work, an knowledge base could be implemented for teaching information skills to students. Teaching information skills was identified as an especially demanding activity for subject librarians, particularly in the first term of the academic year. Such knowledge base, if implemented as, for example an intelligent tutoring system, should not prevent the subject librarian from doing the teaching - what seems to be an important element of job satisfaction - but could be used as an additional tool. This approach would require substantial study of students as well as of the expert knowledge in information seeking and use.

In addition to that, a knowledge base which incorporated some part of the subject librarian's knowledge could be employed in the training and education of future professionals or paraprofessionals.

5.5.2 Enquiry and Reference Work

In the enquiry and information work area, a knowledge-based system could be used for answering reference questions within small and specific domains. In fact, the relevant literature testifies, this has proved to be one of the most popular areas of research in the area to date (for example: Richardson, 1995).

The subject librarians interviewed showed scepticism about this sort of systems - even though they believed they could be useful in future if the technology advanced. They thought that difficulties in up-dating such systems and their limited area of performance were major drawbacks.

Another task related to enquiry work was identified as offering opportunities for the development of support systems: online searching. The interviewees frequently showed apprehension for the fact that a great number of online systems run on different software and make use of complete different command languages. One suggested that a system that was able to function as interface to these databases would be useful. Research on using intelligent interface to online databases exists and some of these systems have been implemented.

5.5.3 Administrative Area

The administrative area was probably where more diversification of activity was found. Several sub-set of activities were identified here such as collection development, including resource allocation and materials acquisition; budget control; liaison with departments; and team management. Liaison with departments and staff supervision seemed to lie outside the scope of knowledge-based systems but collection development and budget control could be helped by systems for assisting the decision making processes. However, in spite of subject librarians management of the budget for their subjects, this was not an activity specific to their expertise. Hence, it did not show to be appropriate for a possible

line of investigation. Collection development, on the other hand, is an area that has received some attention from expert system developers. Johnston and Weckert (1991) applied techniques from intelligent systems to build a selection advisor system. The system was based on an existing model of selection criteria. The selection criteria is divided into six categories and points are allocated to each category and totalled. The total points indicate whether the library must, should or could get the item. A similar approach is the one by Sowell (1989) whose expert system uses a system of weights for the factors involved in selection and some method of combining them, to arrive to a final recommendation.

One alternative way to the problem would incorporate subject knowledge at the level used by subject librarian in collection development, instead of enumerating general factors and assigning values to each of them. This approach conforms to a suggestion by Williams (1991) that there is a need for more subject related knowledge if effective material selection is to be achieved.

The data of Study One pointed to possible areas of subject librarians' activity in which knowledge-based systems technology could be applied. As a result, these areas were also deemed suitable for knowledge elicitation and domain modelling. Next stage of the research work concentrates on the modelling of one of these areas, namely, teaching activities.

Chapter 6

Expertise in Library Research and User Education: Results of Study Two

Traditionally, students are taught library research skills in user education programmes; library research being understood as the use of information sources, resources and services available in libraries or accessed through them to satisfy an information need. The divergence between librarians' information research models and academics' information research models and the continuing debate over which is the ideal model for instructing students in academic environments made it necessary to approach the phenomenon from both viewpoints. Study Two aims at understanding the phenomenon from the perspective of those two main groups of participants – librarians, when teaching students, and academics, when seeking for information and promoting it amongst students - in order to develop a grounded theory of library research.

Study Two was based on interviews with faculty and librarians in the Faculty of Agronomy in the Federal University of Rio Grande do Sul, in Brazil. Interviews were complemented by observation of teaching sessions carried out in the library of the Faculty during data collection. Study design and analysis procedures have already been discussed in Chapter 4 "Qualitative Research and Grounded

Theory". The present chapter concerns itself with the display of empirical evidence and the interpretation of results. For the sake of clarity it is divided into two parts: data from academics and data from librarians.

The results from the two data sets - academics and librarians - are presented in this chapter as topics subdivided according to the main categories of the theory derived. Not all topics, however, correspond exactly to the categories of the model; for instance, the first topic "personal information" is not a component of the model but is necessary for the presentation of subjects' personal characteristics. The model is presented and discussed in its totality in Chapter 8. In that chapter the emphasis is placed on defining the categories and their relationship in a conceptual and integrated level, whereas in this and the next chapter the emphasis is on describing the data collected according to the categories derived. Therefore, in these two chapters, excerpts from the interviews are presented and they serve to two purposes: description of the findings as they fit the case study, and empirical evidence of the categories found in the data.

6.1 Academics

Data collected from academics covered the three main areas mentioned in the Research Design section of Chapter 4. Based on the coding paradigm proposed by Strauss and Corbin (1990), analysis followed those broad areas to reveal information on academics' roles, their perceptions on students, their own information-seeking behaviour and knowledge, causal conditions for their seeking information, and the context in which information seeking and user education takes place.

6.1.1 Personal Information

Personal data for academics were collected in order to identify their area and range of expertise. This was achieved by specifying the number of years of experience in teaching and research, formal qualifications, and their research and teaching interest areas. Data collected during this part of the interview had a factual character to it and in this chapter takes the form of descriptive analysis. Also specified is the number of academics interviewed per department. Data are shown in the tables below.

Table 6.1 presents the total number of staff in each department, the number of interviewees in each department, the percentage of academic staff interviewed in relation to the number of staff in the department to which they are affiliated, and the percentage of staff interviewed in each department in relation to the total number of subject interviewed. The thirty-four interviewees represent forty-two per cent of the eighty-one academic staff in the Faculty.

Department	Total n° of staff in the Department	N° of Interviewees/ Department	% of Interviewees/ Department	% of Interviewees/ Total n° of Interviewees
Soil	20	7	35.00	20.60
Zootechnics	16	6	37.50	17.65
Phytopathology	10	6	60.00	17.65
Agrometeorology	12	5	41.66	14.70
Crop Production	11	5	45.45	14.70
Horticulture/Forest Sci.	12	5	41.66	14.70
Total	81	34		

Table 6.1: Number and percentage of interviewees according to department.

Thirty-four out of a total of eighty-one academics were interviewed for the present study. Theoretical sampling and maximum variation sampling approaches,

department was chosen. Half of those thirty-four teaching staff interviewed had been working in the field for sixteen years or more. Only four of them had less than five years experience. Table 6.2 shows the academics from specific departments according to the number of years they were in the profession, which for the purpose of this research began when they started working as researchers or lecturers either in that or other university. Percentages are given for total of interviewees in the department.

Department	Less than 5 years		5 to 10 years		11 to 15 years		16 to 20 years		More than 20 years	
	N°	%	N°	%	N°	%	N°	%	N°	%
Soil	1	14.28	-	-	1	14.28	2	28.57	3	42.85
Zootechnic	1	16.66	1	16.66	2	33.33	2	33.33	-	-
Phytopath.	-	-	2	33.33	3	50.00	1	16.66	-	-
Agromet.	1	20.00	-	-	1	20.00	1	20.00	2	40.00
Crop	-	-	-	-	1	20.00	2	40.00	2	40.00
Hort./Silv.	1	20.00	1	20.00	1	20.00	-	-	2	40.00
Total	4	11.76	4	11.76	9	26.47	8	23.54	9	26.47

Table 6.2: Academics by number of years in the profession.

All academics interviewed had a post-graduate degree in their area of specialisation, either a Master's or a Doctorate. Nine interviewees had a Master's degree and twenty-five had a Doctorate. Table 6.3 shows how these academics are distributed according to departments.

Degree	Soil		Zootech.		Phytopat.		Agromet.		Crop		Hort./Silv.	
	N°	%	N°	%	N°	%	N°	%	N°	%	N°	%
Master	1	14.3	3	50.0	2	33.3	1	20.0	-		2	40.0
Doctorate	6	85.7	3	50.0	4	66.7	4	80.0	5	100	3	60.0

Table 6.3: Number and percentage of interviewees with a Master's or a doctorate according to department.

6.1.2 Roles and Information Needs

The factors that caused academics to get involved in information seeking and in user education are related to their role and the corresponding activities they carry out in the academic environment. Three broad areas of activities involving information handling were identified:

- Teaching activities, comprising teaching at the undergraduate and post-graduate levels, lecturing and giving short courses to those outside the university.

- Administrative activities, comprising activities such as being dean or sub-dean, head of department, member of committees, etc.

- Research activities, comprising activities related to supervising post-graduation students, being involved with extension programmes, and executing research projects.

Information seeking related to research and teaching activities was explored in the present work; administrative activities, however, are not directly scientific or subject oriented and do not involve information handling that is of interest to user education. Therefore, the administrative activities were not considered in the work here presented.

6.1.2.1 Teaching Activities

Teaching activities occurred mainly at two levels: undergraduate and post-graduate. At the undergraduate level academics were involved in teaching students who were pursuing the degree of Bachelor in Agronomy and, in some cases, students from the Veterinary Medicine Faculty. All but seven academics from the thirty-four interviewed were not involved in teaching at this level at the moment the data collection took place; nevertheless, they had been involved in it before. Five academics of those teaching at the undergraduate level were giving

courses in the first (basic) part of the Bachelor in Agronomy course, the remainder were teaching in the second (intermediary) and third (professional) parts. The high level of academics teaching at the second and third parts of the course is due to the fact that the first level was mainly taught by academics from the pure sciences, such as biology, chemistry and physics who were not strictly speaking part of the Faculty.

Twenty-three of those interviewed were involved in teaching and/or supervising at the post-graduate level (those previously mentioned who were not involved in teaching at the undergraduate level, were all involved at the post-graduate level). They also participated in one or more of the four Master's and three Doctoral programmes, namely, Master in Environment and Agriculture Microbiology, Master and Doctorate in Zootechnics, Master and Doctorate in Soil Sciences, and Master and Doctorate in Phytotechnics.

In addition to teaching at those two formal levels, academics taught short courses to farmers and agriculture extension agents when invited. This, however, did not seem to be an important or frequent activity since it was cited only by five interviewees.

Duties related to the teaching role included preparing assignments, marking coursework and exams, preparing lectures and tutorials, and preparing handouts. Moreover, most academics felt that one of their responsibilities was instructing students on how to search effectively for information. They thought they should stimulate students to do so and promote situations where students could learn and exercise those skills.

6.1.2.2 Research Activities

Research activities were found to be closely related to the existing post-graduate programmes, since all the Master's and Doctorates in the Agronomy Faculty are research programmes. The staff involved in teaching and supervising students on these programmes were also carrying out research projects. Their projects and their students' projects were almost one and the same thing since the students' work normally was a subset of the academic's research work.

In addition to post-graduate students, academics also supervised the work of certain undergraduate students. These undergraduates had been selected to work on an academic's research project, for which they received a grant, owing to their achievements and interests. They are known in Brazilian academic institutions as "scientific initiation students".

Apart from executing and supervising research projects, academics were sometimes involved with extension work, that is, application of their research into operational settings. That activity was also closely related to research because, in the case where it was identified, one activity informed the other.

Duties within the researcher role involved the preparation of papers, grant proposals, books, etc.; supervising students – and orienting them on searching for information on their specific projects, and carrying out actual research. All these tasks motivated, at different levels, the seeking of information.

6.1.2.3 Information Needs

Teaching and research were identified with the two main roles of academics. These roles were associated with different activities which cause information needs and the initiation of information-seeking processes. The satisfaction of those needs through information seeking represents the outcome of the process.

Information-seeking behaviour of agronomy academics, as is the case in most user studies, started with an information need. Specific, detailed events demonstrating information need situations were not sought during the interviews. The emphasis was placed on identifying and describing the tasks and strategies the academics performed during information seeking and on establishing the relationship between these tasks and strategies with user education. However, analysis of the results has shown that tasks and strategies were related to two main reasons for seeking information: on-going needs and sporadic needs satisfaction.

Sporadic needs, as identified in the empirical data, were related to activities that trigger specific information-seeking situations, such as the writing of a paper in a new area, the literature review for a project, or the search for new references to add to reading lists for undergraduate courses.

On-going needs, on the other hand, were related to the needs that were not clearly labelled as such since they did not seem to require a specific cause to happen. In fact, they were part of an almost constant process that started when one became involved in the academic life and ended with retirement. It can be summarised as the enormous effort of keeping up-to-date in one's speciality. On-going needs did not always trigger active information-seeking tasks and strategies, it may well be that information came to the one who needed it without being sought or even asked for. This was often the case with well-known researchers who had an array of contacts in the area, both in terms of colleagues and research students who directed them to material which could be of interest.

The overall finding was that activities, and corresponding duties related to academics' roles as educators and researchers, created information needs and caused the beginning of an information-seeking process. Role and information needs of experts were, thus, shown to be important elements for the model; they were the causal conditions for the phenomenon of information seeking to take place. Moreover, the satisfaction of those needs through information seeking

represented the outcomes, or consequences accordingly to the coding paradigm, of the process.

6.1.3 Students' Library Research Skills

User education, as a formal activity within libraries, was not perceived by academics as part of their activities, but academics thought their role as educator meant that they had a part to play in the development of student's information skills, both as stimulators of information seeking and use and as promoters of situations where students would learn and exercise those skills. Librarians were thought to be responsible for teaching the specificity of information seeking, particularly those related to using bibliographic sources.

Academics perceived differences in the learning needs of students. Many of them expressed the opinion that students who would become researchers, scientists or academics needed in-depth knowledge on how to explore and use information sources. Students who would become extension agents or administrators had a lesser need for the sort of detail and rigour needed for information seeking in a scientific context, yet they needed to be able to find, select and use information mainly of a factual and technical nature. They differentiate the first type of students from the second mainly by stating that the former were post-graduate students or undergraduates already showing an interest in research, and the latter were those who wanted to get a job as practitioners as soon as they left university.

Another recurrent notion was that information skills were learned by practice when there was a need for it; for example, when students started working in research or at the post-graduation level and needed extensive literature reviews for their projects.

> It's difficult to get the students to go to the library. They only go when we give them an assignment. Well, post-graduates are different, they are

> obliged to go to the library because they have to search for information to do their research project, then they are obliged to attend. (A.5)

Academics also thought that it was important that students learned how to search for information before they embarked on research because students could not afford to waste more time than the necessary in completing their projects due to lack of searching skills (postgraduates' lack of skills may cause delay in their dissertation/thesis submission – for example, A.1, A.4, A.34,A.19,A.8).

Most academics did not consider that stimulating students to use the library was a role for librarians, nor did they think that librarians should be responsible for teaching information use and evaluation skills; they thought those were their own roles. Nevertheless, there was a role for librarian as instructor in how to do a information search, how to use the library, and how to use specific sources. Stimulus to students should come from within the courses with teachers asking for bibliographic searches to be done and giving up-to-date lists of reading material.

> Our area, fruit culture and horticulture, is a very dynamic area, things happen every day. So, technology changes every semester and we try to get the information and induce the students to make a habit of reading, of seeking new things and new discoveries. (A.22)
>
> I think that this anxiety for knowledge, for keeping up-to-date, has to be fostered by the learning method and this I think does not happen in all courses (A.31)

It was found that academics thought there was an opportunity for using computers in user education. There seems to be an enthusiasm with the new possibilities technology could provide in information searching, and, at the same time, apprehension with the realisation of the things they were missing. For example, there was a general enthusiasm with the new - at the time of the interviews - introduction of CD-ROM databases in the library and, at the same time, disappointment when they were unable to locate papers in the library whose references were retrieved from the CD-ROM database.

Today the trend is for these people to use computers more frequently and to look for ways they can, through computing, learn and search for information (A.1)

This side, informatics, I think is basic to avoid wasting time. Because the student does not have much time to spare, he should be more agile (A.3)

6.1.4 Context

A series of contextual factors were perceived by academics as affecting information seeking and use of students and academics in the Faculty of Agronomy. These factors were categorised into three main sub-categories: *discipline specificity*, *institution structure*, and *social-economic-cultural environment*.

6.1.4.1 Discipline Specificity

Specific characteristics of Agronomy as science were perceived by academics as affecting the creation and use of its body of literature. Agriculture was seen as strongly based on regional characteristics and, as such, heavily dependent on information produced and used locally. Importance of information on climate, soil and crop species, for example, varies according to the place where the information was generated. One example of this is the following statement from an interview:

> In agronomy there is a basic part, fundamental, and there is one part which is applied, and this applied part is strongly regional, strongly local, because of weather conditions, soil, etc. So, information is developed locally and evolves rapidly. (A.1)

In spite of having this local characteristic, agronomy was also perceived as part of a global attempt to improve agriculture activities. Its scientists were part of an international community and they relied on this global network for knowledge progress. International literature, mainly from USA, UK and to some degree Australia and Spanish-speaking countries, was essential for carrying out research

and teaching practices. Academics used and cited, according to their accounts, mainly foreign material, although most of their own publications would be found in national journals.

> You see, to do science in a country like ours it is very important to have this vision, because you cannot take... for example the case of wheat, if you are talking about winter wheat in the USA, that does not serve us, the spring is also different. So, you have to look at research from there, understand its concepts on its own environment and then bring these concepts to our reality; look if it is possible or if is not. Now, if you have incomplete information you cannot do that (A.23)

Agronomy was also perceived as practice-oriented, concerned with the application of a vast body of knowledge from several other disciplines, specifically scientific ones, to improve animal and vegetal production. Owing to its characteristic as a practical area grounded on scientific knowledge, there is a perceived need to translate scientific knowledge into practical knowledge, which can then be used by practitioners and farmers alike.

In addition to the life sciences, agronomy also embodies several other disciplines such as administration, economics, mathematics, statistics, engineering and sociology. This multidisciplinary approach in agronomy made it necessary to have a wide general knowledge from a variety of fields to operate in the discipline and, at the same time, deep knowledge of one of its specific sub-areas. Specialisation within the area was sought and needed to keep track of the developments and master the subject.

> ...those are plants that the economic side is very dynamic, because they are of a short cycle and are specific to certain parts of the year and the supplies sometimes are not very good, balanced. Then you have to work in a large spectrum of subjects, from the basics found in biochemistry, in physiology, in botany, to the social side: what the consumer wants, how the people in the supermarket want them displayed, what kind of lighting they want to give a nice coloration. So, it is a vast spectrum. (A.7)

Those characteristics originated from the scientific and applied knowledge could also be observed in the structure of the undergraduate course, which was divided

into three phases: basic, where students were exposed to the sciences which are considered the baseline of Agronomy, with courses ranging from mathematics to sociology; intermediary, when students were introduced to courses on Agronomy but still on a general level - at this point they had courses on soil analysis, animal production and plant diseases; and the professional phase, when students took courses on very specific topics within Agronomy, such as bee production or wheat production.

Other feature of agronomy, also related to its multidisciplinary approach, was that it is a vast area of study. Even divisions of it were still considered very broad:

> Our department is Horticulture and Forest Science, but they are two worlds completely different. You go from a horticultural activity, super-dynamic, to the activity of managing forests (A.7)

Owing to the scientific character of the area, communication of information between academics was mainly through journal and conference proceedings at a national and international level, and through journals, meetings, theses and dissertations at a local level. Books were not considered the major source for dissemination and seeking of information. However, information for extension agents and agriculturists had a practical character to it, with specialised magazines and newspapers articles as an important communication media. Types of information used by agricultural related people, apart from scientific information translated to practice, included information on prices, rates, climate, and economic conditions.

Many graduates would work in the countryside, away from an easy access to information. The countryside as a work place, then, was an important element that influenced information seeking in Agronomy.

> Now, the problem of our graduates is that they go to the countryside, they know there are places where they could get the information but they are far away. It is difficult to see them getting it from where they are (A.27)

6.1.4.2 Institutional Structure

Another major contextual element identified was the institutional structure, which was understood as the factors that characterised the Faculty, its library and the university as a whole.

The Faculty was perceived as a place for knowledge creation and dissemination in agriculture, and one of the focal points for agricultural research and learning. High quality national centres for the study and research of specific aspects of agriculture exist in Brazil, but these are specialised institutions only concerned with their own specialisation. Faculties of agronomy at Federal Universities, on the other hand, benefit from the presence, in the same institution, of a wide spectrum of disciplines, for instance chemistry and biology, which contributes to improving agricultural knowledge. Accordingly, the Faculty was seen as a suitable place for the translation of basic theoretical knowledge from the pure, social and life sciences into agricultural practice.

Although a very traditional place for agronomy learning and research, analysis revealed that several institutional problems were identified by academics; one was the physical location of the Faculty. Originally placed away from the central campus, where the other university units were located, staff felt they were isolated from the rest of the university, even though in the past two decades most university departments and Faculties had been transferred from the city centre to a distant campus, just a few miles past the Agronomy Faculty. This perceived isolation was thought of as a major difficulty for information exchange with the other disciplines which are important to agronomy. It was acknowledged, though, that this isolation might not be an actual problem anymore but a perception kept out of habit. One interviewee confirmed it when talking about the lack of journal titles in the library.

> We lack exchange with other libraries, maybe it is a habit, the agronomy has always been geographically isolated. It is perhaps a bad habit of ours not to seek in other libraries with the intensity we should, because many of the journals we don't have here, are in the Bio-science, in the IPH, in other branch libraries. (A.4)

A further difficulty related to institutional context is the excessive administrative duties that the academics need to carry out. These duties, as perceived by most subjects, hinder research and teaching which is most apparent in the lack of time for information searching and reading. One of several examples is illustrative

> This is the way, unfortunately it is the time we spend on administration, budgeting, buying research products. Then we work as teachers, as accountants, as technicians, there isn't much time to go to the library, to keep informed. (A.8)

Another problem identified, which, it was thought, would speed up academics' activities when solved, was the lack of information technology support, both in the form of equipment and instruction on how to use them. This was seen as a condition that would improve the problem of shortage of time, particularly in the process of searching for information. At the time of the interviews, the computers available were few and connected to a local network and Internet via telephone modem. Information technology support was also highly desirable for students' work.

The library was perceived by academics as being an important sector of the Faculty. Generally academics thought the librarians were helpful and were trying to do their best; however, several problems were identified, amongst them collection deficiencies, mainly due to cuts on journal subscriptions during the previous decade. Academics believed the library generally had the main national and international periodicals in the area, although more specialised journals were lacking. Particularly affected were academics who worked on their own or with an under-representative research group because the library subscribed only to the more frequently used periodicals. They felt the library had been better provided years earlier because they frequently found periodicals titles from which they would like to see recent papers but that had stopped coming a few years back. That was one reason for the collection being perceived as outdated. Another reason for this perception was that few new books were bought by the library.

Another problem related to library collection was the lag-time between publication of journals and books and the time they were available in the library.

Access was the approach used to compensate for collection deficiency but not without its own problems. Journal papers not found in the library but identified through a database on national holdings as available in another site could be ordered through inter-library loan – the non-identified ones could be ordered through international ILL. However, this as a lengthy process since there was no centralised agency providing the service, and expensive for students and academics alike since there was no special funding for it and the requester had to pay for the charges.

> Where we have a clear problem is in collection, books some times are not really up-to-date, they cannot subscribe to all the journals, there are journals that sometimes we cannot get, even by ILL. So, the main problem I see is the lack of resources and structure. (A.2)

In addition to the these elements, the physical environment of the library was not considered pleasant or inviting. The ground floor where it is situated was not specifically designed for it and had been adapted.

6.1.4.3 Social-Economic-Cultural Environment

Broader contextual elements appeared frequently enough during analysis to provide evidence that social economic and cultural factors were perceived as affecting the context in which information seeking took place.

Effects of the national economy and the consequently tight financial situation of state universities such as UFRGS were apparent when academics talked about how different conditions were in other countries and how the lack of money and resources for universities, research and education in general affected the context in which they operate. Several academics interviewed had done their PhD abroad, mainly in the USA or UK, and could compare the reality in industrialised countries to the one in Brazil.

As a consequence of the economic problems in the university and in the country, which directly affected library services and collections, it was verified that personal collections developed with the academic's own or research related funding tend to grow to compensate for the problem.

Among other factors mentioned, the language barrier made it difficult to use widely the main body of literature in English in undergraduate teaching. The language barrier was a major problem since most of the scientific literature was in English. Spanish was another important language but that was not a major problem since most Brazilians can understand and read Spanish because of the similarities of both Latin languages. In undergraduate teaching it was unrealistic to expect students to read many complex texts in English thus the bibliography had to be restricted. At post-graduate levels students reading in English was a condition to start studies. All academics interviewed mentioned this factor, as the example below shows:

> One of the students' problems, mainly undergraduates, is foreign languages. Not all of them know English and our bibliography is almost all in English. Post-graduates no, they have to read mainly in English, otherwise they become outsiders. At least eighty per cent of the scientific literature today in the area is in English (A.1)

6.1.5 Knowledge Sources

Information seeking caused by both on-going and sporadic needs, and happening in the context described, was identified in academics' data as operating towards and from two conceptual sources: *external knowledge sources* and *internal knowledge sources*.

6.1.5.1 External Knowledge Sources

External sources referred to the sources normally associated to the process of information searching and were of either a formal or informal nature. These

external sources were conceptualised as *public knowledge sources* and *private knowledge sources*, terminology borrowed from an often described typology used in the study of knowledge systems and redefined for the purpose of this work. Both *public and private knowledge sources* were indispensable categories for information seeking and retrieval, although not all of them seem to be employed all the time. Their use affected the information-seeking process as well as determined the success of the outcomes.

6.1.5.1.1 Public knowledge sources

Public knowledge, similarly to the use made in studies of knowledge-based system (for example, Hayes-Roth, 1983) and discussed in Chapter 2, in the present work represents the information that is published and made available to the public such as in books and journals. It is the knowledge that is registered and shared with a wide audience, potentially the whole world. Instances of *public knowledge sources* were identified such as library collections and personal collections, and all the available published documents related to the area. Personal collections and personal files were also considered instances of *public knowledge sources* because they incorporate items which were originally published, such as books and journals, or photocopied material and notes taken from published material, in the case of personal files.

As an example of a type of *public knowledge source*, the scientific journal stood out as the most frequently used among the academics interviewed. Conference proceedings and sources of factual information such as statistic yearbooks, weather maps or nutrition tables were also mentioned. Books were seen as of little use for research purposes, but textbooks were often mentioned when the need of the search was related to undergraduate teaching. In this cases the academic had probably a copy of the book in his personal collection.

Public knowledge sources, as already specified, comprised the body of literature of the subject and was related to both library collections and personal collections

of this literature. Consequently, it was at the level of public knowledge found in libraries that user education traditionally operated.

Several tactics were found among academics to deal, systematically or not, with *public knowledge sources*. These tactics were conceptualised in terms of tasks and are described later on in this chapter.

6.1.5.1.2 Private knowledge sources

Private knowledge belongs to individuals. In the study of knowledge it comprises rule of thumb and heuristics (Hayes-Roth, 1983) and is also referred to as tacit or implicit knowledge (Weckert, 1991), but in the model it has been redefined to signify the sort of information acquired from people rather than from the literature. People, in this case, were the individuals recognised by the searcher as being able to provide help, orientation or answer to a questioning. They were normally seen as authorities in the subject and could be a colleague, a recognised expert, or in the case of knowledge regarding the subject literature, a librarian. Occasionally, students were also sources of private knowledge for the academic.

Thus, *private knowledge sources* were other human beings. The form of interaction between the academic and *private knowledge sources* is of interest to this work. The easiest and commonest form of resorting to private knowledge was through talking to colleagues from the Faculty and also to peers outside the Faculty.

Owing to the proximity and also the specialisation of academics and the vast scope of agronomy, it seemed to be easier for researchers to get someone "from inside" the institution to talk to when seeking help with an information problem. Alternatively, there were other sources of private knowledge they would turn to, such as colleagues from other Faculties in the same university or other universities, mainly overseas institutions where the academic had done his post-graduation studies or where they would find someone from the Faculty who was presently studying at. All of these, however, were sources originated from a very personal circle, that closer to the academic; other private sources, from a more

distant circle, some times a stranger to the academic were also resorted to. The importance of knowing personally someone to be able to resort to them when needed appeared as an important element for an academic seeking information from a *private knowledge source*. The traditional and consolidated concept of "gatekeepers" appeared again appropriate to describe those who were the leaders in contacts outside institution and, consequently, leaders in research inside the institution.

Conference participation was of particular importance because, apart from allowing the rapid dissemination of public knowledge, it also gave the chance to create and strengthen personal contacts which could then become *private sources of knowledge* for the academics. Academics regretted not having more opportunities to go to conferences abroad:

> In this sense is a pity that we don't have the chance to go more often abroad, because every one that goes abroad brings back a large number of sources. People who are studying abroad send us lists of material to be bought. (A.4)

Apart from talking to close and distant colleagues and attending conferences to widen the scope of acquaintances that would become informal sources, academics also communicated at a personal level to obtain information in written forms. Owing to the availability of a electronic network, although its use was not completely widespread in the Faculty, some academics were resorting to e-mail to contact colleagues. A study conducted in a just few months later would probably identify many more instances of, and implications for, the use of electronic networks.

Participation in meetings, conferences and the like were cited by the academics interviewed as important sources of information and, because of their double nature – informal and formal – were difficult to classify. It became clear, however, that the double nature of the event could well be accommodated inside the model proposed: the "hard" side to these events, that is, the papers presented and formally registered are *public knowledge sources*; and the "soft" side, that is,

the spoken and written words, exchanged in a formal or informal manner but not officially registered are *private knowledge sources.*

An interesting aspect of the information-seeking behaviour identified was the interplay between the use of one or the other type of source. Resorting to a personal knowledge source would almost inevitably at one point lead to a *public knowledge source*. This may not be the case with other users group, such as the practitioners in Agronomy, but it was the case with scholars, probably because the nature of their scientific work requires that they be able to acknowledge formally the source of information used. It was not explicitly observed within the scope of this research but it is quite acceptable to expect that the reverse is also true, that is, the use of a *public knowledge source* would lead to seeking a *private knowledge source*. This could be the case if, for instance, the subject matter of a journal paper was not easily understood and an expert in the subject was available to provide further explanations.

6.1.5.2 Internal Knowledge Sources

In addition to *external knowledge sources*, it was found that *internal knowledge sources* were also highly relevant to, and were used during the information-seeking activities of the academics interviewed. *Internal knowledge sources* had implications for, and were affected by, those information activities. These sources, or knowledge bases, were identified when academics referred to "memory", "experience" or used sentences like "people that have knowledge of the subject" or "...knows how to use the database". They were also particularly clear when staff talked about students, their skills and the knowledge they had or needed. For this reason, many of the examples taken from the interviews and presented here are from situations when academics were talking about students and not particularly about themselves.

Different categories of *internal knowledge sources* were identified in academics' data: *domain subject knowledge, domain literature knowledge, system procedural knowledge, system conceptual, functional and content knowledge and topic searched knowledge*. Apart from these, there was another source which was not recognised as a single knowledge source because it permeated all the others, but since it showed to be conceptually different from the others, a distinction had to be made and the category was named *general scholarly skills* (discussed in section 6.1.5.2.6).

The categorisation of sources is highly relevant for user education, and particularly for user education and knowledge bases systems, because it allows the identification of different areas that have to be developed in students.

6.1.5.2.1 Domain Subject Knowledge

Domain subject knowledge was knowledge related to the agronomy domain and its related areas. Interviewees had different subject knowledge, according to their area of specialisation, research and teaching, which they would bring to the information-seeking process. *Domain subject knowledge* was also what they were trying to improve when they engaged in information seeking.

> Then, when we start developing a project, we already have a good notion of the existing problem and so develop that work based on the existing information and the need for investigation in that area. (A.1)

> For example, when I started supervising studies on medicinal plants I used to tell students: 'Medicinal plants are a much bigger world, you have to look away from Horticulture, you have to look into plants, into weeds, for example'. 'But how are we going to do that?' They were terrified because there is an enormous spectrum of plants that in the formal agronomy are seen as harmful. Our colleagues don't have knowledge of medicine and, some times, don't have this understanding. (A.7)

6.1.5.2.2 Domain Literature Knowledge

Domain literature knowledge was also knowledge related to the area of expertise, but this time it was concerned with literature of the domain, that is, the

communication of knowledge within the domain. It was the knowledge that, for example, journal papers are an important form of dissemination of information within the domain, that certain journals are bound to bring something new on a given subject, that certain authors' or institutions' research activities deserve special monitoring. Several examples from the interviews exemplify this.

> I know researchers, I know papers that researchers... or research areas of people, and I'd like to know how these areas are evolving. For example, I know two authors that are researching on soil additives and I realise that "Well, in the past five years they haven't published anything that I got hold off", but I know they published, somewhere they published, I only don't know if in the Journal of Soil Science from England or some other...(A.31)

> ...I already know the journals that we have and that interest me, then I go straight to the information. (A.32)

> ...in the floriculture area, the literature in Portuguese is deficient, what exists available in Portuguese is sub-literature, it's literature for hobby, for gardeners, and a lot of translations from books on how to grow at home or how to keep a plant alive. Floriculture is a business activity... (A.14)

6.1.5.2.3 System Concept-Function-Content Knowledge.

System, as employed in the present study, is the combination of tools, structures and devices created or developed to facilitate searching and retrieving of information. Thus, it includes libraries as a whole and the services and sources available from them. *System concept-function-content knowledge* comprised three instances of knowledge that in other contexts could be clearly distinctive. In the case of the data analysed, however, it was found that concept, function and content of a system were almost always described as an unitary thing; isolating its parts would not help the understanding of the phenomenon. Overall, this type of knowledge could be referred to as "knowing about the system".

Instances of this type of knowledge in the data were clear from references to the services the library offers or fails to offer.

Maybe if the library offered, sometimes people cannot ask for things that they don't know (A.4)

...because it's of no use to show what exists, I think it's necessary to show what it is for and why it's important (A.24)

...teach beyond the search; what is available, what exists. (A.6)

I, still today, find it difficult. I go to a library and don't know how to search for everything. There must be several resources there that I still don't know. (A.3)

6.1.5.2.4 System Procedural Knowledge

System procedural knowledge still concerned the system but was knowledge of how to use the system and its components. It was clearly conceptually different from concept-function-content knowledge as can be observed from excerpts of interviewees talking about user education.

First stage should be the presentation of the library to those students who are not used to going to the library. But then there is another stage, there is the student who is already used to going to the library but doesn't know how to search, that it is another type of training (A.8)

They go to do a literature review and they think: 'I want everything about antibiotics'. And they think that everything about antibiotics is going to come up; but, when they get there, there are twenty thousand pieces of information about antibiotics, from synthesis to resistance, industrial production, everything. So, we have to teach these people how to search for this information, how to fish it out, how to sieve. This has to be done by themselves. (A.15)

6.1.5.2.5 Topic Searched Knowledge

Topic searched knowledge was information about the problem being searched. It was distinct from *domain subject knowledge* because it was specific to the person who has the information problem. Matching *topic searched knowledge* with *domain knowledge* available in the system was the aim of the searching process of academics.

Lets suppose one thesis, a simple subject: density of corn seeding. The student tries on the system: density, corn, something like that and he thinks that his review is those two keywords but he is not accessing other fields of knowledge because he didn't open the topic. Keeping with the example: if he looked density and alfalfa, he would gain information that would be useful; density and soya bean, more information. (A.26)

'What keyword should I use?' I tell them: 'You have to think about your work. What is the main theme in it? Take a large group and divide into small pieces of information, small groups, then you are going to arrive to the information that you want. You cannot start from the opposite way, look at, for example, DNA homology and then go to the large group, bacteria. It cannot be like that, it has to be from the large group and then keep partitioning. That's the way it works. (A.15)

6.1.5.2.6 General Scholarly Skills

These were abilities that the seeker had developed over the years and which were also brought to the information-seeking process. Apart from the very general – and taken for granted - skills of oral and written communication in one's language, it also involved the knowledge of the language in which the system operated or the language in which the literature was made available. Language skills, particularly the ability to read in English, were cited by all academics as essential skills for using the scientific literature. The ability to use computers at an operational level was a skill which also fitted into this category.

6.1.6 Information-Seeking Tasks and Strategies

Library research was visualised in the empirical data as a series of information-seeking tasks which were apparent from the description of academics' behaviour. Those tasks could also be described as stages of a process. Although the process was not prescriptive and the stages not mandatory, the different tasks when taken together could explain the activities academics engage in when searching for information. *External* and *internal knowledge sources* were the intervening elements that, together with need, influenced the use of tasks and related strategies.

The following tasks were identified: *tracing*, *selecting*, *locating*, *obtaining* and *using*. As much as possible and when present in the data, different strategies associated to each task were specified.

6.1.6.1 Tracing

Tracing was an initial task, or the first stage in the process, and was carried out by those who either did not have a known source where they thought they would be able to find the information needed or those who wanted to expand on what they already had. It was normally recognised in the information-seeking behaviour of younger academics or by those who were starting on a new project. The task was associated with resorting to *private and public knowledge sources* because the source of information sought could be both a person or a bibliographic item. Normally, however, the result of setting in motion the task was to get bibliographic reference(s), even if the starting point was a *private knowledge source*. There were several strategies that could be employed alone or in combination during this stage. Each one of them is explained below.

Chaining, at its simplest level, was exemplified by the task of seeking papers through citations found in other papers. At a more complex level, it involved retrieving one work cited in a known item and, from its references, retrieve other cited works. In theory the process could lead to an almost endless search; however, because cited works are invariably older than the citing one, the process may be cut short if the items being retrieved appear too old to the researcher. Academics would follow references found in conference papers, journal papers and review papers and would follow, or recommend to post-graduate newcomers to follow, the references found in the bibliography to successful theses from ex-students. One interviewee explained:

> Some journals that I'm interested in, I look and end up reading them, then the way to go is... I don't know if this way is right but from the paper

> references you end up finding things that you didn't have and which were not indexed. (A.5)

Chaining was one of the most cited forms of looking for information in *public knowledge sources*. However, surprisingly as it may seem at first glance, academics did not use Citation Indexes with this searching strategy. Only one of them said he had used it already, all the others had never used theses indexes and most of them did not know about their existence. The explanation for this was found in the difficulty of access to, and use of, the indexes; the only access to the printed version of the citation indexes produced by the Institute for Scientific Information was possible at the Main Library, which was situated at the central campus and far away from the agronomy campus. Access to the databases via a host system was also possible at the Main Library but the service was expensive and had to be paid for by the user.

Monitoring was also related to *tracing*. It consisted of an apparently simple strategy of keeping an eye on what was being published in one's area. The complex side to it was that the person who monitored had to be able to tell which journals or sources were worth monitoring from one's perspective.

Several possibilities were found that serve as examples of the use of this strategy; these were: scanning the library shelves for new books, scanning publishers lists for new material, scanning one or more periodical titles as each issue arrived at the library or was received by the academic, and using the *Current Contents* for the same end. The excerpts taken from the interviews illustrate some of the alternative possibilities.

> And I did the job like an ant, I took all the periodicals that arrived and looked if there was something for my course. I always have to do this, to see if they are talking about something new which I'm not looking for (A.6)

> In the area I'm working there are key people, key researchers from some countries and they are, like in any research area, what we call research leaders. In any area there are half a dozen in the world and they are the ones who really are in the forefront, they publish in certain places and obviously

> we look for what these people publish. Of course, this is a bit narrow-minded, we stay in a very specific area and loose track of the whole, this is a concern. To get away from it we read some reviews. (A.26)
>
> Yes, using the *Current Contents* is easier because we can see what is coming out also in journals that the library doesn't have. It gives a good covering if we can follow the *Current Contents*. (A.16)

Exploring randomly and *exploring systematically* were other two different strategies that were used for *tracing*. The first was a strategy that subverted the normal procedures librarians advise for searching, in fact it was almost an "anti-search" and would probably never be recommended to students. Its basic and radical form was exemplified by some young academics (below) and consisted of getting collections of several journal titles and looking through every one of them for papers relevant to the topic being searched. Still, the researcher had to posses some knowledge of literature to choose the periodicals to look in.

Other instances of it were cases of looking on the shelves for books or theses on specific subjects, looking in a few journal issues which the researcher suspected should have something on the specific topic searched, or browsing personal collections for items they knew about but did not remember exactly where they were.

> ...traditional way of taking piles of periodicals and look one by one. It used to be a very popular approach and I think it still is the major way of searching; take the more important journals where there are publications in the area, seat down and look one by one, first the table of contents and then go after the information. (A.30)

Exploring systematically was the formal type of subject searches carried out in libraries, that is, bibliographic tools were searched according to their specificity to find references. In the data it varied from using databases, indexes or abstracting services, subject catalogues and organised indexes to personal collections.

> When the idea for the project happened, I went to the CD-ROM databases. I consulted the *AGRICOLA* database with the librarian. Went to that from

> Medicine; *MEDLINE*. The *Life Science*, which is from Bio-science. And also that from *ASFA*, which is called *Aquatic Science*. This one we don't have here in the university. (A.29)

Exploring systematically was not a very common strategy employed by academic staff, they seemed to resort to it only when they had a major work which needed a formal literature review or embarking on a new area. However, some of them resorted to a strategy that allowed them to trace sources as if they had done the searches themselves. This alternative strategy was labelled *surrogating* and consisted of asking scientific initiation or post-graduate students to do a search for them and/or asking post-graduate students to present a seminar for which a literature review was necessary. This strategy was identified on several accounts.

> (talking about the CD-ROM databases) ...I am aware of it but I don't personally use it. I ask my students to use. (A.31)

> I ask the post-graduate students, when they are doing their literature reviews. I give them several subject and when they do their own searches they do also a search for me. (A.32)

> ...I send my students: 'You go there and take... do a search, go to the Herbage Abstract or go to such and such abstract and with those keyword do a search', then I ask the scientific initiation students and the post-graduates to do that. (A.33)

Another strategy associated with the use of *private knowledge sources* was labelled *accepting* and consists of accepting suggestions of what to read from other people. It was a relatively common strategy for academics who were working with students, particularly research students. It requires from the academic the demonstration that accepting unsolicited suggestions of reading material does not mean a criticism of his/her own state of knowledge. The academics who cited the strategy demonstrated to be comfortable about accepting suggestions from students. This strategy was not, however, as completely passive an approach as it may seem considering that the academic needed to create favourable conditions for the situation to happen. This strategy is different from

the previous – *surrogating* - or the following –*contacting* - because it involved getting unsolicited information rather than purposefully seeking it.

> I'm not paying attention and suddenly a paper appears on my desk. I mean, they have this freedom – I'm not sure it's freedom perhaps initiative. Lets say they are reading a good paper that they know I may not be aware of or something like that, then they leave a copy on my desk or they leave the reference on my pigeon-hole in the department. So, this is very common and they know I'm not going to take it as a criticism that I'm not up-to-date. (A.31)

> ...also indirectly from students because as they come with their literature reviews from projects or theses, we... it is even an easy way to keep informed because it comes ready-made. (A.34)

> We don't have much time for information searching. However, when we participate in vivas we are obliged to read the theses and in them we find very up-to-date bibliographies and research results. (A.8)

The other instance of *accepting* was when academics received material from publishers or even companies that worked in the area. Companies, specially chemical industries, sent information about commercial products or about research on areas they were interested in. The academics involved seemed to be aware of a danger of questionable information control by some of the companies but, at the same time, acknowledged the relevance and quality of the service by other companies.

> There is a company that sends me every month an abstract of various journals, then I read the abstracts and send them a fax saying which papers I want. That is quite helpful. (A.20)

A third strategy that made use of *private knowledge sources* was *contacting* colleagues and was the most cited strategy, both for *tracing* and *obtaining* material, which is the other stage in the information seeking of academics. Colleagues here is understood as people with whom academics worked, people who worked in the same area in other institutions, people they met in conferences, ex-supervisors or fellow students, extension agents, farmers, etc. Particularly important for those using this strategy was the contact they had with

colleagues who were temporarily studying abroad. *Contacting* colleagues for *tracing* happened both purposefully or by chance, that is, academics would contact colleagues specifically for help or in the course of their contacts they would receive it without soliciting. *Contacting* happens by way of having meetings, over the phone or through writing of faxes, letters/notes or e-mail messages.

> ...the group, our ex-students, students from other universities, researchers. We are always helping each other (A.31)

> (talking about e-mail) I have made big use of it to contact colleagues that are abroad in order to exchange information. We have now three... fours colleagues that are in the USA, and one in Spain. Because there are some material that we don't have access here, for example a CD database - we have the *AGRICOLA* database on CD but in the USA they have one or two more in the agricultural area. So, we at least ask them to put keywords in there and see what there is. That has helped a bit. And some times they send the full papers, when possible. (A.22)

The last strategy identified for *tracing* was *prospecting*. *Prospecting* was not an often detected strategy. However it was so vividly illustrated during one interview, and fitted so well with other accounts that it stood as a concept in its own right. *Prospecting* resorted to *private knowledge sources* and happened in areas that did not have a large amount of publicly available knowledge. It consisted of finding first-hand information about, for example, how people grew herbs for use as a popular medicine. Also, it involved the finding of information from inside institutions which would, otherwise, not make it available to the public.

> (Talking about the *AGRICOLA* database on CD-ROM) If you are starting I think it's a good step. Now, if you want to go deeper in certain areas, at national level, it does not give you much information. It gives basic information because it retrieves information at an international level. If you want specific things about Brazil, and things that are of large importance to us, that kind of information you have to go... it's really like prospecting. 'How do you prospect?' you are going to ask me. Where do you prospect? *IBGE*, *FEE*, go to *CEASA*, then people from *CEASA* discover something from a secret meeting that happened in the *Mercosul*, then there is someone

> that I don't know who has the copy of the meeting, then we go there and battle. You know, it's prospecting (A.7)*

6.1.6.2 Selecting

Selecting references is the second stage in the information-seeking process identified. It was the task concerned with the decision that makes one choose to follow, or not, the source/reference in order to get the item and use the information. The decision making process involved in selection and relevance criteria are complex topics of studies in their own right and were not explored extensively in this work. The empirical study highlighted its occurrence as a seeking task but did not allow the identification of related strategies. Some of the deciding factors to select information, however, seemed to be related to the language abilities of the searcher, authority, perceived subject appropriateness, time schedule and availability of the item. Except for the last two factors, all of the others were elements linked to *internal knowledge sources*.

The account given by an interviewee was illustrative of the task:

> Abstracts...we try to use full works but the abstract is one way of locating works and through the abstract it is already possible to have an idea if we should order the work or not, in case we don't have it in here. So, it is a first step, to have an idea about the work and then to see if it's necessary to have the full work or not. (A.1)

Selecting, as the others stages in the model, are not mandatory and could have been bypassed if, for example, the seeker thought that the source of the information was reliable enough or if the number of references retrieved was small.

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* IBGE (Brazilian Institute for Geography and Statistics), FEE (Economic and Statistic Foundation) and CEASA (Provisions Centre), Mercosul (South American Common Market).

6.1.6.3 Locating

The third task identified was *locating*. It consisted of identification of items previously selected, for physical access. It is not yet the physical access to the item(s) but the identification of a place where they can be located. On many occasions the process of seeking information would start at this stage, such as when they already knew what documents would solve their information needs. *Locating* related to the use of both *internal* and *external knowledge sources*.

One example of the type of data that indicated the existence of this task was:

> ...Horticultural Abstract to find works easily and then, after finding this works, locate them in the journals. (A.8)

There were several strategies connected to this task; many of them were similar to strategies for *tracing* but had essential differences related to the specific task to which they were associated. *Pursuing systematically* represented searching on library catalogues or any other catalogue or similar information unit holding list. Searching OPACS or union lists for items not available locally and which they could request via inter-library loan was also included here. *Pursuing systematically* resembled *exploring systematically* for it made use of bibliographic tools but its purpose was to locate those specific known items. *Pursuing randomly* consisted of searching directly on shelves or collections (including personal collections and files) without the use of searching tools. It differed from *exploring randomly* because academics who used this strategy had already items in mind and were at this moment only looking for them. *Surrogating* was a strategy for *tracing* as well as for *locating*, only that in this task researchers would ask others - including students and sometimes library staff - to get them the specific items instead of asking them to do a subject search.

6.1.6.4 Obtaining

Obtaining involved having access to the physical item(s) searched or the information sought. *Obtaining* was exemplified by situations when the searcher got to the item on the shelves of a library or personal collection, when someone handed the item to him or her, when he or she received it from ILL or from a colleague, when he or she bought it, when he or she received it from a company, etc. *Locating* and *obtaining* were very similar, almost indistinguishable in some situations, such as in the situation when the seeker was browsing the collection, looking for a known item (*locating*) and, at the same time, *obtaining* it. However, they presented distinct features, particularly clear when the item was not available in the library.

> Even if we don't have this literature in the library, if there is the abstract and if the work is interesting and you have the time, you can order, because some times we do not have it here but Embrapa has, the Agriculture General Office or some other place. (A.9)

The example shows that the seeker traced and selected items, then found out it was impossible to get the item locally and sent for it outside. Finding out where they were available was part of the *locating* task, *getting* the papers was part of *obtaining*. For example:

> (talking about the *AGRICOLA* CD-ROM database) ... I think it's very good in terms of having the information but the access later... For example, I remember that I had to pay each paper that I ordered from outside (A.3)

Strategies associated to this task, apart from *getting* the item personally or via inter-library loan, for example, were *contacting*, *surrogating* and *accepting*.

Contacting was specially important to academics in this task, they would constantly ask friends to send material, particularly colleagues from the department who were on study-leave abroad where probably the collections were more complete.

> ... such as when you use a CD-ROM and there is a colleague that is doing his PhD in Florida then he has in his library the journal, then I ask: "Look,

> take a copy of such and such thing and send me because I didn't have access from here', this way we have done it (A.12)

Also usual was *surrogating* through sending students to get material or *accepting* material from others - people and institutions.

These strategies taken as a whole allowed many items not available locally to be retrieved and used. Again, as in *locating*, the information seeking and use may started from this stage, for example, when receiving unsolicited items from people or institutions.

> I use some services from *Embrapa*. Then... Recently they sent me a collection from a Symposium. That was an extremely important literature for me. (A.32)

The conceptual distinction between *tracing*, *locating* and *obtaining* is that the first was concerned with identifying possible items, the second was concerned with identifying where and how the item could be accessed, and the last was concerned with accessing the physical object.

If the information seeking started with *locating* or *obtaining*, the academic still had to select material. As was pointed out at the beginning, the process approached here was neither linear nor were all of its steps mandatory or rigidly sequential. The process is a useful presumption but cannot be taken to its final consequences. Being a human complex activity, information seeking is naturally subject to these multifaceted aspects.

6.1.6.5 Using

At this point of the process, the actual seeking stopped but one more stage – *using* – had to be included in the model for it was not common to hear academics talking about information seeking and information use as separate things. Library research was seen as both the searching for and use of information.

Examples of *using* were made explicit when the academics were talking about themselves or the students:

> But I think that they do more or less what is expected: go to see what books there are, take, read, elaborate. I think that is it. (A.6).

> I can't. I'm on my own in the area. For you to be able to write a book you need to have at least a time slot to go to the library and see what new things there are, read, structure things inside your head, sit down in front of the computer, and prepare the text. (A.7)

The information-seeking process grounded in academics' data was found to be not a linear process and probably did not finish with the task of *using* information. Reading a paper could lead to other sources through *chaining* or create a need for getting information on a new subject, which could be achieved through *exploring systematically* or *exploring randomly*. Information seeking seemed to be a never-ending process for academics, this is why the on-going need was a better explanation for those situations when there was not a clear information need to start the process from.

6.2 Librarians

Data about the seven librarians interviewed were collected and analysed using the methods and techniques described in Chapter 4. The present section presents and discusses the results of that analysis.

6.2.1 Personal Information

The first librarian to be interviewed (L.1) was a head librarian. She was responsible for, and the person most actively involved in, user education at the branch library. Like all the librarians interviewed she had a first degree in librarianship and had been in the profession for the past eleven years and in the

present position for the past five. In Brazil, a first degree in librarianship is required by law of all those who hold a position as librarians. Library schools train generalists librarians, the specialisation comes with experience or a second degree the librarian may choose to take. None of the librarians interviewed held a second degree and they claimed to have acquired subject knowledge through work.

The second librarian interviewed (L.2) was the youngest in the profession. Like all the librarians in the library, she worked in the inquiry desk few hours a week as the reference librarian on duty. Her activities in that reference work area, though, were limited. She had no formal involvement with user education. She had been at the branch library for the past four years.

Similarly to the previous librarian, interviewee L.37 had limited involvement with reference and user education, she also had less experience on the subject knowledge (two years in the subject specialised library and fourteen in the profession). She was one of the subject librarians interviewed who specifically referred to the disadvantage of not having a formal education in agricultural sciences. All four branch librarians talked about the need to work as a group to overcome problems related to subject knowledge limitations; as a group they had opportunity to share experiences and help each other.

Interviewee L.38 was the one who had been longer at her position as a agricultural science subject librarian: fourteen years. She seemed to be comfortable with the subject and did not show any concern about limitations on domain knowledge. Like the head librarian, she was actively involved with reference work and user education.

Interviewee L.38 was responsible for the database searches carried out in the library. Database searches were those carried out either in online databases (the ones made available by the Brazilian Institute for Scientific and Technological Information) or CD-ROM databases. The CD-ROM databases available at the

various branches and the central library were searched by a librarian accompanied by the user. The reason for this was explained as a need to rationalise the use of limited technological resources.

The fifth librarian (L.5) to be interviewed was the director of the library system. Although she did not have any personal involvement with actual user education, her position as the co-ordinator of the system and its branch libraries meant that her account was very important to put the service into perspective and give an overview of the system.

Interviewee 40 (L.40) was a librarian based at the central library who was responsible for user education at the library and who gave support to branch libraries on matters related to user education. As such, she did not work in any specialised area or discipline. She was the co-ordinator of the working group on user education at the library system for several years and was perceived by peers as the authority for user education in the university.

The last librarian interviewed for the present study was not specialised in the agronomy area; nevertheless, her account as someone actively involved in user education and present co-ordinator of the working group on user education at the library system was highly relevant to the present study.

6.2.2 Roles

Librarians' participation in the library user education program was characterised by a mediation role. Their mediation role between information and those who wanted to use it meant that teaching was provided to allow users the full exploitation of information sources and services.

Data revealed that the librarians investigated had a clear objective in mind when they talked about user education, that objective was the goal of teaching. The

achievement of that goal was the desired outcome of the process involved in user education. The goal was *learning* and could be summarised as "helping users to be independent library researchers". An independent researcher was one who "would be able to stand on his own feet" (L.35). He or she would be able to carry out searches for information independently and effectively (L.39), would learn skills which he or she would be able to transfer and apply to other environments (L.38), would also have to know the tools to be able to keep up-to-date in his/her professional work (L.35). Finally, an independent library researcher would not ask repetitive and simple questions at the reference desk, and that would be used for more demanding and difficult enquiries.

6.2.3 Context

The context in which user education and information seeking took place was identified and described by academics. Although librarians did not describe context with the same richness as academics, the categories and subcategories identified in the study conducted with academics were valid for librarians as well.

In terms of institutional structure, there was the acknowledgement that user education was not having the impact it deserved, both in the agronomy library and the university library system as a whole. One reason for that, in the librarians' opinion, was the reduction of staff; the other was attributed to library automation, that since the late 1980s, when it started, was absorbing most of the human and financial resources. SABi, the in-house software used, was still being developed and the conversion of the card catalogue to digital format was a very time and resource consuming activity. A large amount of effort was put into retrospective cataloguing. Several librarians mentioned this fact (L.38, L.39, L.40), as one librarian summarised it:

> SABi took a heavy toll because of the need to keep inputting data. Many people in libraries, and there weren't a lot, had to dedicate to that so some had to leave the group and our group got smaller (L.41)

In spite of the fact that user education was not a very widespread activity, all interviewees confirmed its importance and the need to promote it inside the university libraries. One interviewee talked about her high involvement with user education and the results it presented:

> Having one person dedicated to that...That person can do a lot; can study, can read a lot. There was a time when there were two of us working on it. Not only this but we had a bigger slot of time for it. We did a lot, we even prepared a work to present in a seminar about training of research students. We were able to do an interesting job. (L.40)

Another institutional contextual element identified which had an impact on user education and information seeking was the view of the university libraries as an integrated system. Librarians emphasised this aspect and the fact that researchers, academics, students, etc. needed to use more than one library to take advantage of the information resources available at the university for the purpose of their research, teaching and study.

Another element present in the data and related to the broader context was the change brought about by information technology. Librarians thought that e-mail, Internet, database searching and several other services were having an impact on information seeking.

> ...including resources that are available outside the scope of our libraries and that we can access from here, such as databases, and all the information that are available on networks today. That extended considerably the volume of information that they [students] have available, because via Internet and Bitnet we can access the whole world. So, it's a very rich information resource that they have available. (L.39)

That impact was already being felt on user education with the introduction of new resources on some teaching sessions. The move was slow, however, owing to the limited resources available.

6.2.4 Types of Mediation

Different types of user education activities were taking place in the university library. These activities were identified in the data collected, which represent subject's perception of the actual situation, and were related to the types of knowledge that the librarians aimed to improve. The types of knowledge have been categorised according to the types of knowledge identified in the data about academics, namely, *external sources* (private and public knowledge sources) and *internal sources* (domain subject knowledge, domain literature knowledge, system concept-function-content knowledge, system procedural knowledge, and topic searched knowledge, general scholarly skills).

6.2.4.1 Lectures

Lectures as a type of mediation consisted of sessions aimed at giving an overview of the system, its structure and the use of its resources. It frequently happened in lecture rooms, was attended by a large number of people and had a rather formal character. General mediation was normally provided to new undergraduate students at the beginning of each semester, when they started their courses. Some post-graduate students, when asked by their course co-ordinator, also attended the lecture type of mediation. Lectures aimed at developing concept-function-content knowledge and, to a much lesser extent, procedural knowledge of the broad "how to use the library" type. The perception was that most students would not retain much of what was said because of no associated need and practice during the lecture. This type of session had to be attractive and intended to be informative although avoiding information overload.

6.2.4.2 Library Orientation

Often, after the general lecture, students were taken to the library to interact with it physically. Groups were smaller and students were shown the different sections

of the library and their purpose (concept-function-content knowledge). They were also shown the catalogue and the way to do a search on it and locate material on the shelves (procedural knowledge).

6.2.4.3 Workshops

Workshops were the opportunity for specialised mediation to be provided. They took place in a seminar room in the library and the students had a chance to develop concept-function-content knowledge and procedural knowledge about specific sources they would need to use for an assignment - in the case of undergraduates - or for their research work - in the case of postgraduates. These workshops happened on-demand only and normally were solicited by the academic responsible for the course. One such session was observed during field work; in it students came to the library with a lecturer to find articles for a class assignment within the main sources for the course subject (*domain literature knowledge*), they were introduced to *Biological Abstract* and *Current Contents* on paper, shown what type of information they could find in them and how to search (*system knowledge*). After the explanation they had a chance to try by themselves and, with the help of the lecturer and the librarian they decided about which keywords to use (basic *topic searched knowledge*). They were also shown a search on the *AGRICOLA* database but did not have a chance to try it by themselves.

6.2.4.4 On-Demand Help

On-demand help was not a formal type of mediation, but it was clearly part of the teaching side of the librarians' job. It consisted of individual help given by the librarian from the reference desk. At it simplest level, it involved an explanation of how to use the catalogue or a specific library service and/or a brief library orientation. A more complex example was help given to a post-graduate student or researcher on how best approach an information need. All types of *internal*

knowledge sources were in play. On-demand help was stressed not to be cost-effective (L.3) and happened only when really necessary (L.40).

These mediation types do not actually constitute sub-categories in the model, they are rather empirical indicators of mediation taking place. In addition, mediation strategies, to be applicable, had to be materialised in the form of types of mediation.

6.2.5 Properties of Mediation

Several elements would intervene in the aimed outcome of user education, that is, learning. For user education to have a positive outcome it had to have certain characteristics. The following characteristics were found in the data.

6.2.5.1 Needs Related

Mediation, to be most effective, had to happen when students perceived there was a reason for them to take it: "There is no point in feeding information into people's heads if they are not going to use it, no point" (L.35).The reason could be a need arising from a personal problem, a class assignment, or a research work, the latter frequently in the form of a Master's or doctoral project and/or dissertation.

6.2.5.2 Practice Oriented

Mediation had also to be practice oriented. Students would not learn and retain what they had learned if they did not have hands-on experience. Learning by doing was a key factor.

> To prepare an instruction of this type and dissociate... to leave it very theoretical is not worthwhile. There must be a very strong link; what is

given here must be required at the classroom. There must be an interaction (L.38).

6.2.5.3 Stimulus Related

Stimulus came from the identification by the user of a need to learn library research skills. Cultural, personal, and other variables affected the perceived need. For instance, it was pointed out that if the lecturer did not stress the importance of information searching or did not seek much information, he or she could not be a source of stimulus to students (L.39).

6.2.5.4 Gradual Complexity

Superficially, librarians tended to characterise the degree of complexity of mediation according to the information needs of undergraduates and post-graduates. However, they recognised that some undergraduates had more sophisticated needs than the average undergraduate, such as the case of scientific initiation students. In addition, interviewees acknowledged that future practitioners needed to develop sophisticated skills if they wanted to be successful in their fields. The complexity of mediation increased according to stimuli and needs of students and not according to those stereotyped sub-divisions. One interviewee said:

> We thought that we were burdening them with too much information and it was getting tiring, so I said: 'We are going to release first what is general, what we have got here. From there on we are going to make ourselves available. The moment the work starts to happen, we lay the basic directions for them to work, from there on they will come to look for us and we are going to help them. And that was what we did. (L.41)

6.2.6 Mediation Strategies

Mediation is the name given to the category that represented the teaching role of librarians. Mediation was sub-divided into four different layers. These layers were not steps of a process, it was absolutely normal to resort to only one of them if that was diagnosed as appropriate to students; nevertheless, the layers when taken together represented a progressive degree of complexity in users education.

6.2.6.1 Directing

Directing was the most basic layer of mediation. It consisted of developing elementary aspects of library skills, or basic concept-function-content knowledge and procedural knowledge, for the purpose of *locating* items and services within the library. Examples were the instruction about the catalogue and how to use it to find a book; instruction about the organisation of material on the shelves and how to find the physical item on them; and general information about library structure and services. Mediation of this type was not necessary to all students, previous experience and good orientation devices within the library could be sufficient. However, new undergraduates received this type of mediation in the form of a lecture combined with a library orientation session, in their first week in the Faculty. Alternatively, students not familiar with the system would receive this type of mediation at the reference desk as on-demand mediation.

> ...One visit to the library when we can show them where the catalogue is, where the material that they are going to use the most is, where the books are, where the periodicals are. (L.38)

On-demand help of the *directing* type was very common, according to reports from the librarians interviewed (L.35, L.36, L.37, L.38).

6.2.6.2 Expanding

Expanding was the second layer on the four-tier model. It consisted of a teaching session given to a group of students who had one single need as a group; either a class assignment or to learn about the tools on one specific area. Students would have an opportunity to develop both types of *system knowledge* at a specific level, basic *topic searched knowledge* and basic *domain literature knowledge*. Example of *expanding* mediation was observed during field work. It consisted of demonstration and practice on the use of the *Plant Breeding Abstracts*, the *Current Contents: Agriculture, Biology and Environmental Sciences,* and the *AGRICOLA* CD-ROM database to undergraduate students taking the course GR404 - Principles of Phytopathology.

Most undergraduates from the Faculty of Agronomy seemed to leave university having received this type of mediation, although it only happened in some courses of the agronomy, that is, those in which the academics involved showed an interest. The mediation provided was restricted to teaching the use of some specific bibliographic tools.

6.2.6.3 Elaborating

Elaborating was more sophisticated than the other two layers inasmuch as it involved mediation which was planned with the specific information needs of students in mind. It consisted of a teaching session given to particular groups of students who were collectively interested in learning about an area or specific sources but who also had individual and specific needs. This type of mediation was more commonly given to groups of post-graduate students from one of the several programmes, in the form of a workshop. What really differentiated it from *expanding* was the level of elaboration of needs brought to the session, which affected the level of mediation given and the individual support required.

One example of this mediation strategy was given by the a librarian (L.4) who had recently held one session of this type. She attended to a small group of doctoral students who were doing extensive literature searches on the topic of their theses, all of which were in the same area. Their initial searches on printed tools were not very successful and they wanted to learn more about the use of the *AGRICOLA* database, particularly the formulation of search strategies, to take full advantage of its potential. Other examples included a workshop given to post-graduate students on methods of citing when that showed to be a problem to students in one of the Master's programme.

Students developed all types of knowledge at a certain level with this strategy. In the first of the above mentioned example, *system procedural knowledge* was evident; in the second, *general scholarly skills* was emphasised.

Topic searched knowledge was also an important type of knowledge associated to this mediation strategy. One interviewee talked about students even changing topics after going through this type of mediation.

> We divided them into small groups[...] because it is at this time that they start to observe and to put together a real situation according to their needs. They start searching to see what they can find and what they cannot find. We talk about other things too: the subject is too hard to find anything, then there is an economical and intellectual cost on that, perhaps the subject has to be changed or adapted. We suggest that they talk to their supervisors. Other typical situation is to find very general things, there is a big amount of it, so they have to select the findings. All these things appear during instruction and the students experiment possible situations. From there on they will be able to take care of themselves. (L.40)

6.2.6.4 Exploring

The final mediation strategy was also more sophisticated in terms of information needed and knowledge acquired . It happened mostly when help was given outside formal teaching sessions to the few who required it , that is, it was informal and selective. The informality was similar to *directing* when that was

given as on-demand help. The difference between the two, however, was that in exploring the informality of the on-demand mediation was directed to explore detailed information about one's topic and one's area. *Domain knowledge* and *topic searched knowledge* were the main *internal knowledge sources* developed.

The study conducted with librarians and academics to elicit their domain models on library user education and information seeking finishes with the presentation of the data collected. They were presented in this chapter according to categories discovered and their relationships. The full and integrated grounded model is presented and discussed in Chapter 8.

Chapter 7

Students and Library Research: Results of Study Three

The present chapter introduces and discusses the results of Study 3, on students' seeking behaviour and knowledge sources. Study Three aimed at eliciting information-seeking and information-use experiences of students and their perceptions on knowledge needed for them. In the context of knowledge-based systems, modelling of user's data is not normally associated with a knowledge elicitation phase but with a requirement phase or an interface design stage. The model of the user education domain, however, would be incomplete without the view of the third side of the triangle, that is, the students.

Analysis followed the three main broad topics of data collection, as described in section 4.4.3.3, and was built on the categories discovered in Study One. Data from Study Three reveals the essential behaviour of students in relation to information seeking and associated knowledge which was used or in need of development.

7.1 Personal Information

Table 7.1 shows undergraduate students distributed according to the course stage they were at, age and involvement with research. The last element in the table was identified by asking students if they had a scientific initiation grant; half of the interviewees had such a grant. A scientific initiation grant, as referred to in Chapter 6, was an opportunity given to undergraduate students who showed interest to work on a academic's research project. Owing to the reduced number of grants, students were selected based on their abilities and interests and according to specific criteria established for every project. Academics interviewed in Study Two mentioned differences between regular undergraduate students and scientific initiation undergraduate students, emphasising that the latter were more interested in research, were stimulated to search for information, and used the library more often than other regular students. The high proportion of students who hold a scientific initiation grant in the sample was due to the application of principles of theoretical sampling, as explained in Chapter 4 section 4.4.3.2, which favours the revealing of rich cases for analysis through sampling of significant cases, as was the case here. The same applies to the high representation of undergraduate students from later stages in the programme.

Undergraduates			
Student	**Stage**	**Age**	**Research**
Student 1	8th semester	22	no
Student 5	5th semester	23	no
Student 7	9th semester	28	yes
Student 9	7th semester	22	no
Student 10	7th semester	21	no
Student 12	6th semester	22	yes
Student 13	7th semester	22	yes
Student 14	7th semester	21	yes

Table 7.1: Personal data for undergraduate students.

The course leading to the degree of Agronomy Engineering had a normal duration of eleven semesters, or five and a half years. Several students, as commonly done in the Brazilian education system, did a preparatory course after they left school to be able to pass the national examination required of all those who enter university. The age differences were accounted for by the different time periods spent on the preparatory courses and/or years-out after school.

Master's Students			
Student	Stage	Age Group	Programme/Specialisation
Student 2	1st semester	20-25	Phytotechnics/Fruitculture
Student 3	1st semester	26-30	Phytotechnics/Horticulture
Student 4	1st semester	20-25	Phytotechnics/Crop Production
Student 6	3rd semester	31-35	Microbiology/Not specified
Student 8	1st semester	26-30	Phytotechnics/Phytopathology
Student 11	Writing up	20-25	Phytotechnics/Phytopathology
Student 15	Writing up	26-30	Zootechnics/Not specified
Student 16	1st semester	31-35	Phytotechnics/Fruticulture

Table 7.2: Personal data for Master's students.

Students working towards a Master's degree from one of the four Master's programmes in the Faculty were also interviewed in the library, as explained in Chapter 4, section 4.4.3.3. The reasons for the higher number of students from certain programmes, for example Phytotechnics (Table 7.2), were not clear since the interviews were conducted over a period of time at different times of the day. It could be caused by certain programmes being more popular than others, attracting a larger number of students and, consequently, having more students doing library work; as well as it could be caused by some courses requiring and stimulating students to do more library work.

Doctoral Students			
Student	Stage	Age Group	Programme/Specialisation
Student 17	3rd year	30-35	Zootechnics/Nutrition
Student 18	1st year	36-40	Phytotechnics/Fruitculture
Student 19	1st year	36-40	Zootechnics/Reproduction
Student 20	4th year	30-35	Phytotechnics/Agrometeorology

Table 7.3: Personal data for doctoral students.

Doctoral programmes lasted for at least four years and passing of a Master's degree was one of the conditions of entry to them. Consequently, the average age of the group tended to be higher than for Master's students (Table 7.3).

The major difference between students was the type of study they were engaged in. Undergraduates were taking the Agronomy Engineering degree and being prepared to work as practitioners in the field or to follow a researcher career through pursuing of a post-graduate degree. Post-graduate students were working towards a Master's degree or doctorate and were training to be professionals who would carry out research and teaching activities in agronomy.

7.1 Roles and Information Needs

Two main roles were found for students in the academic setting studied: learner and researcher. The learner role pertained to the formal relation with their university course, whereas the researcher role related to the part the students played in user education. Undoubtedly the students were learning when carrying out information-related activities in the library or elsewhere; however, their

major role in library research, as observed in the data, was similar to the role of academics when seeking information. Interestingly, in spite of the students fitting into three distinct groups in the Faculty, this division did not reflect in the number of roles they played in library research. It did, however, reflect in the level of expertise in information-seeking and use. Frequently doctoral students showed more types of knowledge at use, and more varied use of the strategies for information seeking, than Master's and undergraduates. In turn, Master's frequently showed a higher level of achievement than undergraduates. It has to be stressed, however, that these characteristics were not mandatory, for example, some undergraduates (particularly those on a scientific initiation grant) showed a level of achievement as good as some Master's students.

The findings also showed that overall the needs of students were of a sporadic nature. They initiated information seeking tasks in order to solve a problem either proposed by a class situation or emerged in the course of their research work.

7.2 Information-Seeking Tasks and Strategies

The processes students went through when looking for information and the needs motivating these processes were similar for undergraduate and post-graduate students. The major difference identified was the increasing degree of sophistication of the processes in the transition from undergraduate to post-graduate, reaching a point where models of post-graduates were very similar to models of academics.

In general, the information-seeking processes of students followed similar steps to those of academics, although receiving different emphasis, and required the use of the same *internal* and *external knowledge sources*, even if some of the former were significantly less developed in certain cases.

Undergraduate students had a basic understanding of research work, and particularly of that related to information gathering.

They sought information largely when they needed it for studying for exams, for completing assignments and for research work related to their role as scientific initiation students, whenever appropriate. They did very few independent searches caused by a desire to be informed in particular areas of interest.

Post-graduate students sought and made use of information available in more advanced ways than undergraduates. Pursuing a Master's degree was the first step on the post-graduate research ladder of the Faculty. It was at this level that students started receiving formal and in-depth instruction on information seeking.

Master's students sought information specially for their research projects and also for assignments related to courses they took in their first year on the Master's programme. Teaching staff gave reading lists for the courses they taught but those were basic lists and students were expected to carry out independent searches for the assignments they were given.

> Teachers give a reading list but for review works we have to come to the library and check works from several years, in journals. (S.3)

Students at the next level of the post-graduate education, that is, doctoral students, went through processes for seeking and using information which were similar to academics. In fact, some doctoral students were also academics who were pursuing advanced degrees.

Similarly to Master's students, doctoral students sought information for their research projects and also for assignments related to courses they had to take. They also got reading lists from courses they were taking, but they were expected to carry out extensive and independent searches for information, particularly when related to their topic of research.

The following tasks have been identified in the information seeking process of undergraduate, Master's and doctoral students and categorised accordingly:

7.2.1 Tracing

Tracing was not a particularly regular stage in undergraduates' search processes. They normally looked for information sources which had been suggested by teachers , that is, the ones that had already been pointed out to them. Those sources were in the most part books and articles from general Agricultural Science periodicals.

When required for an assignment or for the research project they collaborated, strategies for *tracing* such as *exploring systematically* or *chaining* were employed. *Exploring systematically* for course-related information occurred only in the rare occasions when students were required by teachers to conduct a search on one of the bibliographic tools available at the library; these tools were abstracting and index services for specific areas and Current Contents, all on paper. The assignments requiring the use of these tools appeared to be more concerned with making the students practise the use of bibliographic tools than with the use of the documents identified through these tools. All the students were able to point out those situations where they were given instruction in the use of bibliographic sources but many remarked that after they had completed the assignment they never used those sources again. They also mentioned the difficulties with language – English –in which most of the bibliographic sources and the papers they indexed were written.

Another difficulty was relate to the high level of specialisation and detail of the information contained in the bibliographic sources available, which did not satisfy the basic information needs of undergraduates. One student explained that he had tried to use one of those sources for a group assignment but that the papers

retrieved on smoking related diseases were not useful because: "I needed something more general and what I found was too specific" (S.9).

CD-ROM databases for *exploring systematically* were not used by undergraduate students. They were all aware of their existence and had at least been introduced to the tools during a library instruction session. CD-ROM databases were searched by a librarian so they had never tried them by themselves. They showed particular interest in computer-based tools for information searching during the interviews.

Chaining was also mentioned by undergraduates as a strategy for *tracing* but mainly for research related work. One student said she had looked at conference proceedings for the subject of her research and found three interesting references to papers from journals (S.12). Another way of *tracing* when carrying out independent information searches was by *exploring randomly* shelves for appropriate material.

Contacting was also employed occasionally between fellow students; when that did not work undergraduates resorted to contacting academics (S.14, S.10, S.1). None of them at the time was using e-mail or the Internet for their researches although most of them showed awareness of and interest in the services. This shortcoming may have been due to the lack of availability of the service, the dial-up type of network used, and the limited number of microcomputers in the laboratories and in the library. Students mentioned that some colleagues were using electronic mail at home.

Part of the undergraduate students interviewed monitored periodicals out of personal interest in an area to keep informed with new developments (S.7). The articles read by undergraduates were basically from periodicals of general interest in agriculture and were written in Portuguese. One student explained:

> I try to read periodicals whenever I can, things like "Globo Rural", something accessible, to be informed of what is going on. But I don't read everything, only the part I like most in Agronomy, not everything. (S.5)

Frequently Master's students had to find sources for their information searches. The most frequently used strategy for that was *exploring systematically*. They all mentioned using, or planning to use soon, abstracting and indexing services on paper and CD-ROM databases. They seemed to collect a large list of references from searches of these types, and specially from the ones carried out on databases. Outputs of 1.000 references were cited (S.3). Students said they would rather select from those huge lists than miss something relevant to their researches (S.6).

Although *exploring systematically* was widely used, *exploring randomly* was not dispensed with. Master's students would look through several volumes of journals they knew could have something relevant on their topics.

> I examined the main journals that I knew had papers on my line of work, I reviewed everything, sought all those journals. (S.15)

Another strategy used by Master's was *monitoring* material published on their area of study. This was mainly done from some journals they found particularly relevant for their topic of research: "Some new journals, when they arrive, stay on display. We go and have a look at them" (S.6).

Chaining was also a strategy mentioned for *tracing*. Master's students would find references to documents from papers and from theses by former students. *Chaining* from local theses was also mentioned, and encouraged, by academics.

> I was looking for works on a subject and I looked in theses, in their bibliographies, and I realised that one journal stood out, that there were lots of things about it. (S.2)

> [talking about a database search] I started selecting the ones which were similar to my work, then I started to work with the citations to those works I had read. They indicated where to continue searching. (S.7)

Contacting fellow students or supervisors for help was another of the strategies used. It was expected that those *private knowledge sources* would help to clarify matters (S.4) or suggest a source to follow (S.2, S.6). Because the array of professional relationships started to widen at the Master's level, emphasis on this strategy seemed to be stronger than amongst undergraduates.

Strategies found in the information seeking of doctoral students were similar to those described for Master's students except that deeper, or more specific, *domain and system knowledge* seemed to be available for the carrying out of strategies.

Doctoral students resorted to *exploring systematically* and *exploring randomly* to carry out searches. One significant case of the latter was described by a student:

> We know the most important journals in the area and, some times, we do those kamikazes searches; open all the issues from, let's say, 1990 to 1994, opening every issue. My literature review was like that, the computer had a problem and I worked manually. I hate abstracts... (S.20)

Monitoring what was published on their topic or area of research seemed to be an important strategy for identifying up-to-date information. *Chaining* was also mentioned as an important strategy.

Professional connections at the doctoral level were apparently stronger, and *contacting* colleagues was a very much cited form of *tracing*. Attending meetings and conferences was employed to create and improve these connections (S.17, S18). Colleagues doing PhDs abroad were contacted as well as researchers known to the students. Differently from other students, doctoral students used electronic mail to contact those colleagues (S.17, S19). The reason behind this fact may be ascribed less to interest than to university structure: doctoral students were, after the staff, the first to be assigned Internet accounts at the university. The other students, including undergraduates, could request an Internet account but many were not aware of it yet.

7.2.2 Selecting

Selecting references was not a well developed stage in the undergraduates' information-seeking process. Particularly because students did not have very sophisticated *domain knowledge*, they tended to accept opinions on the quality of sources from teachers and/or more advanced students. One said:

> Colleagues help. Veterans know: 'A good book on entomology is this or that' they know it already. (S.5)

They could, however, use some criteria of relevance to decide about information they had decided to seek, that is, searches that originated from a specific, personal need. That was the case, for example, of S.9 who perceived the papers identified through a bibliographic tool as too advanced for his needs.

Master's students had more sophisticated mechanisms for *selecting* references to information than undergraduates. That was probably due to their more sophisticated domain, *tasks* and *system knowledge*. One student said that things he would look for when he had a list of references to select from were availability and relevance (S.4,S.6, S.11). Relevance was the criterion cited by most. One example was:

> I choose them depending on the subject, if it's closely related to what I'm looking for. Reading and choosing. I read the abstracts and whenever possible I look at the tables and graphics and have an idea of how the work was done. (S.2)

For doctoral students, *selecting* references was a stage similar to the one for academics. The extent to which deeper *subject and system knowledge* affected selection was not explored.

7.2.3 Locating

Locating items was one of the main stages in the information processes of undergraduates. This was due to the fact that they, as has already been pointed

out, most frequently resorted to *public knowledge sources* and references which had been provided by teaching staff in courses reading lists. Having such references, they only had to trace and locate them:

> The courses have reading lists and with the title and author's name I can see if the library has it. If it hasn't, the teacher provides it. (S.7)

Students would preferentially resort to the library catalogue to trace items. They used the catalogue mainly for author and title searches and, occasionally, for subject searches. SABi, the online catalogue, was poorly used; the main source was the card catalogue, which was still being updated. The number of terminals for access to the online catalogue was too small owing to the limitations of the dial-up network.

Some students mentioned using Inter-Library Loan (ILL) services for requesting material not available in the library but it was unlikely they used the system for course related information, since the sources suggested in reading lists were always available at the library. Furthermore the ILL was a paid service. Scientific initiation students occasionally used the ILL to order material for the academics they worked with.

Master's students resorted to the library catalogue to trace items or went straight to the shelves they knew had the material sought. The online library catalogue was not yet widely used owing to structural problems but also owing to long-standing habits and lack of orientation on its use. S.16 said he had once tried to use the online catalogue in another library and got so confused that he wished he was using the simpler card catalogue. He acknowledged the fact that he was not computer literate but added "I'm used to looking on the card catalogue and so far it has not given me any problem, so I keep using it".

The ILL service appeared to be used to a larger degree by Master's students, specially after they had a database search done. Students mentioned the problem

that several of the documents identified through such searches had to be requested from outside the library.

Contacting was also a way of *locating* items for Master's students. They asked librarians, colleagues and supervisors for assistance in finding items. Often, they were directed to other libraries where they would be able to locate the items.

7.2.4 Obtaining

Problems related to *obtaining* items in the library were pointed out by all students. Undergraduate students mentioned the limited number of copies of textbooks available for loan, that books were not on the shelves when they needed them, and difficulties with matching the classification number got from the card to the books on the shelves. As exemplified in *locating*, above, students also got material from their teachers.

Master's students located items mainly at the agronomy library and also at other libraries of the systems and in private collections. ILL requests provided a large number of items.

Doctoral students presented characteristics of *locating* and *obtaining* items similar to those of Master's students, with the exception that at this level personal contact was more important. Colleagues would send material to them from other places, particularly other universities in Brazil and abroad. In addition, collections of special libraries in institutions around Brazil were widely used.

7.2.5 Using

The using task was well-defined in the students' data. In almost all the instances verified in the data collected, students of the three levels sought for information to apply directly to a specific situation. The specific situations were normally

related to the writing up of a course work, research paper, dissertation, or thesis. Other instance of the application of the using task was preparing for exams.

7.3 Knowledge Sources

Knowledge sources categories discovered in the data from academics were also appropriate for students of all three levels. The degree of use of these sources differed according to the category of student.

7.3.1 External Knowledge Sources

External sources, in the form of *public* and *private knowledge sources*, were used by all groups of students.

For undergraduates, *private knowledge sources* were mainly academics and colleagues; academics as teachers in a class situation and as tutors when helping with specific problems, and colleagues in the form of more advanced students, who would advise them, and fellow students, with whom they would discuss their topics. For post-graduate students, *private knowledge sources* were represented mainly by colleagues, academics and other researchers.

Public knowledge was obtained by undergraduate students primarily from books and a few national journals available at the library, and by post-graduate students from international and national journals, theses, conference proceedings and books.

7.3.2 Internal Knowledge Sources

Internal knowledge sources, as in the academic model, comprised *domain subject knowledge*, *domain literature knowledge*, *system concept-function-content knowledge*, *system procedural knowledge* and *topic searched knowledge*, as well as *general scholarly skills*.

Undergraduate students showed *internal knowledge sources* beginning to develop. *Domain subject knowledge* and *topic searched knowledge* were apparent, for example, in an undergraduate's description of a subject search on poisonous animals for a course paper.

> You got the subject and have to find it on the catalogue. There is no... sometimes you cannot find it. You have to search on poisonous animals... you have to look for alternative ways. I think of snakes, scorpions... I use the names of the animals I know. I try arachnid, poisonous... That is the way I go. (S.5)

Another undergraduate student, also describing a search done for an assignment, revealed instances of *domain subject knowledge* and *topic searched knowledge*.

> I start by assessing everything I'm going to need. First, what subject is the work about - for that I need to go through class notes, and then I look in the library and can organise what and where to look for. (S.1)

Domain literature knowledge improved as they made use of bibliographic material. One student's account exemplified his knowledge of the literature and its evolution. He explained that he could find information about his topic in books but they were all too old; instead he chose to consult journals. He added:

> Here, more or less we know the journals the library has got, we know more or less the subject each journal deals with, more or less. So, we go to that journal. I know that Informe Agropecuário deals with cultures, and there is a binder in the library with all the subjects of the journal. So I look for the subject and see if it is there, on that journal. [How did you get to know about it?] The binder I saw there, more or less by chance, but the journals we get to know because we have to search in the library since we enter the Faculty. (S.7)

From his account, apart from *domain literature knowledge*, *system knowledge* can also be observed at play. As in the case just cited, *system knowledge* was most apparent in descriptions of library use.

Data suggested that scientific initiation students were a step further on information seeking than their colleagues not involved in research. The main cause was the need to carry out information searches related to research work, which meant using more sources than handouts and books from reading lists. One such student explained that they carried out searches for academics and received feedback from them, which helped to improve their skills (S.13). Another explicitly said that they had to search more often than other students on journals (S.12) and two others claimed they would not normally search on indexing and abstracting services for class assignments; however, they would do it for the research projects they worked on (S.14, S.7).

Data from Master's students showed that they started developing more sophisticated knowledge structures during their searching processes, which allowed them to select critically the sources they found. They admitted that their *domain subject and literature knowledge* improved according to the progress of their research work:

> A good proportion of the material I know already. It has been a short time since I started working intensively in this area. Well, short time in a way, it has been more than one year. With time you learn which are the best and I go to those first. (S.2)

> Now I know which books are essential for us, and the journals. The ones we particularly use here are *Phytopathology* and *Plant Disease*. After some time, we know what to look for. (S.11)

They also developed their topics according to research progress which, in turn, affected *topic searched knowledge*:

> ...it was something new and there wasn't much bibliography, I thought there would be more but I think it was the topic, I believe it was exotic. (S.2)

Topic searched knowledge combined with *system knowledge* helped to define the search strategy:

> The insect that I'm studying... We realise there isn't much research work about it. I had a meeting with my supervisor and we decided to look for information on it using its genus, otherwise there would be little information. But trying, at the same time, to limit it to avoid getting lots of things we are not going to use. (S.8)

System knowledge related to concepts, function, contents and procedure in libraries affected information searching and had to be augmented to help successfully finding the information needed. Some students reported:

> If you go there [the reference desk] they help you but sometimes we don't know what to ask for [...] You have to learn to use every library, for example, in the Bio-Science Faculty Library, Microbiology is separate, but that is not told to people and then you go to the shelves and don't find anything. (S.6)

> Something that happens to me is that I still get lost amongst the shelves here, but that is a problem I have. A problem with the codes and the distribution of subjects. (S.4)

> I'm starting and I don't have the experience to say: "In the Bio-Science there are certain things, here in Agronomy there are others. For example, my subject is insect but until I discovered that in Zoology, in the Bio-Science Library, I get more information than I get here, I wasted time that could have been saved. (S.8)

Lack of *system knowledge*, particularly *system procedural knowledge*, caused frustration and Master's students were ready to accept help to overcome these problems.

Doctoral students appeared to have refined *internal knowledge sources*, which they resorted to when needed. Their tasks for information seeking were very similar to those of academics.

They did not seem particularly concerned about *domain subject and literature knowledge* or *topic searched knowledge*. That was probably a result of their experience in the area since they had done research work at Master's level before

starting their doctoral, as it is common in the Brazilian educational system, and had also worked as professionals.

Except for interviewee S.20, they were all working in a very similar area of research to that of their Master's degree. S.20 was still working in the same field within Zootechnics, however.

Doctoral students knew the titles of the main journals in their fields, the major researchers within and outside the Faculty and were aware of, or participated in conferences that happened in the area. They also talked confidently about their topic and about the subject knowledge related to it. (S.17, S.18, S.19, S.20)

What seemed to be a problem for them was *system knowledge*, specially *procedural knowledge* related to the use of computer database. Two doctoral students exemplified this:

> [after doing a database search with colleagues] We opened the subject too much and we realised there were things that we didn't need. And then we didn't know how to narrow it and we stopped there. (S.20)
>
> When I used the database, using keywords, it got too broad and I couldn't...even using more keywords and trying to narrow the search I couldn't get good results. It got from too broad to too narrow, very quickly (S.18)

The other two doctoral students, however, did not show this type of concern about electronic databases and said they were frequent users of those tools. They seemed more concerned about retrieving the relevant material than with the search itself.

For all three levels of students, general skills were observed to be employed during information searching. Language skills, of particular interest within this work, were a great concern to undergraduates who tried hard to avoid having to process information in languages other than Portuguese. Master's students, if possible, would also avoid getting too much material in foreign languages, but they were resigned to the fact that most of the relevant material was in English.

Doctoral students did not mention English as a barrier to their information seeking and use.

7.4 Context

Generally, students interviewed thought that developing information-seeking skills was an important element of their education. They recognised the need for being able to search for and use information effectively, both for academic success and for their professional life.

Undergraduates tended to feel satisfied with their skills at library use. The use they made of information resources and their perception about library related work probably caused them to think that there was not much to learn in user education courses. One student said:

> People who want to use the library know that they have to look by subject or author, or then they look and if they don't find it, they talk to librarians. I don't think there is much training to do. (S.10)

That was, nevertheless, an extreme example; a more representative example was given by another student:

> When I arrived, I didn't know how to search; number, shelves, etc.. I began trying, it's not difficult, the thing is simple but a simple training would help. (S.5)

Master's students, however, tend to disagree with that perception. Their more complex needs made them perceive instruction as something more than just help in locating books on the catalogue and then obtaining them from the shelves. They saw information searching as an integral part of their research work and were concerned about accessing all the relevant information to their dissertations. One student explained what he wanted from user education:

> [We need]...orientation on the way we can do our dissertation in a way that we don't have to change it a lot, because sources change, it's not librarian's fault, but in a way that doesn't harm us. (S.8)

All levels of students, undergraduate, Master's and doctoral, were interested in learning how to use electronic sources for accessing and retrieving information. The undergraduate student who claimed there was not much to learn about libraries (S.10), emphasised that what had to be taught was searching for information within electronic environments. Master's students also placed great importance on learning how to exploit computer technology for information searching (S.16, S.3, S.6), as did doctoral students (S.17, S.18).

Library research skills learned when one needed to apply them (S.11, S.13, S.15), when having the possibility of practising them (S.17, S.7, S.20, S.17), and stimulated by academics (S.2, S.5) or by a desire to learn (S.9, S.17, S.19) were the main themes in students' data on user education.

This chapter dealt with the discussion of the categories of the model according to the data found in the study of students from the Faculty of Agronomy. The integration of the findings from this study with the findings from the other two is presented in Chapter 8.

Chapter 8

A Model of Library Research and User Education in an Academic Library

The aim of this chapter is to discuss the model of library research and user education in a Brazilian academic library, which emerged from analysis of Study Two and Three. The discussion concentrates on defining the categories and subcategories of the model, explaining the nature of their relationship, and relating the model to similar studies in the library and information science literature.

8.1 The Derivation of the Model

The grounded model derived from the three studies is based on some premises, or a basic framework, that guided analysis and the integration of the three separate studies into a single model.

The first of these premises is the understanding that user education as happening in academic contexts comprises three distinct types of participants, namely academics, librarians and students. These participants relate to each other to

achieve their particular objectives in the process of information seeking and use. Perceiving the problem as a triangle of subjects was an important starting point because it allowed the analysis of the phenomenon in its entirety and, in doing so, helped to overcome the traditional antagonism between academics and librarians' model of library research, a fact that is widely debated in the literature.

Secondly, it was accepted that the three types of subjects are equally important in their participation in user education: librarians are specialists in literature tools and in searching and retrieving information; academics are specialists in the domain itself and are the ones who really do scientific research; students are the target group of user education programmes and should not be perceived as empty buckets to be filled with knowledge but as active agents in their learning process.

The third premise is that in order to understand the instructional part of the subject librarian's job, it is necessary to understand how information seeking is performed by the users, and what sort of knowledge they need during this process. At this starting point, the problem under study could be depicted as in Figure 8.1.

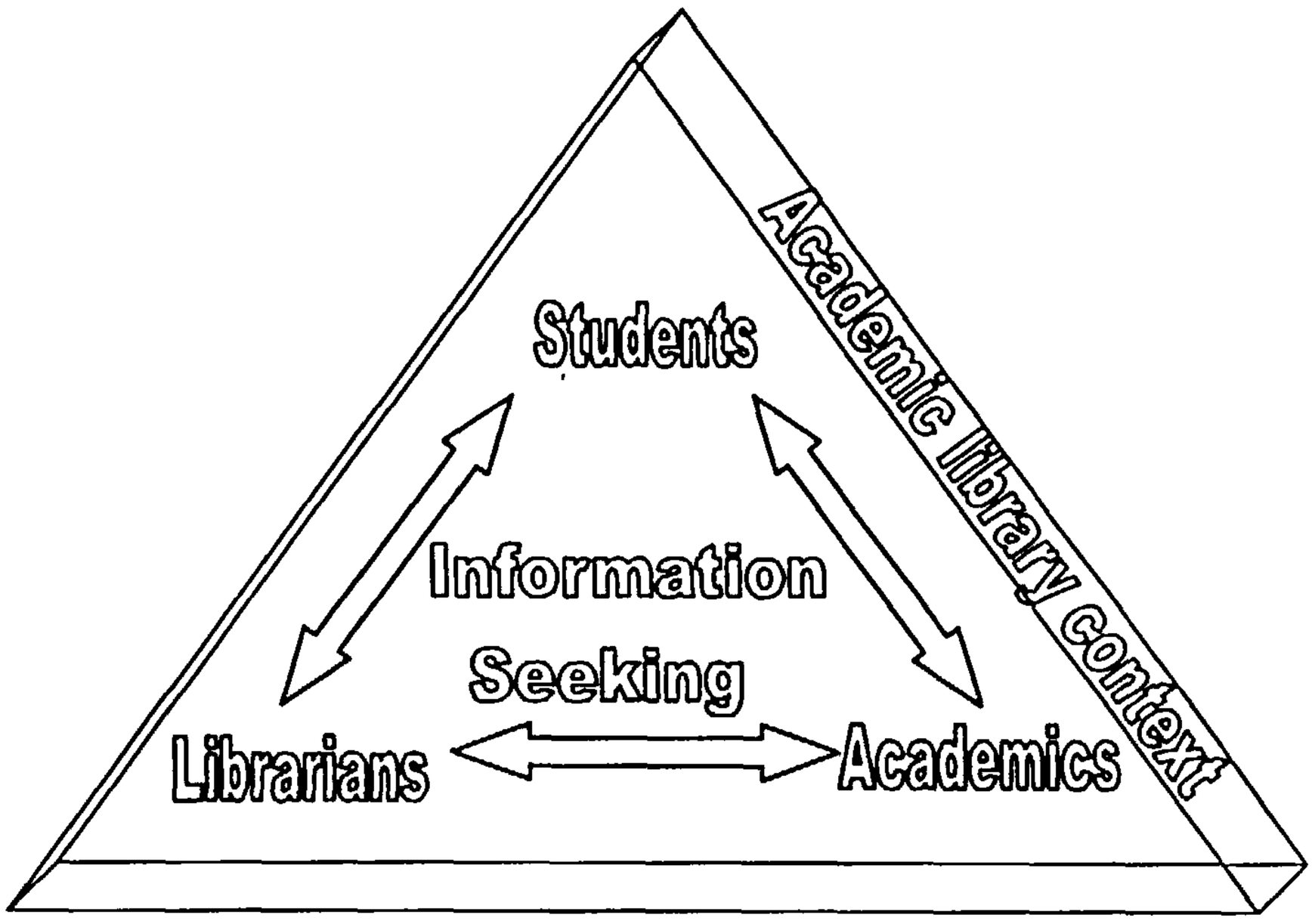

Figure 8.1: Basic framework for deriving the model

Another assumption that guided both data collection and analysis derives from information needs and use studies. It is based on the understanding that people have information needs, that these needs trigger, or not, specific behaviour, and that the behaviour can be observed (either from actual observation or self-reporting through interviews).

Finally, as the approach stemmed from a knowledge elicitation approach - to develop a conceptual model of the domain - major elements normally associated to studies within that approach were purposefully looked for, namely task, task-related knowledge and strategies. That is, the understanding was that patterns of information-seeking behaviour are in the form of tasks and strategies which are, in turn, related to the use of knowledge sources.

Furthermore, elements such as causes, context and outcomes of the phenomena under study were also purposefully looked for. This accords with the naturalistic characteristics of this research work, its user centred conception, and its grounded theory nature.

The basic framework presented above and methods from grounded theory allowed analysis of data and guided the interpretation of the theory. The model intends to represent library research skills as actually applied by academics, taught by subject librarians, and learned by students.

The jargon of the knowledge-based system domain, e.g., knowledge sources, domain knowledge, etc. was borrowed to label the concepts that emerged. In the model, however, these concepts have been redefined. This is in accordance to grounded theory methods, which via its concept of theoretical sensitivity explain that "the literature can be used to stimulate theoretical sensitivity" (Strauss and Corbin, 1990, p.51).

Analysis and discussion of each of the three studies have already been separately presented in Chapters 5, 6 and 7. In this chapter, the aim is to define the

categories and subcategories of the model, describe their relationship and discuss the derived model of library research and user education in a Brazilian academic library.

A main overview of the model was given in Chapter 4, Section 4.5, in the form of a diagram that shows the categories and their relationship (Figure 4.1) and a theoretical statement about them.

8.2 Categories and Subcategories of the Model

The following are the categories and subcategories derived from data analysis of Study One and Study Two:

8.2.1 Library research

Central to processes of user education, in the case studied, is library research. Therefore library research is the core category of the model. Library research, in the model, refers to the process normally associated with seeking and using information sources to satisfy an information need related to an academic activity. It comprehends a number of tasks and related strategies used to interact with information sources and systems such as the library itself, sources available through the library, and other sources of information such as people or institutions which complement bibliographic sources. Thus, library research includes, for instance, monitoring the literature of a specific area, using the library catalogue, locating material on the shelves, interpreting bibliographic records, managing of a retrieval session on a CD-ROM database, etc. During the process, cognitive states of the user are used and modified.

8.2.2 Roles

The two roles in the model are researcher and educator. Researcher is a role associated with the activities of academics and students, and educator is the role associated with librarians and academics.

Roles are the causal condition that start both information-seeking tasks and mediation strategies. Causal conditions for information seeking in an academic environment are related to researchers' information needs resulting from their role in academic activities such as research, learning and teaching. The role of subject librarians and academics are also the causal conditions for mediation to take place: subject librarians' activities as educators have as a major goal the fostering of independent library researchers who, through learning, are able to satisfy their own information needs. Other studies (Wilson, 1983; Leckie et al., 1996) also found the origin of information needs to be associated with work role. Analysis did not reveal a specific role for students. In the proposed user education model, student's role is the same as academics, that is, they are also researchers. The distinction between the two lies in the different level of competency in information seeking they show. Generally, this level of competency could be represented as an incremental continuum which starts at the apprentice level (frequently associated with undergraduate students) to expert level (frequently associated with academics), passing through the level of competency frequently described by post-graduate students.

8.2.3 Information Needs

Information needs is a category associate with the roles played by academics and students, that is, the researcher role. An information need starts an information-seeking process, which may be mediated or not. Two major subcategories of information needs related to activities of academics and students were specified:

on-going and sporadic needs. On-going represents lasting information needs, that is, not needs that are immutable but needs that continue to develop over a long period of time. Normally, as found in the data, on-going needs were associated with academics who had been working on the same area over an extended period of time. Sporadic needs, on the other hand, represent punctual needs, that is, those which are situation and time specific, and were typical of students but occurred also in academics' library research process.

8.2.4 Tasks

The tasks defined in the model are related to information seeking. They could also be described as sub-tasks to the overall information-seeking task, or stages in the process of seeking information. Tasks are goal-oriented (Wielinga et al, 1993) and are normally associated with sub-tasks and problem solving strategies to accomplish them (Firlej and Hellens, 1991).

In the model, a number of information-seeking tasks have been defined together with associated strategies. However, all tasks could not be specified at the same level of detail since the data gathered did not provide evidence to equally develop each element to such a level of specificity; for example, the case of selecting and using tasks. To improve the theory in these respects, models developed particularly for those tasks by other researchers could be integrated into the one presented here. The following tasks and corresponding strategies are defined in the model:

Tracing

This is the task related to the identification of sources that can satisfy information needs. Sources are, thus, references to documents judged relevant by the user to solve an information problem. The identification of these references is mainly based on the relationship between subject and document. The task resembles what

has been described as subject searching in librarianship jargon but it is not limited to actual searches in information systems, it involves also the use of less formal mechanisms such as contacting people to get the needed information. Strategies related to this task are chaining (identifying sources through citations), monitoring (identifying sources through, for example, publishers lists, periodicals, tables of contents, etc.), exploring randomly (identifying sources through browsing of parts of collections), exploring systematically (identifying sources through databases and abstract/indexing services), surrogating (identifying sources by means of delegating the task to others), accepting (an open-minded approach to receiving unsolicited items), contacting (resorting to personal professional contacts when in need of suggestions of items), prospecting (resorting to institutions to get sources on obscure/restricted information).

Selecting

Selecting is the task related to the decision to follow or not a reference retrieved for the purpose of getting the documents identified. This is a task whose strategies were not specified in the data of academics, thus they are not presently included in the mode. As it has already been pointed out in Chapter 6, selection is related to relevance criteria employed by the user to pursue or not an item. Data from studies on document selection and use, which are major areas of study within information science, could be connected to this task in order to develop a more general substantive category. For example, Wang & White (1995) presented results of a study on criteria for document use during stages of selecting, reading and citing a paper. Nineteen criteria were identified in their longitudinal study together with six decision rules which apply to each stage. Criteria of these type have an impact on selection task and determine strategies to accomplish the task (the authors call the strategies rules and named them chain, dominance, elimination, multi-criteria, satisfice, scarcity) but that is not present in the substantive theory derived in this study.

Locating

This task relates to the identification of selected items for access, not the physical access to the item itself but the identification of its location. This task is similar to the one which has been described in the literature as " known item search", that is, a search for a known item through its access points. Strategies of locating task are pursuing systematically (identifying a particular item through location devices such as the library catalogue), pursuing randomly (identifying a particular item through browsing), and surrogating (identifying a particular item by means of delegating task to others).

Obtaining

The obtaining task happens when the user has a physical contact with the information content of a document. It involves getting the physical item or having access to its content if it is a virtual document. The empirical findings that emerged from the studies provided only instances of the first type due to the nature of the services available during data collection. However, it is reasonable to infer that as full-text electronic resources become more common, documents are located and obtained at the same moment in time. Apart from getting the item, the other strategies for this task are contacting, surrogating and accepting.

Using

Using is the processing of the information obtained by the individual. It may not be perfectly characterised as an information-seeking task but it was impossible from the empirical data analysed to separate it from the other information-seeking tasks. The using task provided feedback which affected the other tasks and information needs. Again, studies such as by Wang & White (1995) can contribute elements not present in the grounded theory derived from this research.

8.2.5 Task Related Knowledge

The grounded model of library research shows elements that intervene with the information-seeking tasks described. These intervening elements are described as external knowledge sources and internal knowledge sources.

External Knowledge Sources

External knowledge sources are of two types: public and private. External knowledge sources comprehend the information sources and their intellectual contents. Brooks (1980), discussing the ideas of the philosopher Karl Popper, who named the world of objective knowledge as World 3, explains that it is composed of "...the products of the human mind as recorded in languages, the arts, the sciences, the technologies - in all the artefacts humans have stored or scattered around the Earth." (1980, p.127). It is this understanding of Popper's World 3 by Brooks that better describes this category of the model.

Public knowledge sources are constituted of knowledge made publicly available and recorded in documents, such as in books, papers, CD-ROMS or Web pages.

Private knowledge sources represent knowledge which belongs to individuals. The reason private knowledge sources are categorised as external is based on the understanding that external, in the model, means outside the mind of the individual who is seeking information, not necessarily external to other individuals that can serve as sources of information to that individual. The moment an individual serves as information source, he or she has to externalise the information he or she possesses for it to be of use to the individual who is seeking that information. This externalisation, however, does not have to be in the form of documents made available to the whole scientific community in the form of literature.

Private sources are similar to what has been described in the literature of scholarly communication as "informal channels" (for example: Orr, 1977 quoted by Stoan, 1991), that is, forms of communicating information which are beyond the scope of structured bibliographic sources. Formal channels, on the other hand, are similar to public knowledge sources mentioned above.

Internal Knowledge Sources

Internal knowledge sources are not identified with the traditional division of formal and informal sources in the scholarly communication literature. Internal sources are the personal knowledge states of the seeker. They are states of what Buckland (1991) called information-as-knowledge, which is personal, subjective and conceptual. Once more referring to Brooks' work, internal sources would belong to Popper's World 2, that is, "The world of subjective human knowledge or 'mental states'." (Brooks, 1980, p.127).

Internal knowledge sources were further conceptualised by subdividing into various instances: domain subject knowledge (knowledge of the discipline and its areas of study), domain literature knowledge (knowledge of the literature of the discipline), system concept-function-content knowledge (knowledge of the existence, types, functions and contents of tools, structures, devices and services which are part of the information systems relevant to the user), system procedural knowledge (knowledge which makes possible to put the system to the use of searchers), topic searched knowledge (knowledge of a problem being searched at a specific point in time), general scholarly skills (not a particular type of knowledge but the abilities developed in the general learning context of one's life).

Some of the instances identified in the empirical data and conceptualised in the model have already been specified in the literature of cognitive research in library and information science. A comparison between the ones found in this study and the literature is presented later on in this chapter.

8.2.6 Mediation Strategies

Another important category derived from the empirical data analysed is mediation strategies. Mediation is the label assigned to the category that represents events related to the educational role of librarians.

Mediation strategies occur in response to information-seeking tasks and aim at altering the state of internal knowledge sources when these are inadequate for seeking and retrieving information. The efficiency and efficacy of information-seeking tasks in retrieving information should improve as a consequence of students being affected by mediation strategies .

Mediation strategies are mainly related to the subject librarians side of the library research triangle, although academics also employ mediation strategies to help students who have information problems.

In the model, the mediation strategies are not rigorous stages of a process, even though they characterise a progressive degree of complexity in mediation. This degree of complexity is associated with the number of people at whom mediation is directed and the capacity of the mediator to deal with general information needs as opposed to individual information needs: the more basic the mediation, the larger the number of students it reaches; the more specific the information needs the students bring, the more complex the mediation. The four different layers of instruction as represented in the grounded model are:

Directing

Directing represents strategies which aim at informing about the system and its use at a basic level. It can reach a fairly large number of students for its general approach to problem-solving and is particularly suited to teaching beginners. At the same time, for its basic characteristics, it is needed by potentially all students. Such need can arise at any time in the course of students' studies. Of the types of

instruction identified in the field study, directing is most closely associated with the lecture and library orientation types of instruction.

Expanding

Expanding consists of strategies directed at developing information-seeking skills to a group of students who have a similar objective within a specific area of the domain, for example, looking closer at a particular literature, tools and sources. It normally reaches a smaller number of individuals than directing and is not potentially useful to all students equally, at least not when they are at different stages of their studies. Workshops are the type of instruction more closely associated with this layer in the data analysed.

Elaborating

Elaborating consists of strategies to develop information-seeking skills in connection to specific information needs as presented by students. At this point, students have already explored at least broadly the tools, literature and sources in the area but need deeper understanding of how to apply and evaluate the use of these tools, literature and sources to their topics of interest. The mediation reaches a small number of students and was associated with the workshop type of mediation.

Exploring

Exploring is a strategy for mediation that generally aims at the level of individual single needs and which are not necessarily linked to formal library user education. Strategies related to exploring are applied occasionally to help individuals in specific and difficult situations related to information seeking that they find themselves in. In the data set analysed, exploring only happened in the "on-demand help" type of instruction.

8.2.7 Properties of Mediation

Four properties of the mediation strategies were categorised in the grounded model: need related (mediation has more chances to be successful the more the students can perceive a reason to learn the skills), practice oriented (mediation has more chances to be successful the more practice is incorporated in the mediation session), stimulus related (the more stimuli from the outside world, including teaching staff, experts, and academic activities, the more students can realise the importance of mediation), gradual complexity (mediation gets more complex as the specific needs of students are incorporate into it).

Properties of mediation affect the strategies to be applied to instruction and are affected by those strategies.

8.2.8 Outcomes

There are two types of outcomes resulting from the user education grounded model. The first type of outcome of the process is understood as changes in internal knowledge sources, that is, when learning takes place. The more developed the state of internal knowledge sources, the better the use of external knowledge sources when carrying out an information-seeking task. The second type of outcome is the satisfaction of the information need that started the information-seeking process.

8.2.9 Domain Context

The broad environment in which user education takes place exerts influence on the process as a whole. Context, in the model, is represented by properties which help to shape the information needs, the information seeking-tasks, and the mediation strategies. The domain context category comprises three subcategories: discipline specificity, institutional structure, and social-economic-cultural environment. They

are enumerated according to greater proximity to the phenomenon; however, they are all equally relevant to the phenomenon.

Discipline Specificity

This subcategory, as the label indicates, is associated with the characteristics of the discipline which shape the phenomenon. In the case studied, characteristics of the Agronomy domain were identified as affecting the literature of that domain and influencing the way information was produced, distributed and used in the area.

Institutional Structure

Institutional structure is the subcategory which describes the elements that characterise the organisation where the phenomenon takes place, that is, library, Faculty and university structures, their history and characteristics. It is related to user education in as much as it directly affects information-seeking tasks and strategies. For example, in the model proposed there is a clear distinction between the information-seeking tasks of locating and obtaining. That distinction was vividly clear in the data analysed when the interviewees described how often they locate in a bibliographic source a document they want to use but could not get due to problems in the library collection. It seems to warranted to speculate that if this type of institutional characteristic was not relevant, that is, if the library had a complete collection or if the access to the documents was expeditious, the information-seeking tasks could have not been identified.

Social-Economic-Cultural Environment

This is the more general contextual subcategory; it accounts for values, problems, and issues of a social, economic, and cultural nature at national level - taking into account the nation insertion in the global environment. The empirical data that grounded the model did not present instances of political context having an impact on the phenomenon; nevertheless, it is not unlikely that such a factor would also be of importance.

A list of the categories and subcategories is given in Table 8.1.

CATEGORIES	SUBCATEGORIES	CONCEPTS
Roles	Researcher Mediator	
Information Needs	On-going Sporadic	
Domain Context	Discipline specificity Institutional structure Social-economic-cultural environment	
Information-seeking Tasks	Tracing	Chaining Monitoring Exploring Randomly Exploring Systematically Surrogating Accepting Contacting Prospecting
	Selecting	
	Locating	Pursuing systematically Pursuing randomly Surrogating
	Obtaining	Getting Contacting Surrogating Accepting
	Using	
External Knowledge Sources	Public Private	
Internal Knowledge Sources	Domain subject Domain literature System concept-function-content System procedural Topic Searched General scholarly skills	
Mediation Strategies	Directing Expanding Elaborating Exploring	

Properties of Mediation	Needs related Practice oriented Stimulus related Gradual complexity
Outcomes	Learning Satisfaction of information need
MAIN CATEGORY	Library Research

Table 8.1: Categories and subcategories of the model.

8.2 Relationships Amongst Categories and Implications

Relationships amongst categories have already been specified to some degree when the categories themselves were described for they cannot be thought of as isolated entities. Nevertheless, a full integration of the parts is necessary to permit both an overall comprehension of the relationships between the results derived from the data of the three studies and an analysis of the nature of these relationships. This section is further sub-divided into parts, which correspond to four main broad types of relationships amongst categories and their subcategories, represented in the model.

8.2.1 Roles, Needs and Information-Seeking Tasks

First of all, and following the basic interpretation framework presented at the beginning of this chapter, it is necessary to specify the nature of the relationship between the three types of participants found in library research, namely academics, librarians and students. It was found that their relationship starts at the role level, that is, they interact in library research according to their role as researchers and mediators. The role concept is an important element in the

model. It characterises the initial stage that originates both an information need which, in turn, starts the library research process; and learning which, in turn, calls for mediation strategies. In a knowledge elicitation approach it is fundamental to start with the identification of a problem, then define the functions of the system, and finally the tasks that have to be performed (Schreiber et al., 1993). In the model, the starting point is human role which determines tasks and strategies.

Two types of roles are suggested in the model: researchers and mediators. None of the roles is specific to only one of the participants (librarians, academics and students) in user education; both academics and students take the role of researchers, and librarians and academics take the role of mediators. Naturally, librarians also seek information to satisfy information needs and students advise fellow students on ways of improving information seeking. However, the stereotyped nature of the model meant that the two roles - researchers and mediators- were assigned according to the major characteristics of each participant.

Academics and students have similar researchers' roles, albeit academics have developed better ways of implementing the seeking tasks and more developed internal information sources. It was not found that students have an exclusive role in user education. Even though they are the ones to whom learning efforts are directed, a role as learners does not appear, in the model, as detached from the researcher role. That is due to the fact that the model shows learning as taking place in the context of library research and not as a separate and isolated activity. At the same time, the presence of different categories of students (undergraduate, Master's and doctoral), did not mean necessarily that these students present different categories of information needs. This finding has implications for user education; it means that the teaching of information skills has to happen when the student presents an information need and according to the type of this need, regardless of the category of students.

The role of researcher originates information needs that are of on-going and sporadic types. On-going needs are associated to experienced researchers (academics and some research students) and trigger all types of information-seeking tasks (tracing, selecting, locating, obtaining and using). They are, however, related to some particular strategies in the tracing task; monitoring, surrogating, accepting and contacting are all strategies employed to satisfy an on-going information need. Sporadic needs are associated to apprentice researchers and also trigger all the five types of information-seeking tasks. However, the strategies closely related to carrying out the tracing task to satisfy an sporadic information need are chaining, exploring randomly, exploring systematically, contacting, surrogating, and prospecting.

The role of the mediator is played by academics and librarians alike; both act as to help the interaction process between students and external sources to foster independent, expert researchers. This finding points to the fact that user education is not an activity exclusive to librarians, as accepted in some academic environments. The difference in their mediation role is that academics do not present explicit mediation strategies for educating students in the intricacies of library research, as librarians do.

8.2.2 Information-Seeking Tasks and Knowledge Sources

Information-seeking tasks are described as stages of a process, although it has been made clear that the stages are neither necessarily mandatory nor sequential. In fact, separating the process into stages is a simplification used to make modelling simpler. Tasks are further specified in terms of strategies, these strategies are not fundamentally exclusive to one task although most belong to just one of them.

According to Steels (1990) tasks are goal oriented and need knowledge to be accomplished. In the case of information-seeking tasks, researchers apply

strategies to interact with external knowledge sources (both public and private) and obtain the information they need. Internal knowledge sources are the different types of knowledge a researcher uses to accomplish these tasks. Naturally, the degree of development of these knowledge states varies according to the position the researcher occupies at that moment in time in the continuum from apprentice to expert level. The types of knowledge which are underdeveloped tend to impair the achievement of effective information seeking in as much as it favours ineffectual behaviour.

Regarding internal knowledge sources, on the whole the five information-seeking tasks need all the six types of internal knowledge sources. When the tasks are taken individually, however, it seems correct to assert that each task is associated strongly to only some of the different types of internal knowledge sources. At the same time, each of the five tasks are used to interact with both types of external knowledge (internal and external), even though the same is not valid for every strategy pertaining to a task.

In the tracing task, the strategies chaining, monitoring, exploring randomly, and exploring systematically are used to obtain information from the literature of a domain, consequently, they are related exclusively to external knowledge sources of the type identified as public. Surrogating, accepting, contacting, and other strategies of tracing are related to external knowledge sources of the type private. This is so because the aim in applying these latter strategies is to get, from a knowledgeable person, an indication of an information source that may be useful for a particular information need. Prospecting, the other strategy for tracing, represents an intermediate approach to using external knowledge sources because it makes use of both public and private types in the form of institutions as sources of information (private) and the literature produced by these institutions (public).

The most evident relationship between the strategies of the tracing task and internal knowledge sources, together with implications for the mediator, are as follows:

- In chaining and the monitoring strategies, domain literature and topic searched are the most used types of knowledge. The implication for the mediator is that when he or she encounters researchers who over-emphasise these strategies when tracing information sources, he or she should balance the ineffectual behaviour by way of developing both types of system knowledge.

- Exploring randomly, to be accomplished, needs basically topic searched knowledge and domain literature knowledge. In order to improve information seeking of a researcher who over-emphasises this strategy, the mediator should stress system concept-function-content and procedural knowledge.

- Exploring systematically requires mainly system knowledge and topic searched knowledge to be accomplished; when employed in detriment of other strategies, the mediator should concentrate on developing domain literature knowledge with the researcher.

- Surrogating and accepting strategies are unlikely to happen in apprentice's information-seeking tasks, however, whenever applicable in the mediation process, he or she should be informed of the existence of these strategies.

- Contacting is a strategy associated with system knowledge; to balance anomalous behaviour the mediator should develop further domain literature knowledge

- Prospecting seems to require all types of knowledge to be accomplished, it is not a surprise that it did not show up frequently in the data of academics and students alike.

Regarding the selecting task, as has already been said, it was outside the scope of the present research work to specify all the strategies related to it, for information selection constitutes a field of study on its own right. However, it is possible in the model, from the data analysed, to state that the selecting task is associated

with criteria present in internal knowledge sources and associated with perceived characteristics of external knowledge sources.

Locating and obtaining tasks make use of both public and private knowledge sources to obtain an information. The strategies pursuing systematically and pursuing randomly, for the locating task, and getting, for the obtaining task, are associated with the use of public knowledge sources. In turn, strategies of surrogating, contacting, and accepting are associated with private knowledge sources.

In respect to the relationship of the strategies for locating and obtaining and internal and knowledge sources it can be said that:

- Pursuing systematically makes use of both types of system knowledge to be accomplished. Since this strategy involves searching for a known item, usually an item suggested by academics in the case of students, the mediator should examine the researcher's lack of topic searched knowledge.

- Pursuing randomly, on the other hand, demonstrate a knowledge of the topic searched, for the researcher is only able to browse purposefully when he or she has a clear objective in mind. However, it may show that system concept-function-content and system procedural knowledge are inefficient for effective retrieval.

- Surrogating and accepting, again, are unlike to happen in the information seeking of apprentice researchers.

- The application of the getting and contacting strategies for obtaining a document imply the use of limited system knowledge. They are, however, of such a basic automatic level that they pertain to the information seeking strategies of any researcher. It is necessary to observe the application of other strategies to decide on which type of knowledge should be developed.

Using, as an information task, is related to both types of external knowledge sources and to all the types of internal knowledge sources, including general scholarly skills and domain subject knowledge, which are not mentioned in the strategies above for reasons given below. However, it is not possible, at the present state of the model, to show the characteristics that describe the relationship between the using task and internal sources.

Domain subject knowledge and general scholarly skills were not mentioned in accord with the strategies above because all of them require at least some sort of these two types of knowledge sources to be accomplished. In addition, many would argue that it is not for librarians to develop domain knowledge and general skills.

Concluding, it has to be observed that most of the time resorting to private knowledge sources leads to public knowledge sources, for instance, a colloquial information exchange leads to a formal document. Furthermore, factors that affect the choice of resorting to one or the other type of source were not clear enough from the data, an informed guess would probably suggest that affective as well as cognitive factors played a role. Those factors remain to be fully analysed in studies that approach the problem from a different point of view from the one taken here. What can be suggested from the data is that convenience, previous experience and easy access appear to be main motivation factors for turning to one or the other external source.

8.2.3 Mediation, Knowledge Sources and Tasks

In the model, when internal knowledge sources are unsatisfactory to carry out one or many of the information-seeking tasks, mediation strategies take place. The limitation of the internal knowledge sources is visible when there is an inadequate and ineffective application of information-seeking tasks and strategies during the interaction with external sources, and failure in satisfying information needs. For

example, when a researcher tries to apply a exploring randomly strategy to get a known item when he or she should be using a pursuing systematically strategy.

Mediation strategies are applied directly to information-seeking tasks and in accord with information needs, while searching of external knowledge sources is taking place. They aim at modifying researcher's internal knowledge sources and, consequently, improving library research. They are employed according to the information task which is intended to be carried out and the type of internal knowledge to be addressed, irrespective of the types of external sources.

Typically, different mediation strategies can be used to accommodate different information-seeking tasks and cause the modification of specific internal knowledge sources.

Directing is applied to the locating and obtaining tasks to develop system concept-function-content knowledge and, to a lesser extent, system procedural knowledge. Tracing, selecting and using, which are more complex tasks, are not appropriately dealt with by this mediation strategy, as are not domain and task knowledge. Here, the mediation can, for example, adopt the type of library orientation and on-demand help.

Expanding as a mediation strategy is aimed at modifying specific system knowledge of both types, topic searched knowledge and domain literature knowledge. The information seeking tasks which are approached by this mediation strategy are tracing, locating, and obtaining. Possible types of mediation are lectures and workshops.

Elaborating is appropriate to develop system procedural knowledge, topic searched knowledge, and, to a lesser extent, system concept-function-content knowledge for it is expected that at this level the researcher already possesses some of it. It is also expected that they already have some refined domain knowledge. All the information-seeking tasks (tracing, selecting, locating,

obtaining, and using) can be contemplated by this strategy. In the data analysed, workshops were the associated type of mediation.

Exploring stands at the higher level of complexity amongst the mediation strategies, thus it is employed to develop in-depth topic searched knowledge and domain knowledge. It can be applied to any information-seeking task but, for its nature, is more appropriate for tracing, selecting and using tasks. On-demand help is one type of mediation adequate for this strategy.

Some properties of mediation interfere with the process as a whole and have to be considered in every strategy, these are: mediation is practice oriented because applies to information-seeking tasks and strategies; mediation should be provided when needed, as demonstrated by students internal states and abnormal behaviour; mediation is stimulated by external factors such as a piece of research being done; mediation should increase in complexity according to information needs of the researcher.

8.2.4 Context and Outcomes

Library research happens in a domain context which is influenced by the specificity of the discipline, by the institutional structure at a local level and by the social-economic-cultural environment in which the phenomenon happens, at a broader level. Context affects the way researchers seek information and carry out library research, for example causing ineffective behaviour, as well as determine the types of external knowledge sources available.

The result of setting in motion mediation strategies during library research are, albeit totally dependent, of two types of positive outcomes: learning and satisfaction of information needs. The former is the causing element for mediation to be applied and the latter is the causing element for library research to take place.

8.3 The Model and Related Studies

The model shows how library research and user education articulate in an academic, domain related, context, taking into account the three human elements that are involved in it: academics, librarians and students, and the knowledge and expertise they bring to the information seeking and use task. The model is grounded on empirical data collected in a Brazilian university and represents the reality found there.

Models of library research and models of information-seeking, searching and retrieval processes have been specified in the literature and were revised in Chapter 3. For a number of reasons, which are given in Chapter 4, it was desirable to research news aspects of both library research and user education using a knowledge elicitation approach. The rationale for the research work presented here has already been given (Section 4.1); nevertheless, some reasons need to be clarified in order to establish the difference of this from other related studies.

First of all, what differentiates this study from related ones is that the models developed so far for user education neither specify the different types of knowledge associated with the library research process, nor were they looked into from the perspective of the work role of subject librarians, and associated tasks and strategies.

Other aspect that distinguish this research work from other studies is that it approaches the study of the user education domain from the perspective of the three human subjects involved: students, academics and librarians. This approach represents a departure from the mainstream studies, which approach the modelling task from the sole perspective of either librarians, academics, or students. The present study is the first to produce a single model of the complex phenomenon.

In addition, information-seeking models have rarely been explicitly integrated into user education, even though most user education programmes are concerned with teaching information skills, and particularly information-searching skills. The model proposed explicitly links both areas of research and development through the concepts of information-seeking tasks and mediation strategies.

One important contribution of the work here presented to the body of knowledge on information seeking is the categorisation of the information patterns observed into two distinct elements: tasks and corresponding strategies. Tasks are goal oriented and can be taken to represent the stages in a information seeking process, whereas strategies are the different ways of accomplishing that goal.

Furthermore, the model is based on empirical research, which uses a methodology to derive theory inductively from the data. This characteristic sets it apart from other models of library research for user education.

Finally, no qualitative model of the kind has ever been developed for Brazilian agricultural researchers and academics, or any other activity/profession in Brazil as far as it is expressed in the literature. As it was expected, the cultural and economic differences showed to have an impact on information-seeking behaviour and on user education, thus the information-seeking tasks and strategies arrived at exhibit peculiarities not present in other models. In addition, it is essential that peripheral countries establish their own research agendas in knowledge and information research (Gomes, 1993).

Some of the most relevant studies and models of library research and information seeking and retrieval found in the literature and relevant to this study are discussed here along with the model of library research and user education proposed.

8.3.1 Models of User Education

Stoan's (1984, 1991) argument that the reference, or library, search strategy is not a valid representation of the sophisticated research carried out within a discipline is not refuted in the model presented in this study. On the contrary, the model presented here is deliberately limited to information seeking. It does not try to equate research skills in general to library research in particular. However, it shows that mediation is necessary and that it can be effective in approaching the actual way scholars seek information. For example, it is possible to employ mediation strategies aimed at improving chaining, one of the most common seeking strategies. In addition, the model shows that academics and students' models of library research are not fundamentally different; internal knowledge sources are structured in a similar way, the only difference is that expert's internal knowledge sources are more developed than students', specially in terms of domain and topic searched knowledge.

Ackerson (1996), based on the literature, has proposed a model which enables graduate students to conduct a thorough literature review and identify significant research in their topics. Her model is a sequential set of search strategies which includes steps of searching subject indexes, identifying reviews, searching for ancestors, searching for descendants, identifying key documents, and current awareness. The steps in her model present some similarities with the information-seeking strategies used in the tracing task of model proposed here. For example, searching subject indexes and identifying reviews, present in her model, can be instances of the strategy of exploring systematically; identifying key documents, searching for ancestors and descendants are all specifications of chaining; and current awareness is somehow similar to browsing strategy.

Ackerson's model, thus, deals only with part of the spectrum dealt with in the model presented here, that is, the tracing task. In addition, the author merges strategies with the information sources in a single stage as, for instance, in the

searching subject index stage. This approach does not seem adequate for an effective modelling of the domain because what is desirable is the conceptualisation of each element of the model separately.

Mann (1993) prescribes the methods-of-searching model as a balance between the different fragmented models he identified. His methods-of-searching model presents eight different methods for searching the universe of knowledge records, all of them based on one actual way of searching, for example, controlled-vocabulary searches in manual or printed sources, citation searches in printed sources, etc.

Mann's model is related to the one presented in this study in as much as it sees library user education as a way of teaching information seeking to new researchers (Hjørland and Albrechtsen, 1995). Ways of searching could correspond roughly to tasks and strategies in the model here presented. However, the similarities do not hold longer because the author, similarly to Ackerson (1996), merges tasks and strategies with information sources, or, as their are conceptualised in the present work, external knowledge sources. Citation searches in printed sources is just one of the examples. In addition, the model shows a clear separation between searching methods on printed, or manual, sources and on computers. One consequence of merging tasks with specific formats of information sources is that the model becomes rigid and unable to adapt to new information sources and formats as they emerge. This actually happened to Mann's model as it had no room to accommodate the use of Internet resources.

In contrast to Mann's model, the model proposed here represents information seeking in terms of tasks and strategies and not in terms of a set of previously defined procedures for using specific bibliographic sources. Accordingly, it is flexible enough to accommodate changes in the information environment such as the introduction of electronic networked sources.

Finally, Mann's method presents difficulties in integrating subject/discipline aspects to it, which is exactly one of the departure point of the model presented here. Mann's criticism of the subject model is that it does not favour interdisciplinary approaches. An argument against his criticism is that mediation offered at the moment individuals are carrying out information-seeking tasks, and which is based on properties of mediation, is able to deal with one or many disciplines simultaneously.

Another relevant study is the one by Mellon (1984) who proposes a process approach to library research as opposed to what she describes as the traditional product-oriented model. The generic model based on data of undergraduate students searching information for a term paper requires that "...library use be viewed as a series or recurring activities that include searching, retrieving, reading or skimming material to evaluate its applicability, summarizing relevant material, and analyzing retrieved information for adequacy and sufficiency" (Mellon, 1984, p.477).

It is clear that Mellon makes explicit more elements than the ones normally associated with library research, including summarising, reading and analysis of information. Although the model presented here accounts, albeit implicitly, for reading and analysis of information retrieved inside the using task and the general scholarly skills, specifications of the them were not elaborated. Clearly, Mellon's model is a model of information literacy rather than library research.

Mellon's model is comparable to the big six skills by Eisenberg and Berkowitz (1990) who did not concern themselves exclusively with library research models but with representing a general approach to information problem-solving. The big six skills included stages of task definition, information-seeking strategies, locating and access, use of information, synthesis, and evaluation. Both models only describe the stages of the process linked to seeking and using information.

The proposed model differentiates itself clearly from the existing models of library research and user education in as much as it is a complete model of the user education domain. It explains the relationship between the two fields, relates information-seeking tasks with types of knowledge used and with information sources, and specifies mediation strategies appropriate to develop knowledge states and accomplish tasks through strategies.

8.3.2 Models of Information Seeking and Searching

Models of information seeking, information searching and information retrieval have become more common in library and information science literature. Wilson (1999) reviews a number of them and states that general models of information behaviour have emerged only in the past ten to fifteen years. Some of these models are relevant to this study and illuminate the findings of the model presented here. Others, such as Ellis (1987), Soto (1992) and Palmer (1990) served also as inspiration for the design of this research work.

The grounded model derived by Ellis indicated six characteristics of information-seeking behaviour of academics: starting, chaining, browsing, differentiating, monitoring, and extracting (Ellis, 1989). Later, from a study on the behaviour of other types of academics, he added characteristics of verifying and ending to his model (Ellis et al., 1993). However seminal, his model is not appropriate to describe the events found in the analysis of data gathered for the purpose of domain elicitation. Ellis's stages combine at the same conceptual level what appear as distinctive categories in the model presented here, that is, tasks and strategies. For instance, his chaining, browsing, and monitoring patterns appear in the model presented here as strategies employed to achieve one goal - the tracing task. Ellis's starting, differentiating and extracting patterns are goal-oriented task and, consequently, of a higher conceptual level than the other patterns in his model. Ellis modelled behaviour for information retrieval system

design, thus his model dealt exclusively with seeking behaviour and did not approach the type of knowledge employed or the information sources used.

Kuhlthau (1991) formulated a search process which was, as Ellis's model, based on empirical research. She studied the information-seeking process of students working towards a specific task - the writing of a research paper - and suggested six stages; namely, initiation, selection, exploration, formulation, collection, and presentation. Her work stresses a formulation stage that is evident due to the characteristics of the study participants, that is, they all were looking for information for their term paper for which they still had to define a topic, or, formulate a focus. In short, Kuhlthau's (1991) model defines tasks but not strategies for each task, and is only able to account for sporadic needs. The search process defined by Kuhlthau is a much cited work for she incorporated new dimensions to behaviour: feelings and thoughts.

In subsequent works, Kuhlthau (1993, 1999a) incorporated guidelines for what she called intervention into the process of information seeking, that is, mediation and education. Based on her studies of users and not on empirical study of experts (librarians and/or academics), Kuhlthau (1993) prescribes five zones of intervention - self-diagnosis, right source, relevant sources, sequence of sources and process - and the mediation/education role that parallels the five zones - locator/lecturer, identifier/instructor, advisor/tutor, and counsellor. Some similarities can be identified between these roles and the combination of mediation strategies and types of mediation in the user education model; even though the mediation in her model is related to the activities performed in reference desks, and not during user education. These similarities, however, are more of a terminology rather than conceptual nature and do not remain after closer examination. For example, Kuhlthau's zone of self-diagnosis does not apply to the model presented here which focuses on user education. Her suggestion of a locator/lecturer role parallels the directing strategy in the model presented here, however the corresponding zone of intervention she suggests for

this role is product driven and aimed at helping finding the 'right source'. The notion of right source does not find correspondence in the model presented here, which defines mediation strategies according to information skills and type of knowledge, not external information sources involved. Nevertheless, Kuhlthau's work is fairly relevant to the study presented here inasmuch as she is one of the few researchers of information-seeking process to relate this process to teaching and learning. More recently, she applied the model to analyse changes in the perception of the information process of a professional, as he became more experienced (1999b).

Drawing from several works, including Ellis' and Kuhlthau's , Westbrook (1993) proposed a different set of actions used in the effort to seek for information: needing, starting, working, deciding and closing. Again, there are few similarities between these actions and the tasks of the user education model. In the model presented here needing does not appear as an information-seeking task but as a cause of information seeking. Furthermore, starting and closing stages are not clearly defined in the user education model as they are in this and other models (Ellis, 1993; Kulhthau, 1991– hers is called presentation instead of closing) because the emphasis was not placed on observing subjects performing information tasks for which they have a specific purpose in mind, such as when observing students looking for information for a project. Instead, the emphasis was on expertise, that is, academics who have been looking for information in their area and most of the time are in the context of keeping up-to-date in the field; and apprentice, that is, students engaged in library research for various and diverse purposes.

Ingwersen (1982, 1996) and Saracevic et al. (1988) developed models of information searching and retrieval, they included need or problem statement, interaction with an intermediary, search activities and evaluation. Since their works are related to retrieval in computer systems exclusively, specific characteristics limit comparison with a model of library research as a whole.

In general, the models of information seeking and retrieval and, consequently, of library research start with an implicit or explicit recognition of the existence of an information need, or a gap in knowledge (Dervin and Nilan, 1986) or still yet, an anomalous state of knowledge (Belkin et al., 1982) or problematic situation (Belkin et al., 1995).

The user education model in this study specifies two types of information needs which start information seeking: on-going and sporadic needs. Stoan (1991) mentioned the existence of similar types of needs in scholarly communication: regular and episodic needs. Although he did not make it clear exactly what each one entailed, the similarities between the two types of information needs in the present model and Stoan's are noticeable.

Ingwersen and Willet (1995) in revising information-seeking studies and their relation to information retrieval, found three forms of information needs: verificative, conscious topical, and muddled or ill-defined. Taylor (quoted in Ingwersen, 1982) in a seminal work described information needs as evolving from an actual but unexpressed need, to a conscious need, a formalised need, up to a compromised need. The first two forms of need in the work by Ingwersen and Willet correspond probably to on-going and sporadic needs whereas muddled or ill-defined needs are not contemplated in this model. As for Taylor's theory, the model presented here dealt exclusively with his compromised need, that which the user brings to the interaction.

The relevant and applicable point about information needs in the model is that it allows to differentiate needs which arise at the beginning of a project (as many studies on students information-seeking behaviour dealt with) from needs which are almost permanent in the effort of keeping up-to-date to one's area of study and research. The first of the two types of needs discovered in the data is more typical of students and new researchers in an area, thus characterising more clearly novices' behaviour. The second one, on the other hand, was more closely related to experts' behaviour. The fact that the research work presented here did

not advance to what is already known concerning information needs is not surprising; information need is an extensive area of research which has advanced considerably and possesses strong models.

The incorporation of the concept of ill-defined needs would be an important addition to the model. An indication comes from Bates (1998) who argues that the use of an information system early in a project will come out of as a much less well specified and articulated information need. This explains why a rigid process approach to library user education is of limited use: it assumes that every encounter with the information systems (libraries included) is the first one, or the one early in the project. In the real situation researched, it was noticed that students may need mediation for specific tasks they have to accomplish, disregarding the stage of the process they where in when library research started.

Library instruction has traditionally focused on teaching information skills from the perspective of undergraduate searching for information for a term paper (for example Ercegovac, (1995), Fister (1992), Mellon (1984), Valentine (1993)). However, if the objective is to foster life-long skills, promote learning and simulate expert's behaviour (academics and librarians), then user education has to also concentrate on the on-going needs of researchers.

8.3.3 Other Relevant Studies

Other studies apart from those on information seeking and use, and on user education are of relevance to the model developed. Particularly important were studies of characteristics of experts and novices' knowledge in information seeking, information searching, information retrieval, and reference work.

Allen (1991) presents four types of knowledge used by people who are searching for and using information: world knowledge, system knowledge, task knowledge and domain knowledge. Vickery and Vickery (1993) identified knowledge of

subject domain, of databases, of information retrieval systems and of information retrieval techniques. Rubens (1991) states that specialists use knowledge to negotiate a question and to develop search strategies, and that these types of knowledge are, still according to her, knowledge of classes and attributes of information sources, knowledge of the world, system knowledge, knowledge of knowledge creation, which implies knowledge of social structures.

There seems to be a consensus in the different studies about domain knowledge and system knowledge affecting information seeking, searching and use. The same does not apply to world knowledge, although its presence is almost implicit in all models because of its broad nature. The model presented here acknowledges the existence of several types of knowledge and introduces the a subdivision of system knowledge and of subject knowledge. The category establishes a difference between knowledge of the literature that can be acquired without being a practitioner in the area (good librarians have it) and knowledge of the field, claimed by authorities in the area of study, that is, practitioners and the producers of the literature (Wilson, 1991).

There are two particular contributions of this study to the literature on the types of knowledge which impact information seeking. These are the categorisation of internal knowledge sources and external knowledge sources, or the separation between the subjective cognitive states of the user and the objective representations of those states in the artefacts produced to communicate information; and the specification of a relationship between these internal knowledge sources and information tasks and strategies.

Next chapter analyses the implications of the model as a whole and draws conclusions from both the model and the research process carried out.

Chapter 9

Conclusions and Suggestions for Further Developments

The research work presented in the preceding chapters made contributions towards, and has implications for, the understanding of the user education domain, seen as part of subject librarians' activities, through a process of modelling the domain from the point of view of its main participants. The model has been discussed and its relation to other studies has been presented in the preceding chapter. Moreover, some implications of the present model in relation to those studies have been raised. The main implications of the model for user education in general and for subject librarians in particular are discussed in the present chapter.

Since grounded theory was used as a technique for knowledge elicitation, the research work also draws conclusions about the application of the methodology to domain modelling for knowledge-based systems.

The objectives of this chapter are, therefore, to summarise the findings concerned with the user education model, to analyse its implications, to point to improvements in it, and to consider methodological issues related to knowledge elicitation and grounded theory for knowledge elicitation.

9.1 The Model Derived: Contributions, Implications, and Suggestions for Improvement

The changing nature of information technology and learning environments force new directions for subject librarians, and these new directions are towards their educational role. This has been identified since the Fielden Report (Fielden Consultancy, 1993), and was also pointed to in Study One of the present thesis. Naturally this role is not exclusive to subject librarians. In Chapter 3, subject librarianship was discussed and it was pointed out that there has been a decrease in the subject librarianship approach in academic libraries. However, even if librarians do not call themselves subject librarian but rather one of the several alternative names for professionals in academic libraries, or if they do not have a formal degree for their subjects, as many of the interviewees in Study One or librarians reported in the literature did not, most of them still do subject related work. Particularly in user education, the design of courses and the development of teaching material normally happen in the context of a discipline or a group of related disciplines. The professional responsible for course design, teaching, and learner support needs to have at least some domain subject knowledge to be able to carry out his or her job successfully.

Within the context of an academic subject, the user education model clarified which factors are most important in user education and the relationship between these factors. Even though the results of the study cannot be generalised, the model has a number of implications for user education and by subject librarians. The overall implication is the suggestion that it can be used for planning and design of user education programmes, in any delivery format, either face-to-face or as a computer program.

In the model, library research is described in terms of patterns of information-seeking behaviour arising from information needs related to subjects' role in the domain, and is expressed as tasks and strategies associated with knowledge

sources, both internal and external to the searcher. Mediation strategies occur in response to information-seeking tasks when these hinder effective and efficient searching. Thus, mediation strategies aim at improving the state of internal knowledge sources and the use of tasks and strategies thereby promoting knowledge and skills learning.

Clearly, the model integrates academics' and librarians' approaches to library research and user education; thus, overcomes the traditional dichotomy between the two approaches. In addition, the third human component of user education - students - has been incorporated into the model. Librarians have been accused of misrepresenting the research process with their tool-oriented models; a model that proposes an integral model of user education has potential for planning user education and liaison with academics.

Instead of applying user education from a form approach (type of reference formats such as dictionaries, abstracts, etc.); or function approach (specific use that can be made of different types of documents such as books, articles, etc.); or even the process of seeking information for a research paper (for example: define a need, look on general sources, evaluate, etc.); the model suggests that user education should be approached initially from the perspective of the task/problem to be carried out, that is, from the perspective of the questions being asked, or the questions to be answered, instead of starting from tools, documents or even stereotypical ideas about the research process of undergraduates only.

One contribution of the model, as already pointed out, is the categorisation of information seeking as composed of tasks and corresponding strategies. This categorisation, which is an addition from the knowledge elicitation area of study, is particularly useful to interpret the differences of behaviour found amongst researchers: the model suggests that tasks are constant across the library research process of the individuals interviewed, whereas strategies are susceptible to personal preferences as well as changes that occur in the environment and the availability of information sources.

The categorisation is also useful to accommodate the effects that changes in the environment have on user education programmes. For example; the introduction of electronic networked resources in academic environments has an enormous impact on the way information is produced, distributed and used. Using the model, it is valid to infer that tasks, which were conceptualised independently of sources, are stable over the course of these changes; whereas strategies, which describe actions over systems or sources, adapt to the new conditions. Whether or not this is true needs to be further investigated by means of studies which accompany people as they assimilate these changes.

Another characteristic that differentiates this study from related ones and that has implications for user education in general, and for the development of knowledge bases for user education in particular, is that the model specifies which internal knowledge sources are used when each information strategy is applied in information seeking. The findings also suggest that if one strategy is inappropriately used, then one or more of the types of internal knowledge are defective, and it is possible to identify which types of knowledge should be developed during mediation.

The implication of this finding, apart from the obvious insights for subject librarians delivering user education, is that it permits to envisage a knowledge-based system that when interacting with students and detecting abnormal behaviour, for example, one task or strategy being used in detriment of the others, is able to infer what type of knowledge is missing and suggests actions, in the form of lessons, to improve that lack of knowledge.

Knowledge-based instructional systems, according to the literature reviewed in Chapter 2, are the ones that diagnose and adjust students' behaviour. The essence of the elements necessary for this type of system behaviour has been captured in the model. The knowledge content of the lessons which are delivered by the system, however, has not been specified through the knowledge elicitation process adopted, so further work should be carried out before they can be

implemented. A more structured technique for knowledge elicitation should be used such as conceptual techniques reviewed in Chapter 2.

Another significant contribution of the model to subject librarians devising teaching strategies and/or designing instructional systems is the categorisation of mediation strategies. The mediation strategies prescribe ways of delivering teaching, which are appropriate to information-seeking tasks and types of knowledge, according to the degree of complexity of the information-seeking process. The tutoring module of a system for instruction needs this type of instructional strategies to decide upon what training material to present to a student and how to do it best. Possibilities are for systems that, upon engaging in a dialogue with the researcher at any point in his or her seeking process, can obtain information about the stage the research is in and, based on this piece of information, provide mediation, through teaching material, tailored to the degree of complexity of the problem. The strategies for mediation have been elicited, further knowledge elicitation remains to be done to simulate the decision process of the subject librarian when assessing the appropriate mediation strategy to apply in individual cases. Task analysis for decomposition of each strategy or think-aloud protocols may be used to carry out these ideas further

The results presented show that there is an incremental sophistication of behaviour and knowledge related to the information-seeking behaviour of students. This difference among students was not observed to be based on the degree students were taking (undergraduate, Master's and doctorate) but on their level of involvement in scholarly research work. Such conclusion was made explicit by the fact that undergraduate students in scientific initiation programmes presented more diverse patterns of information behaviour than their colleagues who were not involved in the same programmes. The implication of this finding is that user modelling for knowledge-based systems derived from stereotypes of students according to the degree levels would be rather simplistic for the case study. A better approach may be the combination of a user individualised profile

based on interest and level of expertise and the appropriate task from the information-seeking process.

At the beginning of the analysis the researcher's notion of the domain was in terms of information skills development rather than the more restrictive bibliographic or library instruction, or yet, user education. However, data showed that the reality experienced by the subjects was that of developing library research skills rather than the broader information skills, which involve, apart from library skills, also communication, computer and study skills. That limitation - if it should be called so - shows that subject librarians are concerned with abilities necessary to access information rather than the broader range of skills for processing and using information, and that the reality does not warrant the introduction of new jargon without substantial changes in libraries.

The focus on such concepts as library research and library research instruction, or user education, may not represent the ideal emphasis in today's academic environment, when the volume of, and access to, networked and electronic information services require of students more than the traditional skills associated with the use of the physical library environment and includes also abilities to access, evaluate, synthesise and apply information. However, it has to be pointed out that even when the subjects used terms such as library research and library user education, library research meant more to them than searching in the physical library building only; it meant, and that was represented in the model, the processes associated with identifying, selecting, locating, obtaining, and using information sources in a variety of formats, including informal sources.

One of the limitations of the model is that it does not account for tasks and strategies related to information selection and use as thoroughly as it accounts for tasks and strategies related to information seeking. That is a consequence of subject's view of user education; that it is concerned with access rather than processing and use of information. For an expansion of the model it has been suggested elsewhere in this thesis that other theories related specifically to those

less-refined categories could be connected to the model to result in a more general substantive theory. The connection to existing theory has been advocated by the main proponents of grounded theory (Glasser and Strauss, 1967) and made explicit by Strauss and Corbin (1990) when they advise "as your theory evolves, you can incorporate seemingly relevant elements of previous theories, but only as they prove themselves to be pertinent to the data gathered in your study" (p.50).

Another aspect is that the study collected and analysed self-reported behaviour and perceptions, and opinions; there was no analysis of actual cognitive processes as they happened. For example, internal knowledge sources were associated with tasks according to subjects descriptions of their behaviour or behaviour of others, as in the case of academics talking about students, and not according to observation of subject's mental traits as they executed the task. Other data collection methods such as verbal protocols, captured when subjects were interacting with external knowledge sources, may have produced more specific and detailed accounts of these interactions.

A further point that has to be made is that pedagogical issues were not exhausted in the study, that is, the work did not concentrate on theory and practice of the more appropriate ways for delivering user education. The research attempted to elicit pedagogical issues related to user education and the data demonstrated these issues to be related to strategies, types and properties of mediation. However, these categories and sub-categories of the model reflect the current approach, not optimal approaches for the promoting of learning of information skills. The findings are determined by the research method employed that is concerned with the development of theory that is grounded in the data and resulting from interpretation of the phenomena observed, not with the assessment and projection of ideal situations.

More advanced pedagogical issues must be considered if the transition from the conceptual model to the design model is to be achieved, those issues can be addressed through studies of the theory and practice as presented in the literature

on instruction design and education technology and in case studies of successful applications such as the more recently available Web-based training resources (for example, Dewald, 1999).

The effects of distinguishing characteristics of the Agronomy domain stress the importance of the subject approach to user education. One of these characteristics is the practice-orientation of Agronomy, that is, the field is concerned with the transformation of scientific knowledge into technical information. This characteristic differentiates clearly academics and practitioners in the area and is reflected on the students. In general, models of the information seeking of scholars are not easily generalised to professionals because scholars' ultimate outcome is to produce knowledge whereas professionals' is to produce services (Leckie et al., 1996), thus the information-seeking behaviour of professionals emphasises informal, interpersonal channels while the situation is reversed for scholars.

In the data analysed this information behaviour was confirmed. In the case of academics, even if private knowledge sources were used at first, they led to using a public knowledge source. Simultaneously, analysis of students' differences in information seeking, showed that there was a clear difference between research-oriented and practice-oriented students, as described in Study Three: research-oriented students seemed to have a greater need and interest for information searching and using than practice-oriented students - that fact was also reiterated by several academics and librarians interviewed. Since the majority of the students are going to become professionals rather than academic researchers, the question posed is: what should be taught to these students? Should all the students use the same library research model? Some authors argue that undergraduates hardly do any research and should not have to follow a model designed from the experts' perspective. The position adopted in this work, however, is that the university has to provide formal and standard education for both practice and theory, not differentiating among future professionals or creating a two-tier

system. Consequently, the model proposed should be appropriate to different students needs and interest.

Future developments of the model could benefit from research on the explanation provided by librarians when delivering one-to-one instruction in a real life situation. Procedural knowledge made available in a manner of problem solving, as when the user asks help to solve a specific and real searching problem, is necessary. Inquiring into those interactions could provide a wealth of data for the improvement of the user education model.

Finally, it is important to stress that this is a qualitative research, so the purpose is not to generalise the findings or to take them as representative of a broader section than that which is contained in the data. Although there are no reasons to believe it differs substantially from other research findings, the model may not be comprehensive in terms of theory of the domain in general. However, it is certainly comprehensive in relation to the phenomenon studied and represents the data gathered in the field work. The model would benefit from further studies in other disciplines, the findings could be compared and the model verified if it holds true for different subject areas.

9.2 The Use of Grounded Theory in Domain Modelling

The result of the modelling process of the user education domain is a conceptual model which is based on a knowledge elicitation approach and grounded theory methodology. As a conceptual model, the present model could serve as a mediation representation for the design of a knowledge based, that is, a framework from which knowledge elicitation would progress. It is acknowledged,

however, that the domain model presented here needs further work to form the base of such system.

In terms of knowledge elicitation, the model is a conceptual representation of the domain that can serve as a framework for a possible design model. The model provides an organisation of the different components of the domain and their relationship, indicating elements that raise implications for knowledge-based systems for instruction, for example, tasks and knowledge sources for the expert model and mediation strategies for the tutoring model.

However, as a conceptual model it does not provide with a specification of knowledge content. For example, the particular tools that belong to external public knowledge sources or the expert's internal specifications of domain subject knowledge would not emerge using this methodology. This is so because grounded theory is concerned with the derivation of categories at the conceptual level, it focuses on topics not content or facts. These findings are in accord with Pidgeon et al. (1991) who suggested that grounded theory is appropriate for analysis of broad instances of a phenomenon.

The relevant aspects of grounded theory to knowledge elicitation found in the present study are related to the specifications of the domain, its characteristics, components and context, all important elements for modelling. In addition, grounded theory provided the specification of a shell for structuring knowledge elicitation in general, which was derived from the coding paradigm proposed by Strauss and Corbin (1990).

The grounded theory coding paradigm helped to structure empirical evidence and to discover relationships between concepts for it functions as a "metatheory" for developing grounded theory. In relating grounded theory and knowledge elicitation to this research work, the coding paradigm showed its relevance for structuring the main elements of the knowledge elicitation approach: role of expertise, tasks, sub-tasks, strategies and related knowledge.

The results of the research helped to redefine the coding paradigm proposed by Strauss and Corbin (1990) according to the purpose of domain modelling. Figure 9.1 shows how the elements of the coding paradigm map into the elements useful for domain modelling and which are depicted in the model.

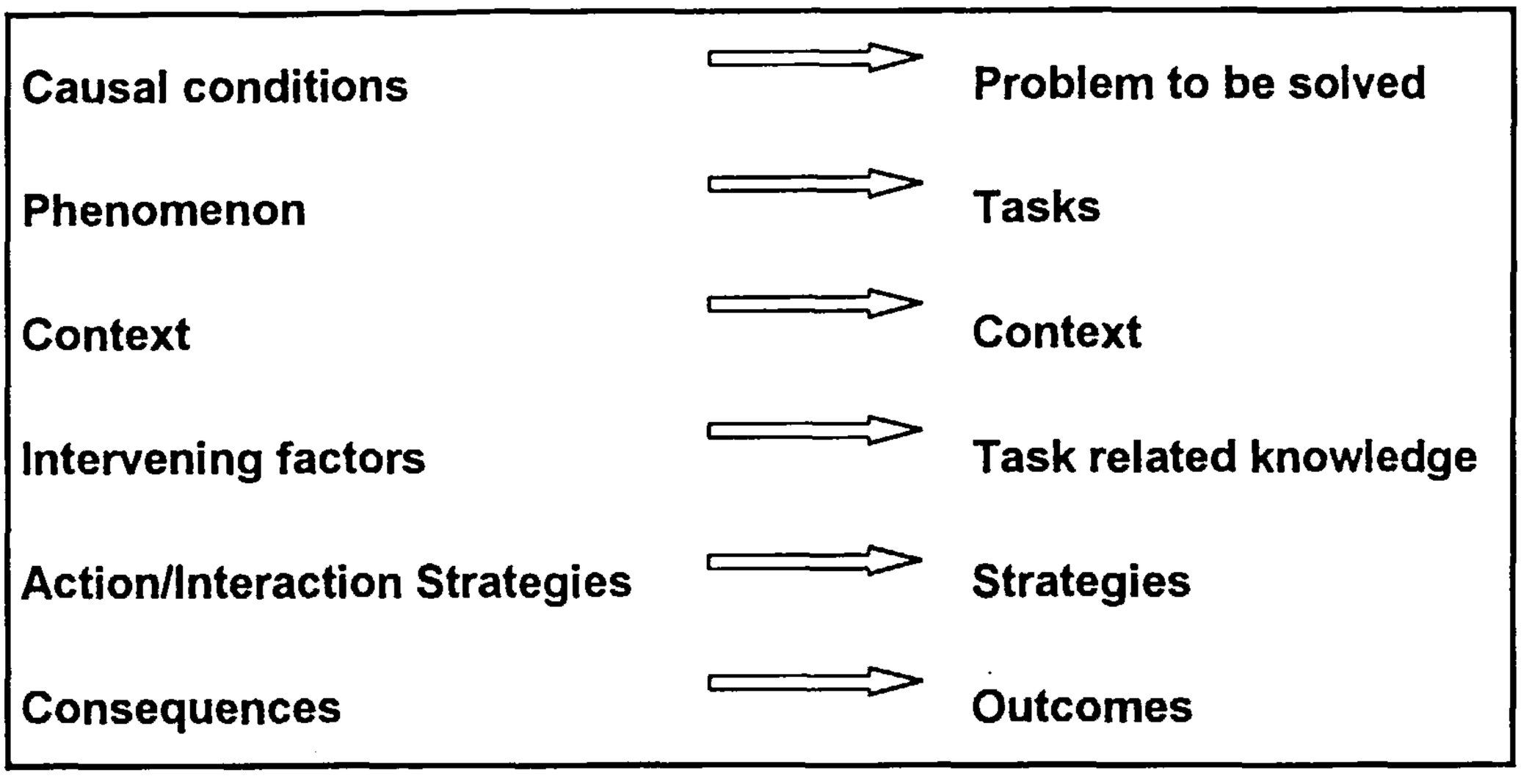

Figure 9.1: The redefinition of the coding paradigm.

The relationship between the elements of the coding paradigm in Strauss and Corbin (1990) and the coding structure redefined for a knowledge elicitation approach are:

Casual conditions in Strauss and Corbin's coding paradigm refers to events or incidents that caused the phenomenon. In the redefined coding strategy, they relate to the roles of experts and/or users in the domain which, in turn, imply in problem(s) within a domain to be solved by the application of expertise.

Phenomenon is represented by tasks in knowledge modelling, that is, the tasks carried out by experts when solving a problem within their expertise are the central events of interest to be identified in the process of knowledge elicitation.

Context relates to the broad environment factors that affects the phenomenon and its occurrence in the case studied. It differs slightly from context in Strauss and Corbin's paradigm which "...represents the specific set of properties that pertain

to a phenomenon; that is, the location of events or incidents pertaining to a phenomenon along a dimensional range." (Strauss and Corbin, 1990, p. 101). It is of interest in a knowledge elicitation approach, which is case-oriented, to identify the context in which the expertise is applied.

Intervening factors, that in the coding paradigm are "the broad and general conditions bearing upon action/interaction strategies" (Strauss and Corbin, 1990, p.103), in the redefined framework are identified with knowledge necessary to carry out the appropriate tasks.

Strategies for accomplishing tasks resemble action/interaction strategies, which in the paradigm are "directed at managing, handling, carrying out, responding to a phenomenon as it exists in context or under a specific set of perceived conditions" (Strauss and Corbin, 1990, p.194.). Finally, consequences of a phenomenon suggest the outcomes of the process studied.

The redefinition of the coding model emerged from the identification, during the application of the coding paradigm to this study, of similarities between its elements and the elements normally associated with knowledge elicitation approaches. It represents a contribution of the grounded theory methodology to knowledge acquisition methods. However, more work is necessary in order to generate the body of research that will be necessary to validate the appropriateness of this framework for knowledge elicitation.

The implication of having the paradigm redefined is that, in combination with grounded theory methods, it can serve as the basis for investigations into other areas of subject librarians' expertise. It can also serve as a framework for librarians themselves to exercise domain modelling related to their activities. Recollecting a quotation by Dow (1992), in the first chapter of this thesis, who suggested that this type of investigations help define the nature of information expertise and systematise the theoretical basis of the discipline, it is added that

both the theory and practice of subject librarianship can benefit from such further studies.

The application of grounded theory to knowledge elicitation may be helpful for certain domains, where there is not a structured model or framework to guide more specific knowledge elicitation sessions and where a theory or model grounded in empirical data is fundamental for an understanding of the domain and the organisation of subsequent knowledge elicitation efforts.

Another contribution of the application of grounded theory to knowledge elicitation is that grounded theory allows for the development of theory as it evolves, that is, the design is allowed to change according to changes in the data collected. Research questions and objectives advanced and were specified from the findings that emerged from each previous stage, or study.

From now one, certain types of knowledge do not have necessarily to be elicited from interviews with experts, some of the public available knowledge in the area can and should serve to this purpose. For example, there is a need to assess questions related to how domain subject knowledge is organised and from where to derive such specification, whether from a thesaurus or other forms of knowledge organisation available in the area, or still yet using some other knowledge acquisition techniques such as concept sorting.

Several other questions to guide knowledge elicitation can now be posed for the conceptual framework proposed to systematise the different components that are central to the domain and their relationship.

The research work reported here sought to contribute to the body of work on user education as part of subject librarians activities, offering insights into both the application of grounded theory to knowledge elicitation processes and the user education domain. Moreover, as an exploratory study, this research work also raises several questions for further investigation which are suggested here.

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Appendix I

Interview Guide for Subject Librarians

Study One

INTERVIEW GUIDE

Part 1: Background

1. What is the formal title of the post or position that you hold?

2. What is (are) your subject area(s)?

3. Did you previously have a background on the subjects? How relevant is it to your job?

4. How long have you been in your present position?

5. Could you briefly describe the way subject specialisation is organised within your library?

Part 2: The job and the expertise

6. Could you state the aim or purpose of your job?

7. Could you describe your job indicating your major duties or responsibilities?

8. How are the activities organised and administered? (How do you divide the time amongst these activities, which are your priorities, which part of your work takes up most of your time, etc.)

9. Could you divide the tasks you perform in terms of activities that involve decision making and activities which involve routine work? (more mechanical)?

10. Is decision making based on knowledge the important aspect of your job. If yes, could you describe the kinds of decisions you make on the job?

11. Would you say that expert knowledge, judgement and experience are the key elements in the performance of your job? Or is it a job that a novice could perform after some tuition?

12. In what aspects the expertise you have differentiate you from the novice subject librarian? (Which are the things that make for your expertise?)

13. Lets take collection development, for example, what kind of knowledge is required to perform the task?

14. Could you describe a typical day of work? Or there isn't a typical day of work for a subject librarian?

Part 3: The relationship with the users

15. Which kind of clientele do you serve directly?

16. Could you describe the extend and nature of your contact with this clientele and the services you provide to them.

Part 4: Evaluation

17. Which part of your work do you regard as the most important? Why?

18. Which part of your work is likely to cause you most difficulty? Why?

19. Which part of your work do you most enjoy doing? Why?

20. Which part of your work do you most dislike? Why?

21. If more time were available at work, is there any activity on which you think you ought spend more time?

22. Can you think of any part of your work in which the expertise or knowledge you use to perform it could be transferred to another person or to a machine?

23. Is there anything else you would like to say about your job?

Appendix II

Interview Guide for Academics

Study Two

INTERVIEW GUIDE

(Academics)

Section A: Identification

1. Firstly, could you please tell me what your position is in the faculty?

2. Could you briefly describe your teaching and research work?

    a. What are your research/teaching interests?

    b. Who are your students?

    c. How long have you been in this position?

Section B: Perceptions on students

3. Broadly speaking what do you expect of the students in relation to the use of the library and information sources?

4. What is the level of information skills students have when they first come to this faculty?

    a. Are there many individual differences? What sort of differences?

5. What sort of skills do you think they have to develop in order to meet information needs they will have here and as professional?

6. How does the faculty as a whole try to develop these information skills amongst students?

7. What is the general level of guidance that the students receive in information seeking during the course as a whole?

    a. How are students encouraged to make use of the information resources?

    b. How are students encouraged to make use of the library facilities?

8. Previously you described to me the level of information skills the students have when they first come to university and the sort of skills they should learn, now I would like to know if do you think they achieve these objectives during their time in this faculty?

a. What contribute to this?

Section C: Information skills programme

9. What is your opinion about the teaching of information skills to students?

a. How important do you think it is?

b. How effective do you think it is?

10. What do you see as its main purpose?

11. What should be taught?

12. Who should receive instruction?

13. When should instruction be given?

14. Who do you think should be responsible for developing instruction?

a. Who should be directly involved in teaching it?

Section D: Information Seeking

15. Consider a situation where you give students an assignment in which they have to use information sources:

a. What sources do they routinely use?

b. Where do you encourage/send students to find information?

c. What guidance is given on sources of information necessary to complete it?

16. How do you keep up-to-date with developments relating to your topic of research/teaching interests?

17. How do you keep up-to-date with other developments in the field?

18. What are the main sources of information for your work?

19. Are there any source that are of particular importance?

20. Have you ever used any index or abstracting service?

a. Have you found it useful?

b. Would you recommend its use to students? In which situations?

21. Have you ever used the Citation Index?

a. Have you found it useful?

b. Would you recommend its use to students? In which situations?

22. Have you ever used Current Contents

a. Have you found it useful?

b. Would you recommend its use to students? In which situations?

23. Have you ever done an online search/have it done for you?

a. Have you found it useful?

b. Would you recommend its use to students? In which situations?

24. Have you ever used e-mail or any network tool for research purposes?

25. Finally, are there any aspect of information skills instruction that we haven't talked about that you would like to discuss?

Appendix III

Interview Guide for Librarians

Study Two

INTERVIEW GUIDE

(Librarians)

Section A: Identification

1. Firstly, could you please tell me what your position is in the faculty?

2. Could you briefly describe the types of duties/work that you carry out?

    a. How long have you been in this position?

    b. What is the extend and nature of your contact with the students?

Section B: Perceptions

3. Broadly speaking what do you expect of the students in relation to the use of the library and information sources?

4. What is the level of information skills students have when they first come to this faculty?

    a. Are there many individual differences? What sort of differences?

5. What sort of skills do you think they have to develop in order to meet information needs they will have here and as professionals?

6. How does the faculty as a whole try to develop these information skills amongst students?

7. Who has the overall responsibility for the co-ordination and planning of the information skills work in the faculty?

8. What is the general level of guidance that the students receive in information seeking during the course as a whole?

    a. How are students encouraged to make use of the information resources?

    b. How are students encouraged to make use of the library facilities?

9. Previously you described to me the level of information skills the students have when they first come to university and the sort of skills they should learn, now I would like to know if do you think they achieve these objectives during their time in this faculty?

a. What contribute to this?

Section C: Ideal information skills programme

10. What is your opinion about the teaching of information skills to students?

a. How important do you think it is?

b. How effective do you think it is?

11. What do you see as its main purpose?

12. What should be taught?

13. Who should receive it?

14. When should it be given?

15. Who do you think should be responsible for developing information skills?

a. Who should be directly involved in teaching it?

17. How do you think user education is perceived by teaching staff?

Section D: Present user's user education programmes

18. I would like to know more about the user's instruction presently given by the library. Could you tell me how it works?

a. What are its objectives?

b. What topics are covered?

c. Who is directly involved in teaching?

d. What techniques for teaching are employed?

e. Who receives the instruction?

f. How are individual differences accommodated?

g. How is student progress measured?

h. How do students react to the instruction?

i. Where does the instruction takes place?

j. When is it given?

19. What proportion of your time is spent in information skills development work?

a. How is this time spent?

20. Have you had any training on how to develop students information skills?

21. What impact has information technology had on your information skills work?

22. What are the main problems you encounter when delivering user's instruction?

23. Is there any form of evaluation of the instruction programme?

24. What are the limitations, if any, of the present methods in meeting students' needs?

a. What improvements could be made to it?

25. Are there any plans for further develop information skills work? What?

26. Apart from formal user's instruction are there other opportunities for students to gain bibliographic/library skills?

27. Finally, are there any aspect of information skills instruction that we haven't talked about that you would like to discuss?

Appendix IV

Interview Guide for Students

Study Three

INTERVIEW GUIDE

(Students)

Section A: Identification

1. What programme are you in?

[Postgraduates] Could you talk briefly of you research work?

2. What year are you in?

[Post] What stage of you research work are you in at the moment?

3. Which age group are you in? a) less than 20 b) 20 to 25 c) 25 to 30 d) 30 to 40 e) more than 40

4. Could you talk about your history as a students? What were you doing before starting entering this programme?

Section B: Information-Seeking Behaviour

5. Where do you normally look for course related information?

[Prompt] Classes, Lecturer, Handout, Books, Journals, Colleagues, Librarians...

6. Where do you look for information when you have a problem related to a topic of study?

[Prompt] Classes, Lecturer, Handout, Books, Journals, Colleagues, Librarians...

7. How satisfied are you after looking for information this way?

8. Can you find relevant information to your needs?

9. What do you do when you cannot find information about the topic you were looking for?

10. Specifically about bibliographic information, how do you choose a place to start looking for it?

[Prompt] Lecturers, reading lists, other people/colleagues, reference sources from the library, catalogues, library shelves...

11. [Postgraduates] How do you keep up-to-date with developments relating to your topic of research?

[Graduates] Where do you look for information for a course assignment?

12. How do you decide if the material you found is appropriate or not to your needs?

13. Do you use e-mail and/or Internet for course-related information searches? How?

14. Have you ever used a bibliographic database in CD-ROM? Agricola?

a. How did you get to know about it?

b. Where you satisfied with the results?

15. Have you ever used any index or abstracting service?

a. How did you get to know about it?

b. Where you satisfied with the results?

16. Have you ever used the Current Contents?

a. How did you get to know about it?

b. Where you satisfied with the results?

17. Have you ever used the Citation Index?

a. How did you get to know about it?

b. Where you satisfied with the results?

18. When do you use those types of reference sources, how do you search for information on them? Do you normally experience any difficulties?

Section D: User Education

18. Have you ever received any type of instruction on how to use the library, the information sources, or on how to carry out research in the library?

[Yes] a. When was that?

b. How was it?

c. Have you ever applied what you learned there?

d. What do you think was missing, if anything?

e. Who do you think should deliver that instruction?

[No] a. Do you think that instruction should be useful for you?

b. What period in the course?

c. What would you like to learn there?

d. Who do you think should deliver such instruction?

19. Do you think you learn enough during the course to be able to search independently for information when you leave the faculty? Do you already feel prepared?

20. Finally, do you believe computers can be used for learning about information sources and library use? How would you feel about it?