Uncertainty in Information Seeking and Retrieval in the Context of Higher Education

Thesis submitted for the degree of Doctor of Philosophy

By

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Abstract

Human information behaviour is an area of research that deals with different aspects of information seeking and retrieval. The increase in information availability on the web has significantly influenced information seeking and retrieval. Several issues relating to information seeking and retrieval in a digital environment still remain unexplored and uncertainty is one of them.

Uncertainty is an important concept within human information behaviour research, and the general belief is that uncertainty decreases in the course of an information seeking and retrieval process, until eventually it disappears. However, in today's digital environment, uncertainty may be caused by a number of factors, and such uncertainty may persist throughout, or even after completion of, the information seeking and retrieval process. The general objective of this research was to study whether uncertainty occurs at different stages of the information seeking and retrieval process in a digital information environment in the context of higher education. This research also aimed to identify whether or not uncertainty persists in an information seeking and retrieval process and also if there is any uncertainty shift in course of a series of information seeking and retrieval processes. A number of techniques, i.e. online questionnaire, in-depth interviews, pre and post-search questionnaire, task-based search, and talk aloud were used to collect data for this research.

Results show that some form of uncertainty is always associated with the information seeking and retrieval process and that there is an uncertainty shift in relation to a series of successive searches. Based on the results of this research, a new model of uncertainty in information seeking and retrieval has been proposed which will assist in designing improved information systems for easy and better digital information access and use.

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Chapter 1
Introduction

1.1 Overview

In today's digital environment, users are very much dependent on information and communication technologies in order to create, manipulate or interact with digital content on different platforms, different media, different languages, and in different formats. Information required by an individual at a particular moment may be available within sources that can be accessed through a variety of information channels. People look for information from a vast range of sources and use it as part of their daily life, whether for work, leisure, or health. However, it is often quite difficult to determine which of the various channels could provide the required information in the most effective and efficient manner (Chowdhury & Landoni, 2006).

We live in an era of information explosion. With the development of a wide variety of technologies a constant flow of information is now entering our lives. This constant flow of information is often described in terms of irrelevant or an excessive amount of information, or in terms of an inability to manage or understand the information (Case, 2007). We may all agree as to certain advantages of the availability of a wide range of information through the advancement of technologies. However, 'every coin has two sides', and there are some problems associated with the ease of access to information. Information overload is such a problem which in simple terms may be defined as receiving too much information (Klaussegger, Sinkovics, & Zou, 2007). Recent usability studies have shown that web users are extremely impatient and that they spend an average of only 27 seconds on each webpage because they think that there is too much 'irrelevant junk on the internet' (Nielsen & Loranger, 2006, p.22). Other studies have shown that the constant flow of information can seriously reduce a person's ability to focus on tasks (Knight, 2005).

Information seeking is 'a dynamic and complex process' (Komlodi, 2004, p.164). It is also 'an intellectual process' (Kuhlthau, 2004, p.5) and it is 'a process of construction with all the accompanying dynamic complexities' (Kuhlthau, 2004, p.30). With the proliferation of the web resulting in wide and easy access to a large amount of information, information seeking is increasingly becoming a complex task involving many steps and requiring various tools, task domains, systems, and searching expertise (Komlodi, 2004). Heimlich (2003) identifies thirteen barriers to access and use of electronic sources and among these 'information overload' has the highest score followed by the 'trustworthiness of information'. Katopol (2006) mentions that information overload and anxiety are the key issues that need to be considered in designing information systems to facilitate information seeking of undergraduate and graduate students who find themselves lost in an unfamiliar information world. Researchers across various disciplines have found that the performance (quality of decisions or reasoning in general) of an individual correlates positively with the amount of information he or she receives – up to a certain extent (Eppler & Mengis, 2003). Therefore, users not only want to have easily accessible information but also want the gathering of the information to be effortless (Melgoza, Mennel, & Gyeszly, 2002). Fortunately information science researchers around the world, especially in the field of human information behaviour, are building integrated frameworks that model different aspects of information seeking, retrieval and use (Spink & Foster, 2007).

1.2 Background and Rationale of the Research

Human Information Behaviour (HIB) is an area of research that deals with different aspects of an information seeking and retrieval process. Nahl (2001) comments that 'in the information fields, the behavioural approach has been dominant in relation to identifying *what* users do *when*. In other words, how they search, what errors they make, what they consider relevant, what they know or comprehend, what choices they make, which feelings they express or how much value they attach to some outcome'. Considerable HIB research has been reported in the literature (see for example, Berryman, 2006; Byström & Hansen, 2005; Fidel & Pejtersen, 2004; Foster, 2005;

Gaslikova, 1999; Heinström, 2003; Johnstone, Bonner, & Tate, 2004; McKechnie et al., 2005; Wilson, 1994, 1997). Much of this research has also been reviewed and analysed in a number of recent books (for example, Case, 2007; Fisher, Erdelez, & McKechnie, 2006; Ingwersen & Jarvelin, 2005a; Spink & Cole, 2005b; Spink & Cole, 2005c).

People seek information to deepen and broaden their understanding about the things around them and, therefore, the users' perspective becomes an essential component in information provision and it is necessary to understand the users' perspective to design more effective services (Kuhlthau, 2004, p.13). Users' information seeking behaviour incorporates the interplay of cognitive (knowledge) and affective (feelings) factors (Martzoukou, 2005). Kuhlthau (2004, p. 23) explains that 'interpreting, choosing, and creating the inconsistent, often incompatible information encountered is likely to cause profound feelings of uncertainty, confusions, anxiety, and even threat'.

Information behaviour is an interdisciplinary area of study which is growing significantly across a wide range of disciplines including information management and librarianship, marketing, media studies, information systems and consumer research (Wilson & Allen, 1999). To these can be added: psychology, sociology and management science, and so on (Banwell, 2001). Therefore, different aspects of information behaviour is an emerging multidisciplinary viewpoint that is providing an increasing amount of theoretical support for research being undertaken in the area (Banwell, 2001).

The increase in information availability on the web has significantly influenced information seeking behaviour (Chowdhury, Gibb, & Landoni, 2009). Information seeking on the web is an emotional experience (Kalbach, 2004). The digital world brings us into contact with networked information systems with the potential to help us locate information quickly and easily at the touch of a button. However, it is far from easy to find the exact information we need quickly because every new resource added increases the time needed to locate the right information (Anderson et al., 2006). Despite extensive HIB studies, several issues relating to information seeking in a digital

environment still remain unexplored (Chowdhury & Gibb, 2009). As Kalbach (2004) comments, 'confusion and uncertainty tend to dominate feelings of enthusiasm and optimism. The joy of discovery and pride of learning can be rare feelings against a backdrop of frustration and a sense of being overwhelmed for many web searchers. Though this situation has been widely commented on and acknowledged, specific design techniques that account for the entire information seeking experience seem lacking'. In a recent paper, Wilson (2006a) stresses that electronic information resources in different formats and structures are becoming the dominant environment, and therefore user interactions on the web and in digital library environments will become a key theme for future research.

As humans struggle to seek and use information within the growing and complex range of information sources available via the web, information science research is concerned with how humans create, seek, retrieve and use information, and particularly with human interactions with information systems like digital libraries and the web (Spink, 2000). From the cognitive point of view information is 'one of the most central phenomena of interest to information seeking and retrieval … understanding this phenomena is an imperative for enhancing our conception of other central phenomena such as, information need formation and development, relevance, or knowledge representation, acquisition and use' (Ingwersen & Jarvelin, 2005a, p. 31).

Uncertainty has become established as a major area of research in information science. Uncertainty in information seeking and retrieval often causes anxiety, and as Cole et al (2007, p. 2093) comment, 'how often do searches for information end in failure due to heightened anxiety? Probably a great many'. Uncertainty is a term used in subtly different ways in a number of fields, including philosophy, statistics, economics, finance, insurance, psychology, engineering and science[1]. According to Hubbard (2007), uncertainty is the lack of certainty, or a state of having limited knowledge.

[1] http://encyclopedia.thefreedictionary.com/Uncertainity

Van Rijsbergen (1996) proposes a logical model of uncertainty and introduced seven types of uncertainty – ignorance, incompleteness, undecidability, complexity, randomness, vagueness, and imprecision – to be considered within a probabilistic approach. Whittemore and Yovits (1973) identify six different types of uncertainty and they develop a model which permits the evaluation of the measure of information in terms of the reduction of uncertainty to a decision maker.

Bates (1986, p. 357) proposes a model of information behaviour that is 'based on three design principles – uncertainty (subject indexing is indeterminate and probabilistic beyond a certain point), variety (by Ashby's law of requisite variety, variety of searcher query must equal variety of document indexing), and complexity (the search process, particularly during the entry and orientation phases, is subtler and more complex, on several grounds, than current models assume)'.

Kuhlthau (1993) proposes that uncertainty is a principle for information seeking. She emphasises that 'uncertainty is a cognitive state that commonly causes affective symptoms of anxiety and lack of confidence [and therefore] uncertainty due to a lack of understanding, a gap in meaning, or a limited construct initiates the process of information seeking' (Kuhlthau, 1993, p.111). Information seeking incorporates the experience of interacting thoughts, actions, and feelings in the process of construction and uncertainty initiates the process, and anxiety and an unsettling discomfort may be experienced in the early stages of the information process (Kuhlthau, 2004).

Wilson et al., (2002) note that uncertainty is a useful variable in understanding information-seeking behaviour. The affective symptoms of uncertainty are mainly associated with vague, unclear thoughts about a topic or problem like what to look for, where to search, etc. In his model of general information behaviour, Wilson (1996) lists a set of factors that affect information access and use. Furthermore, Kuhlthau (2004, p.8)

stresses that 'the concept of an uncertainty principle as a theoretical statement needs further development to include the users' perspective on information seeking'.

Kuhlthau (2004, p.103) defines uncertainty as 'a cognitive state that commonly causes affective symptoms of anxiety and lack of confidence'. She also stresses that 'uncertainty is a necessary critical element in any process of construction' (p.7). In the context of HIB studies, uncertainty is widely recognised as the trigger for information seeking and use. Researchers in general suggest that information seeking process begins with an uncertainty and as the user proceeds through the information seeking and retrieval process, uncertainty gradually decreases. Kuhlthau (2004) points out that a feeling of uncertainty reaches at its peak at the third stage, i.e. *prefocus exploration* but it diminishes at the next stage, i.e. *focus formulation* (Kuhlthau's six stage model is discussed in Chapter3, Section 3.2.1, p. 43). In other words, uncertainty decreases when the searcher proceeds towards the completion of the search process.

Wilson et al. (2000, 2002) agree with Kuhlthau that uncertainty decreases, but they also argue that at any of the four stages of Wilson's model (Wilson,1999c) i.e. problem recognition, problem definition, problem resolution, and solution statement uncertainty may arise and successive searches within the same stage, or any other stage, may be required to resolve the problem. Nevertheless, the basic tenet here is that uncertainty eventually disappears at the end of an information seeking and retrieval process.

The basic hypothesis of the present study is that although cognitive or affective factors in a specific area or topic trigger information seeking, it forms an integral part of the entire information seeking and retrieval process in a digital environment. It is likely that even after a long information retrieval session a user may still be uncertain of several information retrieval factors, such as sources or channel characteristics, comprehensiveness of the retrieved items, reliability, and usability of the information sources or services, and so on. In order to study the phenomenon of uncertainty in information retrieval it is necessary to study the underlying activities, because as

Vakkari (2003) stresses several studies have concentrated on search tasks but only a few on the activities that trigger them.

Traditionally in the context of information seeking and retrieval uncertainty has been associated with negative feelings that result in anxiety, frustration, lack of confidence, technophobia, etc. However, recent research shows that uncertainty does also have some positive impact. For example, Anderson (2006) shows that uncertainty caused by various stages of the information seeking process can lead to creativity and innovation. Therefore, it is extremely important to study whether uncertainty exists at various stages of information seeking and retrieval and how this influences the information seeking behaviour of users.

To the best of the knowledge of this researcher, no research has been done so far to study if uncertainty occurs in the course of different information seeking activities, as a consequence of different information seeking problems or in relation to types of information sources, and if uncertainty has any positive impact on the entire information seeking and retrieval process. This research has therefore been conducted to study these issues and relationships. The reasons for conducting such research have been neatly summed up in a recent research paper:

> 'The current information environment is rich, characterized by a proliferation of information sources and providers, a multiplicity of methods for accessing information, and redundancy of content from multiple sources. In this "overloaded" information environment, many information users tend to experience a sense of information inadequacy and anxiety. How do individuals navigate this complex landscape of information? Furthermore, how do individuals assess the information they find as being enough to satisfy their specific need? In this complex environment, understanding how individuals choose to satisfy their information needs takes on new urgency. Insight into information seeking can be gained by understanding how users seek information sources and how they choose content to meet their needs.' (Prabha et al., 2007, p. 74)

1.3 Objectives of the Research

The general objective of this research is to study whether uncertainty occurs at different stages of the information seeking and retrieval process in a digital information environment in the context of higher education. The domain of higher education has been chosen because the impact on academic users of electronic information systems and sources to support research, teaching, publishing and other activities is potentially enormous; and in the modern digital information environment users are better off than ever before in some ways, but in other ways the information world has become even more threatening (Banwell, 2001).

More specifically, this research has been conducted:

- to establish whether uncertainty occurs in the course of different information seeking and retrieval activities among academic users of different categories: research students, research staff and academic staff in higher education, from different disciplines, different gender and age groups, and different degrees of ICT skills;
- to establish whether uncertainty is caused by any information seeking problems among the selected users;
- to establish whether uncertainty occurs in relation to access to, and use of, a specific type of information channel or source among the selected users; and
- to develop a model showing how uncertainty affects the information seeking and retrieval process in relation to information seeking activities and information seeking problems.

1.4 Research Hypotheses and Questions

The three main hypotheses of this research are:

Hypothesis 1

Uncertainty occurs in relation to different information seeking activities, information seeking problems, and specific information channels or sources.

Hypothesis 2

In the course of a series of information search sessions, uncertainty shifts from one information seeking activity or problem to another.

Hypothesis 3

Uncertainty has a positive impact on the information seeking and retrieval processes especially in the course of a series of information search sessions.

More specifically, this research aims to establish and identify:

- Whether or not information seeking activities, information seeking problems, and specific information channels or sources cause uncertainty in information seeking and retrieval among different user categories in the academic environment.
- Whether or not information seeking activities, information seeking problems and specific information channels or sources cause uncertainty in information seeking and retrieval among users in different disciplines.
- Whether or not information seeking activities, information seeking problems and specific information channels or sources cause uncertainty in information seeking and retrieval among users of different gender.
- Whether or not information seeking activities, information seeking problems and specific information channels or sources cause uncertainty in information seeking and retrieval among users of different age groups.
- Whether or not information seeking activities, information seeking problems and specific information channels or sources cause uncertainty in information seeking and retrieval among users of different levels of ICT skills.

- Are there any correlations among the information seeking activities that cause uncertainty in information seeking and retrieval?
- Are there any correlations among the information seeking problems that cause uncertainty in information seeking and retrieval?
- Does any form of uncertainty persist after completion of the entire information seeking and retrieval process? If so, is there any uncertainty shift?
- Is there any positive impact of uncertainty on information seeking and retrieval?

1.5 Scope of the Research

This study aims to identify if uncertainty exists in relation to information seeking activities, information seeking problems, and specific information channels or sources in information seeking and retrieval processes in the higher education environment. The connotation of uncertainty, in this research, is only related to a number of information seeking activities, information seeking problems and information sources. A number of information seeking activities, information seeking problems and information channels or sources have been identified (see Chapter 3) for this study. This study did not intend to measure uncertainty by using any cognitive method.

1.6 Limitations of the Research

After reviewing related literature and conducting informal academic discussions with a small group of academic users, 14 information seeking activities, 21 information seeking problems, and 17 specific information channels or sources were identified, and only these are considered for this study. The number of information seeking activities and information seeking problems, and specific information channels or sources are not necessarily exhaustive or mutually exclusive. The main objective of this research has been to study whether and how uncertainty occurs in relation to certain information

seeking activities, information seeking problems, and specific information channels or sources. However, in some cases, the degree of uncertainty was measured by analysing the data given in a five-point Lickert scale while somewhat different findings could be obtained if a wider range was used.

1.7 Implications of the Research

Ford (2000) has argued that HIB research, especially cognitive research, has not yielded results and models that can be used by system designers for improved system development. Ford (2000) further advocates that there is an urgent need for this work to be continued, increased and subjected to detailed analysis and re-evaluation. Nevertheless, HIB research has the potential to provide models and results that system designers can exploit; as Banwell (2001) comments, an in-depth understanding of users' information behaviour should underpin the design and delivery of information provision in all contexts. However, this is a challenging area and as Gorman (2001) stresses, the understanding of users' information behaviour in the higher education sector is a complex task.

Since this research is being done to identify if users experience any uncertainty in relation to information seeking and retrieval process, the findings can be useful for system designers to decide the design criteria and to look into users' perceptions, and also users' recommendations, based on their experiences, to develop or modify future systems and services. It is essential to make good human-centred design which will make people more tolerant of difficulties and more flexible and creative in finding information and therefore, will enhance the usability of the systems and services (Norman, 2002). The outcome of this research will help to handle information overload and to keep uncertainty in relation to information seeking and retrieval at bay and it will also give some ideas and pointers for future research.

1.8 Organisation of the Thesis

This chapter provides some background information for this research along with the general objectives, specific research questions, etc. This chapter also discusses the scope and limitations of this research. Chapter 2 reviews literature related to this research. In Chapter 2, different human information behaviour models are discussed and different works on uncertainty are analysed. Methods used for carrying out the various phases of this research are discussed in Chapter 3.

Chapters 4, 5, 6 and 7 are related to the empirical part of the study. The analysis of the quantitative study and its results are presented in Chapter 4. Chapter 5 discusses the correlation among different information seeking activities and information seeking problems. Chapters 6 and 7 discuss different phases of the qualitative study and its results. Finally in Chapter 8 conclusions of this study are presented, and based on the findings an uncertainty model for information seeking and retrieval is proposed. Some recommendations are then made based on the results. Citations in this thesis are presented according to the APA style[2].

[2] http://www.psywww.com/resource/APA%20Research%20Style%20Crib%20Sheet.htm

Chapter 2

Literature Review

2.1 Introduction

Over 10,000 articles have been published on information seeking from different disciplines and there has been a steady growth since 2000: '30 items per year during the early 1970s, 40 during the early 1980s, 50 by the late 1980s, 100 by the 1990, and 120 items per year by 2005' (Case, 2007, p.242). Keeping track of such a rapidly growing literature is a challenging task. Fortunately, a representative range of literature has been reviewed in several publications including:

- '60 years of the best in information research on user studies and information needs' by Wilson (2006b)
- 'A three decade perspective on Tom Wilson's 'On user studies and information needs' by Bawden (2006)
- ARIST chapter 'Information behavior' by Case (2006)

In addition, a number of sources have emerged which deal exclusively or predominantly with information seeking, for example,

- ISIC (Information Seeking In Context) conference series since 1996-
- Special issues of several journals including *Informing Science*[3], *Journal of the American Society for Information Science and Technology*[4], *Journal of*

[3] 2000, vol. 3, no.2
[4] 2004, vol. 55 no.8

Documentation [5], *Information Processing & Management* [6] , and *Library & Information Science Research*[7]

- *Information Research*[8] journal edited and published by T. D. Wilson
- A number of recent books and edited books including: *Looking for information* (Case, 2007), *New directions in human information behaviour* (Spink & Cole, 2005b), *The Turn* (Ingwersen & Jarvelin, 2005a), and *Theories of information behaviour* (Fisher, Erdelez, & McKechnie, 2006).

Given the huge volume and variety of literature in information seeking on the one hand and the lack of sufficient relevant literature particularly on the topic of uncertainty in information seeking and retrieval, which is the main theme of this research, a specific strategy was adopted for choosing literature for this review. Because there was not enough literature on uncertainty in information seeking and retrieval per se to cover for the entire chapter, literature from the peripheral area of study was chosen. The reasons for choosing literature from the wider area of human information behaviour and information seeking and retrieval in general were: first to put the research into proper context, and second to show how and where the issue of uncertainty in information seeking and retrieval fits into the general domain of human information behaviour research.

A top-down approach has been taken to discuss the chosen literature in this chapter. However, since the overall volume of literature is huge, the scope of this chapter has been narrowed down to certain aspects of human information behaviour. Since pre-2000 research publications on human information behaviour has been widely reviewed in the literature mentioned above, most of the publications chosen for this research appeared from 2000 onwards. However, key publications that appeared before 2000 on human information behaviour and information seeking models, and especially those that touch upon the concept of uncertainty in information seeking and retrieval, have also been reviewed in this chapter.

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[5] 2006, vol. 62, no., 6 and 2007, vol. 63 no. 1
[6] *Designing for Uncertainty*, forthcoming, mid-year 2008
[7] 2001, vol. 23, no. 4
[8] http://informationr.net/ir/

The review begins with the definition of human information behaviour, and information seeking and retrieval. This was considered necessary because it sets the overall background of the human information behaviour study in general, and makes a perfect fit for further discussions on the concept of information seeking and retrieval which is a subset of human information behaviour research. Again, the review in these two areas are not supposed to be exhaustive because several representative publications exist that review the entire field, as mentioned above, and moreover, the objective of this part of the review was to set the background, and consequently only representative publications were chosen for this review.

Several models have been proposed in the literature aim to provide a theoretical underpinning of the information seeking and retrieval process focusing particularly on the human aspects. Therefore, representative information seeking behaviour models that are related to this research have been reviewed in this chapter. The main objective of this review which guided the principle of selection of the models, was to find out what researchers have said with regard to the cognitive aspects of information seeking and retrieval and thus to find out how uncertainty occurs, and what is its impact, on information seeking in the modern electronic information environment.

Furthermore, keeping in view the specific scope of this research, i.e. a study of uncertainty in information seeking and retrieval in the electronic environment and among users in an academic environment, it was decided that representative literature in the web information seeking and retrieval in various domains, and within the academic environment in particular, would be appropriate for this literature review. Finally, literature on uncertainty in information seeking and retrieval processes were chosen and analysed critically in order to build a theoretical background and appropriate justifications for this research.

2.2 Human Information Behaviour

A strong relation exists between the philosophy of information and human information behaviour since both aim to explore the concept of information and premise information as a fundamental concept basic to human existence (Spink & Cole, 2004a). Human Information Behaviour (HIB) looks at information and its role in human life at its widest possible level. People seek information all the time, often without any apparent reason, and often without even being aware of the need for information (Spink & Cole, 2004b).

Taylor (1991) defines information behaviour as '... the sum of activities through which information becomes useful ...' (p.221). A definition, from the perspectives of information management, is provided by Wilson who considers information behaviour as 'the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking, and information use' (Wilson 2000, p.49). HIB tries to link the human condition and information together; Pettigrew, Fidel, and Bruce (2001, p.44) comment that information behaviour is 'how people need, seek, give and use information in different contexts.' Davenport (1997) provides a more comprehensive definition of HIB, especially from the perspectives of information management, by saying that HIB is '...how individuals approach and handle information. This includes searching for it, using it, modifying it, sharing it, hoarding it, even ignoring it. Consequently, when we manage information behaviour, we're attempting to improve the overall effectiveness of an organization's information environment through concerted action' (p.83).

It is important to note that information behaviour 'encompasses information seeking as well as the totality of other unintentional or passive behaviours (such as glimpsing or encountering information) as well as purposive behaviours that do not involve seeking such as actively avoiding information' (Case, 2007, p.5). Nevertheless, information and information acquisition are seen as fundamental to human existence, enabling us to constantly adapt so that we can survive in an ever-changing physical and social environment (Spink & Cole, 2005a).

Although HIB is an area largely studied within the field of library and information studies, researchers from other fields have also studied HIB, as McKechnie et al (2005). comment:

> 'HIB literature is being cited, primarily (81.5%) by LIS authors. Fields outside of LIS citing HIB articles include engineering, psychology, education and medicine..... It appears to be a second stage discipline, marked by theoretical consistency and exponential growth in publications and new researchers.'

Emphasising the importance of HIB studies in the context of the modern digital information era, Wilson (2006a, p.683) comments that '....electronic information resources, structured in various ways, are becoming the dominant environment within which information seeking takes place and, consequently, the current engagement with the relationship between seeker and the world wide web, digital libraries and other information structures is likely to continue.....'

2.3 Information Seeking and Retrieval

People engage in information seeking behaviour because their current state of knowledge is inadequate to resolve some problem, or achieve some goal (Belkin, 2000). Marchionini (1995) defines information seeking as 'a process in which humans purposefully engage in order to change their state of knowledge' (p. 5). He further comments that 'information seeking is a fundamental human process closely related to learning and problem solving', and it is a 'high level cognitive process' (Marchionini, 1995, p. 6) A similar view is also expressed by many other researchers. For example, Case (2007, p. 333) comments that information seeking is a 'behaviour that occurs when an individual senses a problematic situation or information gap, in which his or her internal knowledge and beliefs, and model of the environment, fail to suggest a path towards satisfaction of his or her goals'. Information seeking research and theory is increasingly focusing on the role of information behaviour and its impact on cognitive behaviour (Nahl, 2004).

Some researchers prefer the term information seeking and retrieval (often referred to in the literature as IS&R) to information seeking. Ingwersen and Jarvelin (2005) comment that

> 'With reference to the cognitive viewpoint information is one of the most central phenomena of interest to information seeking and retrieval [IS&R] and information science in general. Understanding this phenomenon is an imperative for enhancing our conception of other central phenomena, such as, information need formation and development, relevance, or knowledge representation, acquisition and use' (Ingwersen & Jarvelin, 2005a, p.31).

Although the terms information seeking and IS&R are often used interchangeably in literature, the term information seeking and retrieval has been used in this research where information seeking and retrieval behaviour is defined as 'human information behaviour dealing with searching or seeking information by means of information sources and (interactive) information retrieval systems' (Ingwersen & Jarvelin, 2005a, p.21). Vakkari and Jarvelin (2005) identify the goals of information seeking and retrieval research as:

> '(a) theoretically understanding information seeking and retrieval in the form of models and theories, (b) empirically describing and explaining IS&R in various contexts, and (c) providing support in the design of information systems and information management in various contexts' (p.114).

2.4 Information Seeking and Retrieval Models

Models focus on more specific problems than do theories (Case, 2007). There has been a considerable interest in recent years in producing conceptual models for information seeking and retrieval research (Järvelin & Wilson, 2003). Many models have been proposed to strengthen research in the area of human information behaviour especially in the field of information seeking and retrieval (Ingwersen & Jarvelin, 2005a). However, only certain representative models, i.e. Belkin (1980), Ellis (1989), Ingwersen (1992,

1996), Kuhlthau (1991, 1993), and Wilson (1981, 1997) are discussed in this chapter. These were considered to be particularly related to this research because, as described below they discuss, explicitly or implicitly, the notion of uncertainty in information seeking and retrieval.

2.4.1 Belkin's ASK (Anomalous State of Knowledge) Model

The essence of Belkin's (1980) ASK (Anomalous State of Knowledge) model is that an information need arises from a recognised anomaly in the user's state of knowledge concerning some topic or situation and that, in general, the user is unable to specify precisely what is needed to resolve that anomaly. Anomaly in Belkin's (1980) model is defined as a state of inadequacy which could be due to a lack of knowledge as well as to many other problems, such as uncertainty as to which of several potentially relevant concepts holds in a given situation. Therefore, it is more important to attempt to describe that ASK than to ask the user to specify the need as a request to the system.

The underlying concept in Belkin's (1980) model is that there exists a universe of texts that have been generated by a large number of human beings and the actual communication begins when the recipient engages with one or more texts and thereby completes the communication system; the process terminates when some goal has been achieved. There are two levels of communications in Belkin's model – at the linguistic level generators produce texts that users read; and at the cognitive level the texts are understood as being representation of the conceptual states of knowledge of their generators. Recipients' understanding is modified by their purposes, values, intentions, beliefs and their state of knowledge (Figure 2.1).

2.4.2 Wilson's Model

Wilson's model is widely considered as one of the most comprehensive explanations of information seeking behaviour (Figures 2.2 and 2.3). Figure 2.2 shows Wilson's 1981

model, as modified in 1999, where he placed Ellis's (1989) list of characteristics of information seeking behaviour within the context of an information need i.e. the person's environment, social roles and individual characteristics. That same context presents barriers – personal, role-related and environmental – which must be overcome before successful information seeking takes place.

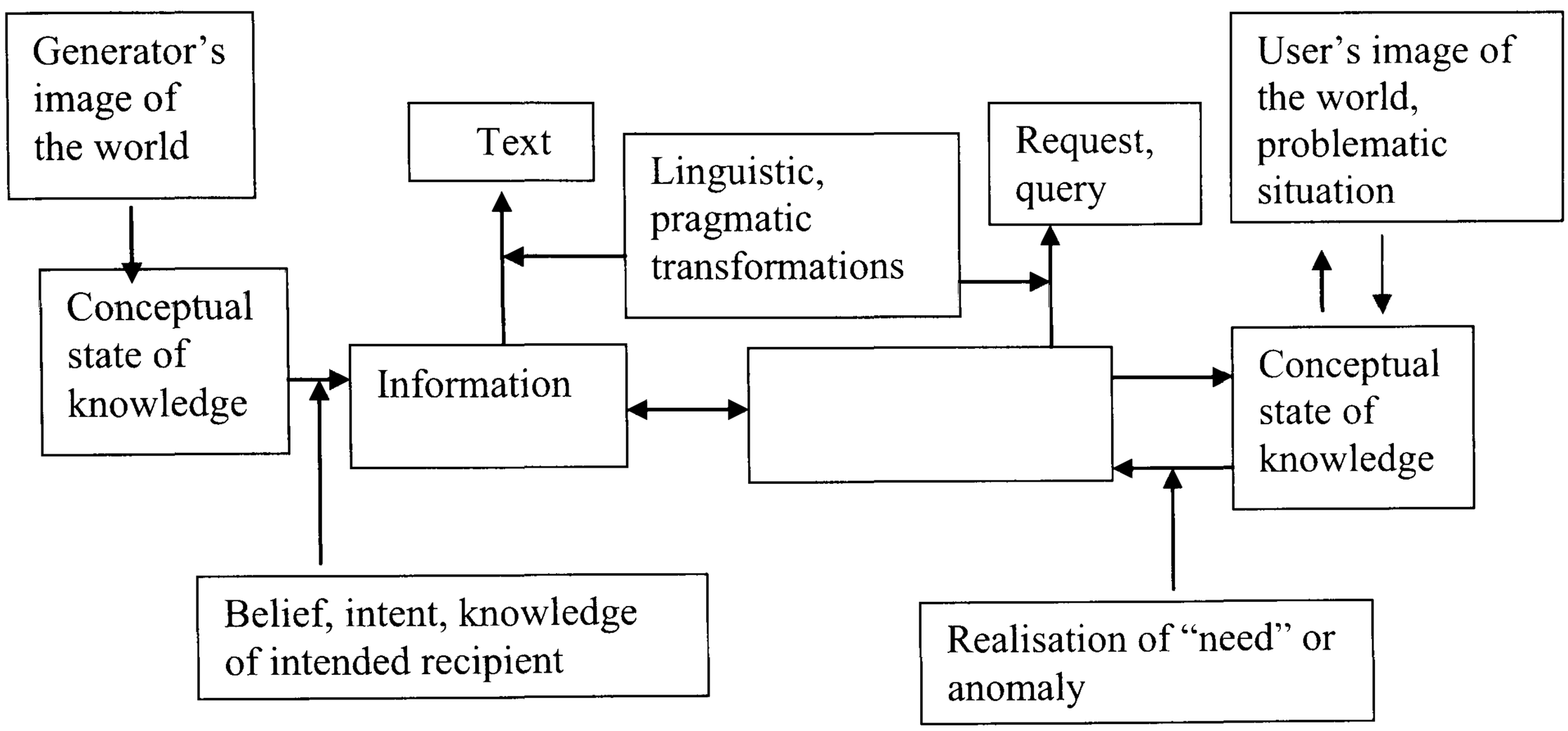


Figure 2.1: The communication system of interest to information science (Source: Belkin, 1980, p. 135)

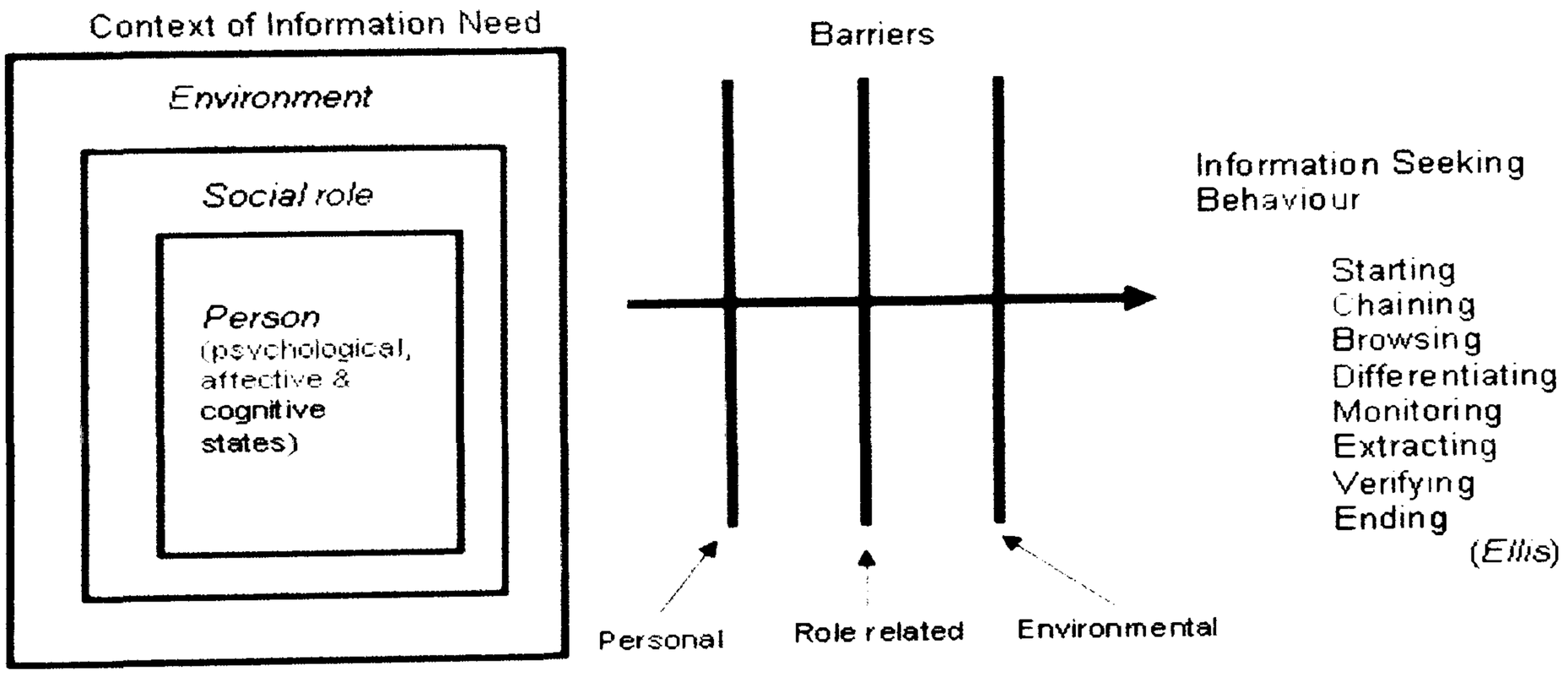


Figure 2.2: Wilson's 1981 model of information seeking behaviour (adapted from Wilson, 1999a)

Wilson later (1999a) described this 1981 model as a 'macro model or a model of the gross information–seeking behaviour' because it 'implies hypotheses about information context without making them explicit, and that it does not indicate the processes whereby a person is affected by context, nor how context then affects his or her perception of barriers to information seeking' (p. 252).

Wilson (1997) subsequently expanded this model, as shown in Figure 2.3. It portrays the cycle of information activities from the rise of information need until the information is being used. It identifies some intervening variables which have a significant influence on information behaviour, and mechanisms which activate it. The rise of a particular need is influenced by the context, which can be the person or the role the person plays in work and life, or environment (social, political, economical, technological, etc.).

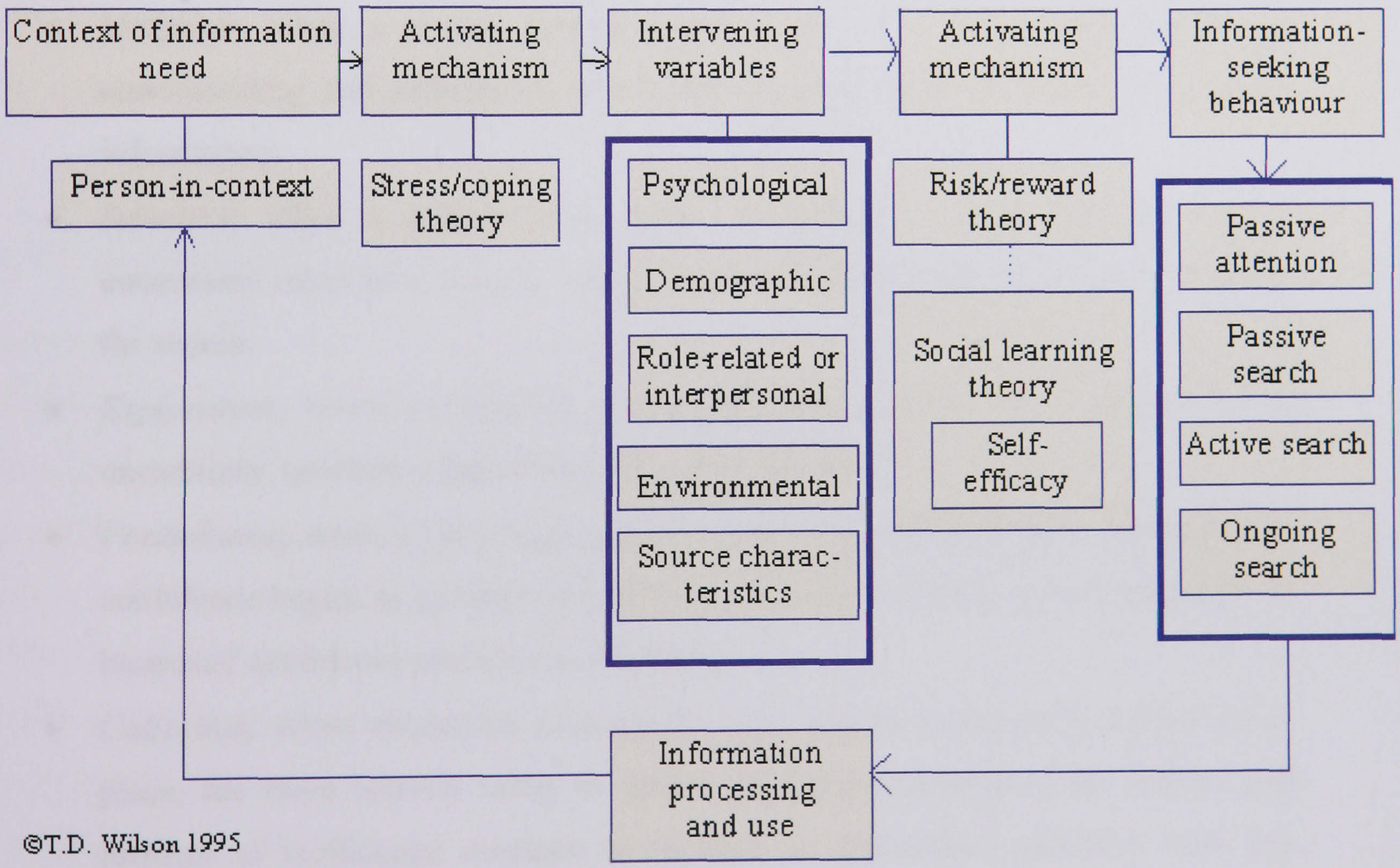


Figure 2.3: Wilson's 1996 model of information behaviour

Two other widely recognised models of information seeking are those proposed by Kuhlthau (1991,1993) and Ellis (1989). Wilson (1999a, p.257) comments that 'It is fairly obvious that the models of both Ellis and Kuhlthau relate to the *active search* mode of information-seeking behaviour and provide, in effect, an expansion of that box in the diagram above'.

2.4.3 Kuhlthau's Model

Kuhlthau (1991,1993) suggests an affective orientation to the information search process. She views information seeking as a process of construction in which users progress from uncertainty to understanding; in other words, uncertainty is reduced through this process. She proposes a six stage process:

- *Initiation,* when a person first becomes aware of a lack of knowledge or understanding and feelings of uncertainty and apprehension trigger a need for information.
- *Selection,* when a general area, topic, or problem is identified and initial uncertainty often gives way to a brief sense of optimism and a readiness to begin the search.
- *Exploration,* when inconsistent, incompatible information is encountered and uncertainty, confusion, and doubt frequently increase.
- *Formulation,* when a focused perspective is formed and uncertainty diminishes as confidence begins to increase resulting in a change in feelings with indications of increased confidence and a sense of clarity.
- *Collection,* when interaction between the user and the information system takes place, the main activity being to gather information related to the query, and feelings of confidence continue to increase as uncertainty subsides, with the identification of relevant information.
- *Presentation,* when the search is completed with a sense of satisfaction if the search has gone well or disappointment if it has not.

2.4.4 Ellis's Model

Ellis (1989) proposes the following categories of information seeking and retrieval activities that may or may not occur in a sequence:

- *Starting:* Identifying relevant sources of interest.
- *Chaining*: Following and connecting new leads found in an initial source.
- *Browsing*: Scanning contents of identified sources for subject affinity.
- *Differentiating*: Filtering and assessing sources for usefulness.
- *Monitoring*: Keeping abreast of developments in a given subject area.
- *Extracting*: Selectively identifying relevant material in an information source; or systematically working through a given source for material of interest.
- *Verifying:* checking the accuracy of information.
- *Ending*: which may be defined as 'tying up loose ends' through a final search.

Wilson (1999a) comments that Kuhlthau's model is more general than that of Ellis in drawing attention to the feelings associated with the various stages and activities.

2.4.5 Ingwersen's Model

Ingwersen's model (1992, 1996) shows the relations among information and cognitive processes. The model incorporates the socio-organisational environment (context) of the current searcher with the IR interaction. The context, in this model, includes the scientific or professional domain(s) with information preferences, strategies and work tasks which influence the existing perception of the searcher. The 1992 model had been expanded in 1996 by including the work task or cultural-emotional interest and corresponding situation as perceived by a searcher. He suggests that various cognitive transformations, starting from recognition of a new problem to the situation where information objects are searched and useful ones are identified in a retrieval system, take place within the cognitive space (Figure 2.4).

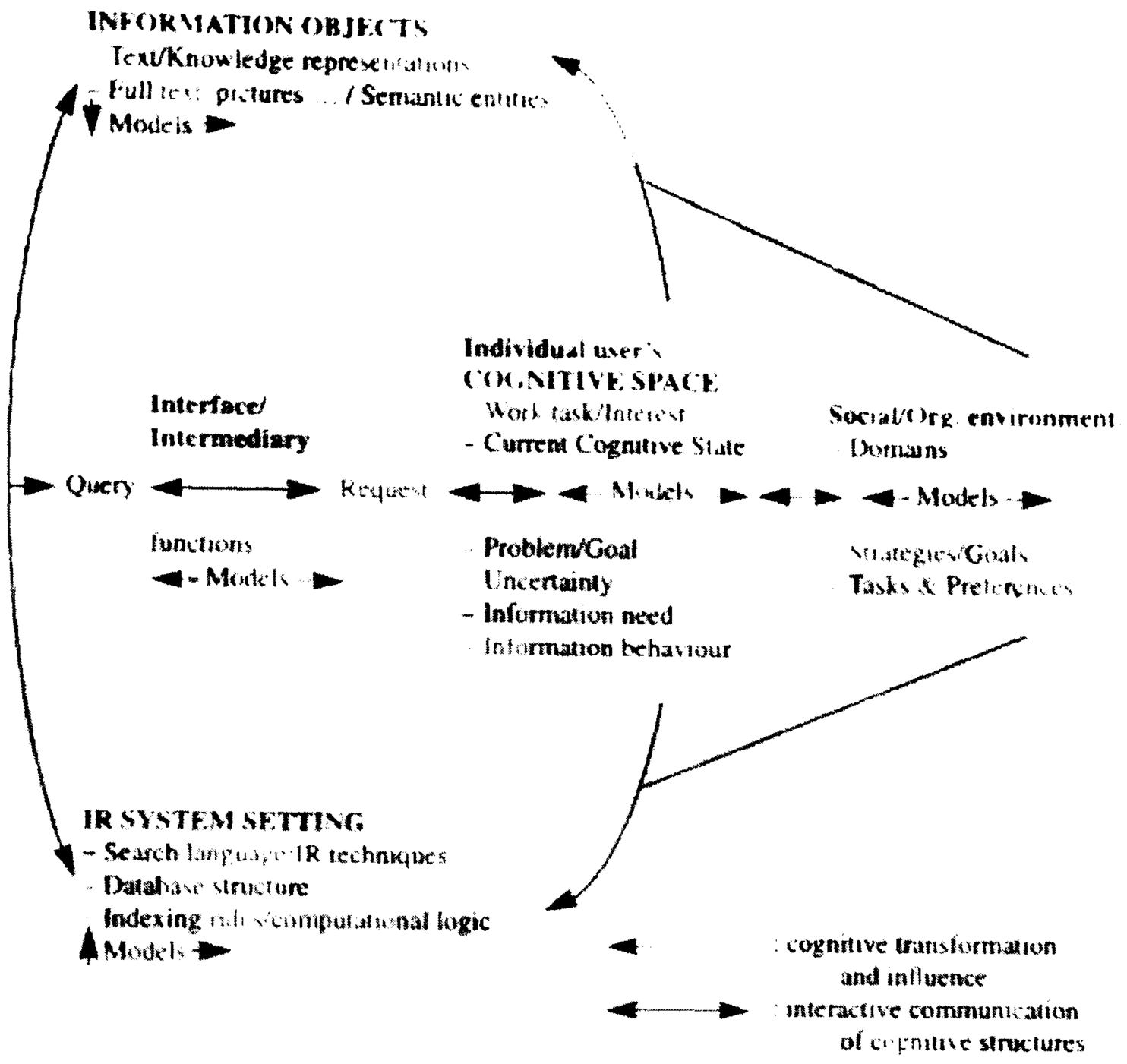


Figure 2.4: Ingwersen's model of the IR process (Ingwersen, 1996)

2.5 Information Seeking on the Web

Seeking information and, in particular, tracing relevant information on the web is a complex task because the same information is diffused, appears in various forms, and is available through different channels. Information seeking on the web is a topic of increasing interest in many disciplines.

2.5.1 Web Information Seeking and Personal Characteristics

Because of fast changing technologies and information overload, searching and evaluating the appropriate information has become a key requirement for success in the digital era. While various organisations and individuals are trying to improve the accessibility of information on the web by developing sophisticated retrieval tools, users'

interactions remain an important issue because retrieving an immense volume of information in response to a web search may influence users' cognitive behaviour.

Some research suggest that while seeking information on the web users adopt different strategies due to their varying cognitive styles (Dilevko & Gottlieb, 2004; Kari, 2006; Kari & Savolainen, 2007; Kim 2001; Palmquist & Kim ,2000; Wang, Hawk, & Tenopir, 2000). Therefore, the information seeking and retrieval process is highly variable because it significantly differs from person to person.

A small number of empirical studies have been undertaken in information science on personal development. One such study has been conducted by Dilevko and Gottlieb (2004) who carried out a survey into workplace experiences with staff members of college and university libraries and the findings showed the possibility for individual growth as a significant part of work satisfaction.

In another study Kari (2006) notes that information search strategies are influenced by development in the context of the internet as well as factors affecting internet use (Kari, 2006). In a subsequent study Kari and Savolainen (2007, p.58) note eleven different relationships between 'Internet searching and the goals of personal development: affecting, associating, causing, concerning, connecting, enabling, exploiting, hindering, illustrating, isolating, and misleading'.

Kim's study (2001) shows that cognitive style (field independence, i.e. individuals who can easily overcome the surrounding context, vs. field dependence, i.e., those who experience more difficulty), online database search experience (novice vs. experienced searchers), and task type (known-item vs. subject search tasks) influence users' search behaviour on the web. Field dependent individuals are more likely to be dominated or influenced by the prevailing field whereas field independent individuals experience information sources as separate and discrete from their backgrounds. The study reveals that online search experience is interrelated with task type and the users' cognitive styles (Palmquist & Kim, 2000).

Wang, Hawk and Tenopir (2000) emphasise that the web is a difficult environment for developing a user mental model due to heterogeneous objects, poor interfaces, and diverse web organisation. Based on the findings, they propose a three-dimensional model to present the findings of user behaviour in connection with interfaces and the web. The proposed model consists of three components: *user, interface*, and the *web* and it can provide a clear framework for developing user instructions (Wang, Hawk, & Tenopir, 2000).

2.5.2 Web Information Seeking in Teaching and Learning

Several studies on information seeking in the context of teaching and/or learning have been reported in the recent past, for example, Dalgleish and Hall (2000), Ford (2004), Hemminger et al. (2007), Talja (2002), Pennanen and Vakkari (2003), and Olander (2007). Dalgleish and Hall (2000) report on the results of a study that provides an insight into students' perceptions of the web as a resource when they seek information related to their studies. The result shows that students find it difficult to identify and select relevant information efficiently, and prefer a simplistic approach to the use of search tools and query construction. Students felt the need for services providing facilities for resource filtering and resource description.

Ford's (2004) model of learning-related information behaviour comprises several components, i.e. basic information processes, information processing types and information processing approaches, and factors affecting information behaviour relating to educational environments and mental states. Hemminger et al (2007) study the information seeking behaviour among academic scientists and more specifically the transition to electronic communications and how this affects different aspects of information seeking. They note that the information seeking behaviour of academic scientists has been significantly transformed by the availability of electronic resources for searching, retrieving, and reading scholarly materials. Talja (2002) develops a conceptual framework for the description of types and levels of information sharing in relation to document retrieval in academic communities where concepts of different types of

information sharing are introduced to describe differences in the goals and purposes of information sharing in different groups and contexts of interaction.

Pennanen and Vakkari (2003) stress that users' conceptual constructs of a topic become more structured and complex when their level of knowledge of a topic or task increases. However, they mention that little attention has been given to mapping the actual knowledge output as students progress through the stages of information searching. They advocate the need to develop more accurate techniques for representing and measuring conceptual structures and how they change.

Information behaviour of a group of computer scientists has been studied over a period of time and some changes in their information seeking have been identified by Olander (2007). It is noted that these computer scientists serve as informal information providers for each other and their information seeking is predominantly within the department. The results show that information behaviour that based on social and professional practices that has changed over a period of time. Some changes are related to the computer scientists' research careers, while others are due to technological developments.

2.5.3 Web and Information Retrieval Behaviour

Kari and Savolainen (2003) propose a contextual model of web searching from an individual's perspective. Two studies by Markey (2007a, 2007b) report on end-users' web information behaviour. In the first part, Markey (2007a) reports that people generally enter a small number of short search statements into online information retrieval systems. Their searches do not resemble the systematic approach of expert searchers who use the full range of information retrieval system functionality. The second paper (Markey, 2007b) examines current models of the information retrieval process, and emphasises that information retrieval is a complex task and involves changes in cognition, feelings, and events during the information seeking process.

In the course of studying the dynamics of interactive information retrieval behaviour, Xu (2007) proposes an integrated framework that explains the mechanisms governing the interaction between users' cognitive states and their manifested behaviour when using an information retrieval system. Kellar, Watters and Shepherd (2007) have identified several web-based task categories, i.e. fact finding, information gathering, browsing, and transactions. They report on the differences in how participants interacted with their web browser across the range of information-seeking tasks. The result shows that participants spent more time during the information gathering stage. Spink, Ozmutlu and Ozmutlu (2002) study multitasking information seeking and searching on the web and they show that multitasking is a common human behaviour and users may conduct information seeking and searching on related or unrelated topics. They stress that as the complexity of information structures and problems increases, more effective information retrieval technologies are required to sustain effective human information behaviours.

The importance of context in information seeking and retrieval has been well discussed by Kelly (2006a, 2006b). She discusses various aspects of context that should be considered when studying online information seeking. Through a longitudinal study she shows how notion of context and usefulness of information changes over a period of time.

2.5.4 Web Information Seeking of Different Categories of Users

Several researchers have focused on the web information seeking activities of different types of users (see for example, Choo & Marton, 2003; Kim, 2005; Kim & Allen, 2002; Lazonder' Biemans, & Wopereis, 2000; Pharo & Jarvelin, 2004; Rieh, 2002; Savolainen & Kari, 2006; Slone, 2002; Tabatabai & Shore, 2005).

Choo and Marton (2003) analyse the web information seeking behaviour of women in the IT profession and suggest that a behavioural approach that links information seeking modes (goals and reasons for browsing and searching) to moves (actions used to find and view information) may be helpful in understanding web information seeking. Kim

(2005), and Kim and Allen (2002) investigate how users' cognitive (i.e., individuals' characteristic way of organising and processing information) and affective (i.e. emotional) characteristics influence the navigational and search behaviours on the web among experienced web users. They note that users' navigational behaviours, such as the use of links, etc. are influenced by the focus control factor and that users' search behaviours, such as keyword searching, are affected by the emotion control factor.

Lazonder, Biemans, and Wopereis (2000) examine the effect of students' web search experiences for locating an appropriate website and retrieving relevant information from that site. The results indicate that experienced users are more proficient in locating websites than are novice web-users. However, the performance of experienced and novice users are equivalent on tasks that required subjects to locate information on specific web sites.

Pharo and Jarvelin (2004) present a method for analysing searching behaviour. The method presents a new approach in information seeking and retrieval by focusing on the search process as a phenomenon and by explicating how different information seeking factors directly affect the search process.

Slone (2002) uses a new analysis and display tool to examine the influences of understanding the system and goals of end-user web searching. The results conclude that users were highly motivated while looking for information for job-related or educational purposes and thus, they are persistent whereas users seeking information for recreational or personal use are not highly motivated. Whether experienced or not, when searching becomes too difficult, they abandon it and they mostly rely on serendipity, linking, and other tasks that are not cognitively overbearing.

Some researchers have focused on quality and relevance judgement in the context of information seeking on the web. Rieh (2002) examines the problem of the judgement of information quality and cognitive authority by observing people's information seeking behaviour on the web. The factors influencing each judgement of quality and authority

are identified in terms of characteristics of information objects, characteristics of sources, knowledge, situation, ranking in search output, and general assumption. Savolainen and Kari (2006) point out that a number of individual criteria including specificity, topicality, familiarity, and variety are used most frequently in relevance judgements. It shows that despite the high number of individual criteria used in the judgements, a small number of criteria such as specificity and topicality tend to dominate.

Tabatabai and Shore (2005) argue that with recent changes in the proliferation of information and the variety of means of retrieval, it is vital to understand why some searchers are more successful than others. They identify that there are many different ways information can be obtained and there is more than one web site that can be used to reach the goal. Therefore, it is important to identify the strategies and attributes that will increase the chance of a successful search on the web. Tabatabai and Shore (2005) note that some specific actions are associated with success in web searching, such as, using clear criteria to evaluate sites, having background knowledge about information seeking, and so on.

2.5.5 Web Information Seeking in Various Domains

A number of studies have also been done on information seeking in different domains other than information science, especially in the field of health (Ankem, 2006), engineering (Kerins, Madden, & Fulton, 2004), law (Kuhlthau & Tama, 2001), journalism (Attfield & Dowell, 2003), sports (Joinson & Banyard, 2002), and in everyday life (Agosto & Hughes-Hassell, 2005). Some work on information seeking in these domains is discussed below to show the diversity of research in this area.

Ankem (2006) studies the use of information sources by cancer patients with a view to identifying the most and least used information sources, the most helpful information sources, and to find the impact of patient demographics and situations on use of information sources. The study shows that many areas of cancer patients' use of

information have either been neglected or barely analysed, and thus an in-depth understanding of cancer patients' use of information is important for developing successful interventions and to inform patients better (Ankem, 2006).

A study of the information seeking behaviour of engineering and law students reveals that information seeking is not only knowing where to find information but also includes problem solving and evaluation of sources (Kerins, Madden, & Fulton, 2004). The study suggests that engineering and law students can benefit from greater information literacy training and awareness, enabling them to acquire the information skills they need to function effectively and efficiently in their future professional lives (Kerins, Madden, & Fulton, 2004).

Kuhlthau and Tama (2001) report on a study that aimed to gain a better understanding of lawyers, how they use information to accomplish their work, and the role mediators play in their process of information seeking and use. The findings reveal that lawyers frequently are involved in complex tasks that require a constructive process of interpreting and learning. They emphasise that the mediator would offer a more uniform system for organising and accessing files, and providing direction in filtering the overwhelming amount of information available on electronic resources (Kuhlthau & Tama, 2001).

While reporting on a two part study focusing on the information seeking behaviour of football fans, and that of cancer patients, Joinson and Banyard (2002) observe that there is a tendency for people to access information more commonly avoided in 'real life', although in the case of football fans, the tendency to 'bask in reflected glory' remains when online, while cutting off reflected failure is minimised. The results of the two studies suggest that information seeking on the web has certain similarities and differences to off-line information seeking behaviours. The act of information seeking is the interaction between the target information, the strategies employed to search, the social environment in which the information is sought and the psychological implications of the information on the seeker (Joinson & Banyard, 2002).

Attfield and Dowell (2003) describe the information seeking behaviour of journalists focusing particularly on the journalists' information seeking, personal understanding, discovering potential content, information gathering and managing information. The study observes work activity in the context of a series of behaviour shaping constraints and cognitive and external resources, and discusses how these are motivated by context, facilitated by resources, and how they enrich the journalists' resource space.

Young urban adults' everyday life information-seeking (ELIS) behaviour have been studied by Agosto & Hughes-Hassell (2005) and the study shows that urban teens preferred certain types of ELIS sources, media types, and query topics. The result shows friends and family are the preferred ELIS sources, cell phones are the preferred method of mediated communication and schoolwork, time-related queries, and social life are the most common and most significant area. Overall, the results indicate a preference for people as information sources among urban youths (Agosto & Hughes-Hassell, 2005).

2.6 Uncertainty

Uncertainty is a term used in subtly different ways in a number of fields, including philosophy, statistics, economics, finance, insurance, psychology, engineering and science[9]. The main objective of this section is to find out how the concept of uncertainty has been treated within the context of information science in general, and information seeking and retrieval in particular. . The Oxford English Dictionary[10] defines uncertainty as "the state of not being definitely known or perfectly clear; doubtfulness or vagueness" or "the state or character of being uncertain in mind; a state of doubt; want of assurance or confidence; hesitation, irresolution."

From the above definition it is can be stated that uncertainty is a state of mind where one is not perfectly clear or has a doubt or vagueness. So, the question remains what causes

[9] http://encyclopedia.thefreedictionary.com/Uncertainity
[10] http://dictionary.oed.com

uncertainty in information seeking and retrieval and what are the implications of such uncertainty.

The cause of uncertainty has been described differently by researchers in the field of information science. According to Shannon and Weaver (1949) uncertainty is associated with the communication of signals from a sender to a receiver, and it is caused by the noise in the communication channel. Hence from the perspectives of the electronic communication theory, the lesser the noise, the lesser is the uncertainty associated with the communication of information.

A different view of uncertainty is held by researchers in the field of information seeking and retrieval. Van Rijsbergen (1996) identifies seven types of uncertainty that are associated with an information retrieval system, viz. ignorance, incompleteness, undecidability, complexity, randomness, vagueness, and imprecision. Furthermore he proposes that a logic-based model of information retrieval can help resolve these forms of uncertainty. However, Wilson (1996) stresses that none of the seven types of uncertainty proposed by Rijsbergen defines 'another type of uncertainty, that is, the uncertainty of the unexpected.'

As opposed to the two schools of thought mentioned above, uncertainty in the context of HIB studies is widely recognised as the trigger for information seeking and use. Researchers in general propose that an information seeking process begins with uncertainty and as the user proceeds through the information seeking and retrieval process, uncertainty gradually decreases. Views of different HIB researchers in relation to uncertainty in information seeking and retrieval are discussed in the following section.

2.7 Uncertainty and Information Seeking and Retrieval

Uncertainty in the field of information seeking research is normally associated with the experiences of the searcher. Kuhlthau (2004, p.103) defines uncertainty as 'a cognitive state that commonly causes affective symptoms of anxiety and lack of confidence'. This

definition is not much different from the dictionary definition of uncertainty provided at the beginning of Section 2.6. However, in her definition she also highlights the likely impact of uncertainty in the cognitive state of the users which eventually leads to an information seeking and retrieval process. Kuhlthau (1993) also proposes that uncertainty is a principle for information seeking. She emphasises that information seeking incorporates the experience of interacting thoughts, actions, and feelings in the process of construction and uncertainty initiates the process, and anxiety and an unsettling discomfort may be experienced in the early stages (Kuhlthau, 2004). Kuhlthau (2004, p. 92) also emphasises that 'as knowledge states shift to more clearly focused thoughts, a parallel shift occurs in feelings of increased confidence'. A similar view has been expressed by other researchers, for example, by Belkin in his ASK model (discussed in section 2.4.1), and by Wilson in his HIB model (discussed in Section 2.4.2) where the basic notion is that uncertainty is a mental state with a gap of knowledge, and it triggers an information need which in turn takes the user through an information seeking and retrieval process.

Researchers have also proposed models to show the role of uncertainty in an information seeking and retrieval process. A conceptual model has been developed by Whittemore and Yovits (1973) to show how uncertainty is reduced in decision making when an information seeker goes through the process of gathering and evaluating information. Bates (1986, p.357) proposes a model of information behaviour 'based on three design principles – uncertainty (subject indexing is indeterminate and probabilistic beyond a certain point), variety (by Ashby's law of requisite variety, variety of searcher query must equal variety of document indexing), and complexity (the search process, particularly during the entry and orientation phases, is subtler and more complex, on several grounds, than current models assume)'.

Wilson et al. (2000) stress that uncertainty is a useful variable in understanding information seeking behaviour. They study uncertainty within Wilson's problem-solving model (1999c) and note that the affective symptoms of uncertainty are mainly associated with vague, unclear thoughts about a topic or problem like what to look for, where to

search, etc. In his model of general information behaviour, Wilson has listed a set of factors that affect information access and use.

2.7.1 Reduction in uncertainty through information seeking and retrieval

Kuhlthau (2004) points out that the feeling of uncertainty reaches its peak at the third stage, i.e., *pre-focus exploration* but it diminishes at the next stage i.e., *focus formulation* (Kuhlthau's six stage model is discussed in Chapter3, Section 3.2.1, p. 44). In other words, uncertainty decreases when the searcher proceeds towards the completion of the search process.

Wilson et al. (2000) agree with Kuhlthau that uncertainty decreases, but they also argue that at any of the four stages (Figure 2.5) of Wilson's model (Wilson,1999c) i.e. problem recognition, problem definition, problem resolution, and solution statement uncertainty may arise and successive searches within the same stage, or any other stage, may be required to resolve the problem. This work is significant to Kuhlthau's work and other studies because it links decision-making situations to different stages of information gathering and assimilation. Wilson (1999a) suggests that both Kuhlthau's stages and Ellis's characteristics can be related to this model.

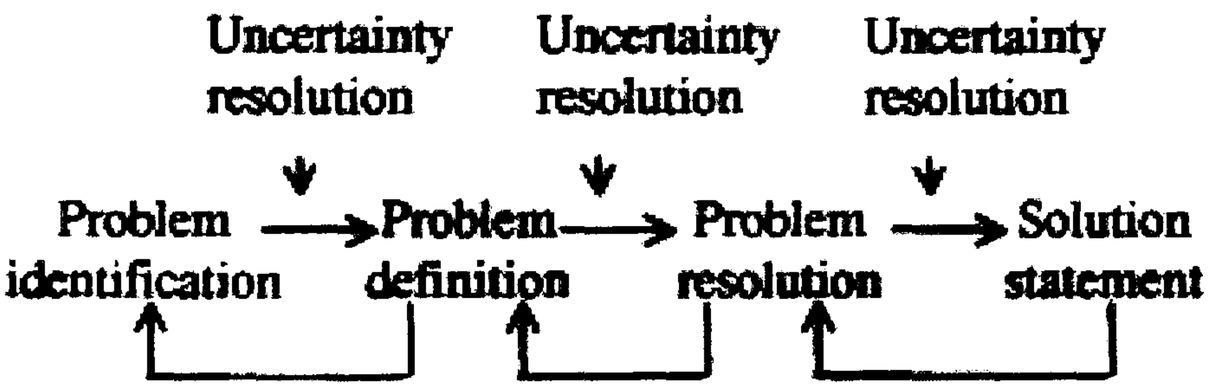


Figure 2.5: The problem resolution chain (Wilson, 1999c)

In 'stress/coping' theory, stress is the result of experiencing a *problem* of some kind and it may be of varying degrees, but it provides the motivation for information seeking

(Wilson 1996). Problems may range from the immediate, urgent or highly significant to relatively modest problems and, therefore, the amount of stress caused by these problems varies considerably. However, information seeking may be considered as a strategy to cope with the problem i.e., the solution of the problem, the resolution of the discrepancy, the advance from uncertainty to certainty. Wilson (1999b) argues that the individual moves from uncertainty to increasing certainty and that there are stages in the problem-resolution process that are identifiable and recognisable to the individual. There are four stages in the whole process.

Wilson (1999c) hypothesise that there is a successive resolution of more and more uncertainty while a search proceeds from one stage to another; where uncertainty fails to be resolved at any one stage, it may be resolved through the feedback loop to the previous stage. Four stages in the problem resolution chain are:

1. Problem identification: this is the initial stage where an individual recognises that a problem exists, i.e. recognises that he/she *has* a problem and defines it as of a certain type. The individual experiences a high degree of uncertainty about the problem and its surroundings and, definitely about how to resolve the problem.

2. Problem definition: at this stage, the searcher will seek for information and by understanding the problem or by gaining some information some of the uncertainty will be removed.

3. Problem resolution: this stage is considered as the main information seeking phase; the searcher seeks to answer the questions like, *What is the answer to this problem? How do I cope with this problem?* At this stage, the searcher expects that the remaining uncertainty will be removed; however, this may not always be the case. Actions other than information seeking may be involved in a full resolution of the problem.

4. Solution statement: this stage is used to signify any application of the solution found and therefore come to a conclusion that '*this is the solution to my problem'* or it may involve actions to implement the solution.

Attfield, Blandford, and Dowell (2003) discuss how writing can be understood in order to account for understanding uncertainty associated with information need, and as a searcher proceeds through a retrieval process uncertainty decreases. D'Ambra and Wilson (2004) design an information seeking model for travel, for use on the web, which shows that as users find the required information their level of uncertainty reduces.

2.7.2 Calls for further research on uncertainty in information seeking and retrieval

The challenges associated with an information seeking and retrieval process in the context of uncertainty have been discussed by several researchers. Kuhlthau (2004, p.8). comments that 'an information search is a learning process in which the choices along the way are dependent on personal constructs rather than on one universal, predictable search for everyone'. This statement reinforces the fact that information seeking and retrieval is an individual process, and therefore it is difficult to prepare a universal search strategy. Furthermore, Yovits and Foulk (1985) find that information may increase a person's uncertainty level in a particular situation.

Belkin, Oddy, and Brooks (1982a, 1982b) comment that supporting uncertainty is a fundamental problem for information retrieval and therefore design of a system should start at this point. Several researchers have advocated the need for further research focusing on uncertainty in information seeking and retrieval. For example, Kuhlthau and Ledet (1996) advocate the need for further research on uncertainty especially from the user's perspective, to understand the impact of uncertainty in all of its manifestations on human information seeking behaviour. In a later work, Kuhlthau (2004, p.8) stresses that 'the concept of an uncertainty principle as a theoretical statement needs further development to include the users' perspective on information seeking'.

Similar views have been expressed by researchers in the context of web information seeking and retrieval. Ramirez et al. (2002) argue that the existing theory and research on computer-mediated communication (CMC) provides a limited view of information seeking behaviour and uncertainty. Sias and Wyers (2001) explain that while information may reduce an employee's uncertainty regarding a specific issue, subsequent events may cause that employee to feel uncertain regarding another issue. Thus, uncertainty is a natural and pervasive aspect of any employee's working life, whether a newcomer or a veteran.

Nahl (2006) states that when people operate with ineffective cognitive behaviours the affective load, such as, cognitive ambiguity, uncertainty, or information overload, is invariably high and attracts affective behaviours that are negative and counter productive to the searcher's goal. For example, a searcher is cognitively disoriented if no relevant results are produced after several attempts. Attfield et al. (2008) note that web information seekers are frequently uncertain about the information they want and, in the context of news research and writing as users proceed through cycles of information acquisition, assimilation and use, they create and maintain personal and informal collections of information.

Thus although there have been several studies in this area, many researchers reiterate the need for further research on uncertainty in information seeking and retrieval.

2.8 Summary and foundations of this research

This review of literature shows that uncertainty plays an important role in information seeking and retrieval. However, looking critically at the works of several leading HIB researchers, one may note some similarities and differences amongst researchers with regard to uncertainty in information seeking and retrieval.

The review shows that unlike the views of Shannon and Weaver (1949) who suggest that uncertainty is caused by the noise in the electronic communication process, and those of information retrieval researchers like Van Rijsbergen (1996) who consider that uncertainty can be reduced by developing an appropriate logical model of information retrieval, HIB researchers view uncertainty as a mental state of the user that triggers an information need which subsequently leads to information seeking and retrieval.

The review shows an agreement among leading researchers, in that in the context of HIB research uncertainty is, explicitly or implicitly, considered to be a cognitive state that is caused by an anomaly in one's state of knowledge, as suggested in Belkin's ASK model (1980) (see Section 2.4.1), or is caused by a gap in one's knowledge about something that triggers an information need as proposed by Wilson in his HIB model (1999a) (see Section 2.4.2). The basic notion of uncertainty in these models is the same in that it refers to a gap in the knowledge of something about a subject or a topic in the mind of a person that urges them to seek information, and as a consequence once the information is obtained the uncertainty disappears. This has also been the proposition of several other HIB researchers such as Whittemore and Yovits (1973), Bates (1986), Kuhlthau (1993, 2004), and Wilson (2000). The same notion is reflected, although implicitly, in Ingwersen's model (see section 2.4.5) whereby he suggests that the cognitive process involved in the information seeking and retrieval processes transforms one's uncertainty at the end of a retrieval process. So, it may be stated that the generally held view in HIB research is that uncertainty is a mental state of the users reflecting a gap in the knowledge which triggers an information seeking and retrieval process, and the gap is filled as relevant information is found, and thus the uncertainty disappears as the search process concludes.

The foundation of the present research is based on the argument that it is not only the gap in the mind of a user with reference to the knowledge about a given subject or topic, but the various complexities associated with the information seeking and retrieval process in the electronic environment can also cause uncertainty among users. Thus, in this research

conventional view that uncertainty is caused by a gap in the knowledge of the user about a search topic is accepted, but it is also proposed that uncertainty can be caused by the complexities associated with the information seeking and retrieval processes in the modern electronic environment.

In other words, this research proposes that there are two major sources of uncertainty in information seeking and retrieval in today's electronic environment: one that is caused by the lack of knowledge about something in the mind of users for which they search for information, and another that is caused by the various specific information seeking activities and the associated problems in the modern electronic information environment.

The later source of uncertainty has been has been noted by several researchers, although not very explicitly. For example, recent studies by Nahl (2006) and Rose (2006) show that uncertainty associated with the information seeking and retrieval process has a significant impact on a searcher's goal and if relevant results are not obtained after several attempts, users may get disoriented.

In other words, the complex activities and processes involved in information seeking and retrieval in the electronic environment, may make the user unsure of the outcome of a search process, and thus may add to their uncertainty. This somewhat coincides with the view of Hubbard who defines uncertainty as 'the lack of certainty; a state of having limited knowledge where it is impossible to exactly describe existing state or future outcome, more than one possible outcome'(Hubbard, 2007, p.19).

The review of literature shows that, to the best of the knowledge of this researcher, no research has been conducted so far to study how uncertainty is caused by some specific information seeking activities and information seeking problems. The main question to be addressed by the present research therefore has been whether and how uncertainty is

caused by, or associated with, specific information seeking activities and information seeking problems.

With this assumption that uncertainty may be caused by one or more specific information seeking activities and information seeking problems, the second major question to be addressed by this research has been whether uncertainty completely disappears after a series of information search and retrieval sessions, which is believed to be the case as per the conventional view of the HIB community as revealed through the review of literature in this chapter; or does uncertainty persist even after a series of information search sessions. Few researchers, including Kuhlthau herself, in a later paper (2006), and Rose (2006) argue in favour of the later proposition.

Furthermore, some researchers mention that uncertainty in information seeking and retrieval may have both positive and negative implications. Referring to Shannon and Weaver (1949), Cole (1993) points out two kinds of uncertainty – *desirable* and *undesirable,* where *desirable uncertainty* is that which is associated with information and *undesirable uncertainty* is that which is associated with noise and errors in a message. Yoon (2007) comments that the cognitive aspect of information seeking involves both certainty and uncertainty related to the information need of a user. Both play an important role for describing the user's information need: uncertainty in the initial need description, and certainty employed in the subsequent need description. He further mentions that certainty and uncertainty complement each other and they form part of the user's perception of information seeking process.

Therefore the third main question to be addressed by this research has been what are the implications of uncertainty on users' information seeking and retrieval behaviour, and more specifically whether such uncertainty may have some positive impact on the information seeking and retrieval behaviour of the users.

The first challenge of this research has been to identify a set of information seeking activities and information seeking problems that are common in today's electronic information environment. According to several leading researchers in HIB such as Wilson (1999a) and Ingwersen and Jarvelin (2005b) the two most commonly referred to HIB models – those of Kuhlthau (1993,2004) and Ellis (1989) – broadly cover the major information seeking activities and issues, and therefore these models were critically analysed to find out whether a set of information seeking activities and information seeking problems could be prepared that could then form the bases of the research questions and the corresponding hypotheses designed to be tested in course of this research.

Thus it was assumed that it would be possible to prepare a list of information seeking activities and information seeking problems that are typical in an academic environment, and although such a list might not be exhaustive, it would be adequate for this research which set out to study whether and how a set of information seeking activities and information seeking problems associated with information seeking and retrieval in an electronic environment cause uncertainty. Furthermore, in accordance with the assertions of Ellis (1989) and Kuhlthau (1993, 2004), it was understood that the various information seeking activities are not necessarily linear, and therefore it was assumed that the uncertainty caused by various information seeking activities and the associated problems could cause different degrees of uncertainty at different stages of information seeking and retrieval by different categories of academic users.

How a set information seeking activities and information seeking problems were identified, and the various techniques and methods used for collection and analysis of data in this research, are discussed in the next chapter.

Chapter 3

Research Methodology

3.1 Introduction

This chapter discusses the methods used at various stages in this research. First, it discusses how the various information seeking activities, information seeking problems, and information channels and sources were identified that formed the basis of this research. It then discusses the techniques and methods used for data collection and data analysis at different phases of this research. Figure 3.1 shows a schematic representation of the methods used in this research.

3.2 Data Collection

Models, techniques, and methods used in this research are discussed in the following sections.

3.2.1 Information Seeking Activities and Problems

As a first stage of this research it was necessary to look into the relevant literature in order to prepare a list of the major information seeking activities, and a list of common problems facing users in the course of their information seeking and retrieval.

As discussed in Chapter 2 (section 2.4), there are several information seeking and retrieval models. Amongst these, two models proposed by Ellis (1989) and Kuhlthau (1993) were studied closely to identify the different stages and characteristics of information seeking activities. These two models were chosen for this research for the following reasons:

- 'Kuhlthau's model is fairly broad in its attempt to cover information seeking' (Ingwersen & Jarvelin, 2005b, p.66).
- Wilson (1999a) comments that Kuhlthau's model (1993) helps in drawing attention to the feelings associated with the various stages and activities of information seeking and retrieval. He further emphasises that 'Kuhlthau posits stages on the basis of her analysis of behaviour' (p.256).
- The features of information seeking behaviour proposed by Ellis (1989) (as mentioned in section 2.4.4) characterise the information seeking patterns of scientists, engineers, and social scientists in academic and industrial settings (Ingwersen & Jarvelin, 2005b). Ingwersen and Jarvelin (2005b) comment that 'Ellis's features provide a set of categories, which may serve the analysis of information seeking at the individual level' (p.64).
- Wilson (1999a) comments that 'Ellis does not present his characteristics as stages but as elements of behaviour that may occur in different sequences with different persons, or with the same person at different times' (p.256).

Ellis's and Kulthau's models were studied closely, keeping in view Wilson's (1999a) comments that there are some 'strong similarities and major differences' (p. 256) between these two models. These two models were used to identify the major information seeking activities, and information seeking problems associated with the information seeking and retrieval processes.

In this research, information seeking activities are defined as the activities that a typical user may have to undertake starting from the selection of the channel or source, to the exploration and formulation of a search query, collection and presentation of the results, etc. Information seeking problems are defined as the problems associated with different stages of the information seeking and retrieval process, such as information overload, ignorance of channels or sources and so on. Specific information channels or sources include only those that were commonly used by a group of academics involved in this research.

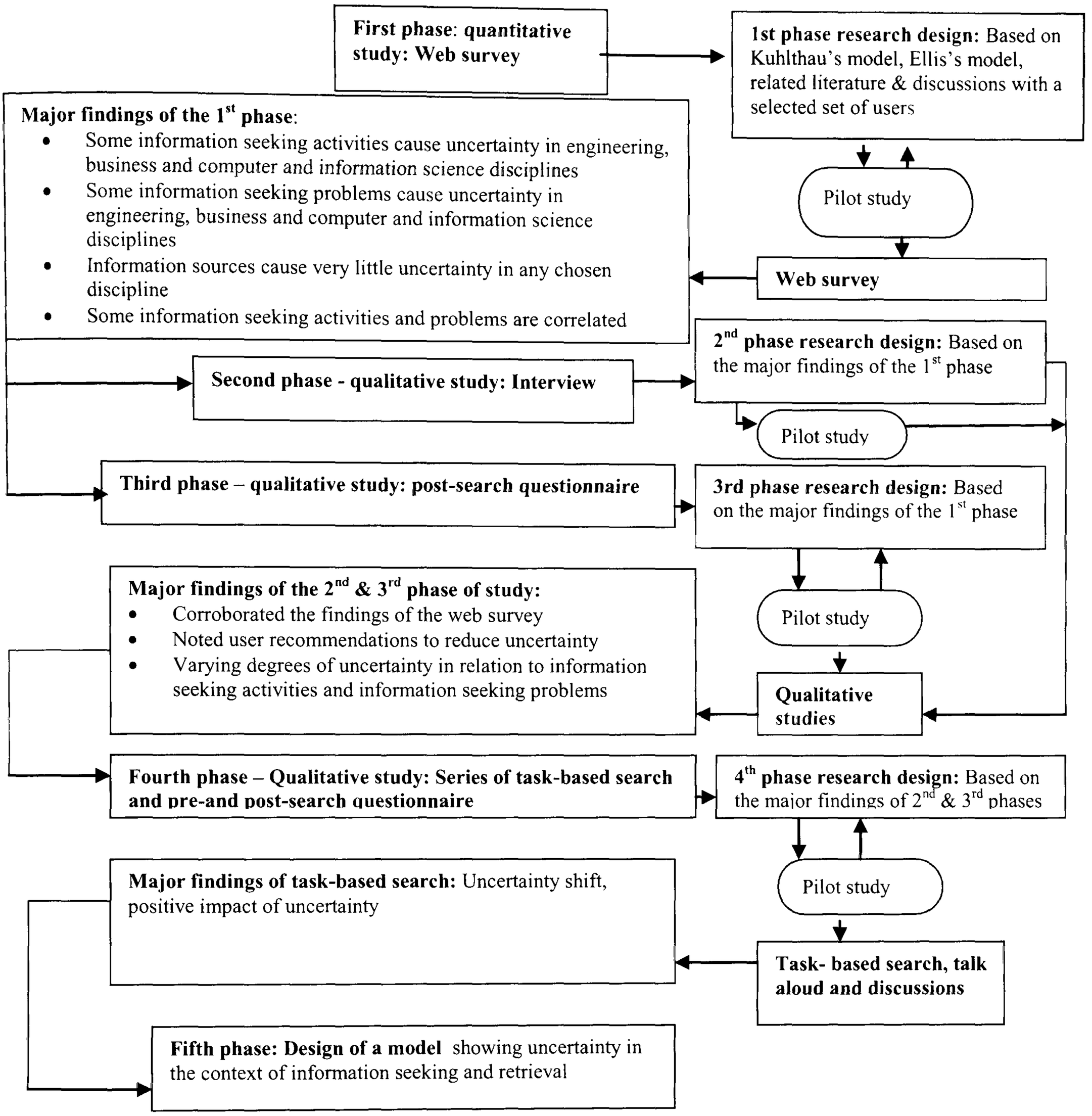


Figure 3.1: Schema of the research

According to Ellis (2006) underlying the complex patterns of information seeking behaviour there are a small number of different types of activity characterised as:

- 'Starting – activities characteristic of the initial search for information.

- Chaining – following chains of citations or other forms of referential connection between material.
- Browsing – semi-directed searching in an area of potential interest.
- Differentiating – using differences between sources as a filter on the nature and quality of material examined.
- Monitoring – maintaining awareness of development in a field through the monitoring of particular sources.
- Extracting – systematically working through a particular source to locate material of interest' (p. 139).

The original model of Ellis (1989) was tested in studies of information seeking behaviour of different groups of users including researchers in English literature, physicists and chemists, and engineers and research scientists (Ellis, 1997), and 'there was a considerable similarity in general and detail between them' (Ellis, 2006, p.139).

Kuhlthau's model (1993) proposes a six-stage information search process and each stage includes a number of actions as follows (Kuhlthau, 2004):

- Stage 1: Task initiation. Actions involved: 'talking with others; browsing library collection' (p. 44)
- Stage 2: Topic selection. Actions involved: 'consulting with informational mediators; making preliminary search of library; using reference collection' (p.46)
- Stage 3: Pre-focus exploration: Actions involved: 'locating relevant information; reading to become informed; taking notes on facts and ideas; making bibliographic citations' (p.47)
- Stage 4: Focus formulation. Actions involved: 'reading notes for themes' (p.48)
- Stage 5: Information collection. Actions involved: 'using library to collect pertinent information; requesting specific sources from librarian; taking detailed notes with bibliographic citations' (p.49)
- Stage 6: Search closure. Actions involved: 'rechecking sources for information initially overlooked; confirming information and bibliographic citations' (p.50).

Activities and actions mentioned in Ellis's and Kuhlthau's models were used to prepare a list of activities involved in information seeking and retrieval in the modern digital environment, such as choosing information channels and sources, judging the quality of information channels or sources, ensuring that all the information required for a given task has been obtained, and so on. This list was checked, and modified, as necessary, through a series of informal discussions with a small set of academic users from various departments (i.e. computer and information sciences, civil engineering, and economics) at the University of Strathclyde. In addition to those initially prepared on the bases of Ellis's and Kuhlthau's models, some other activities that are quite challenging in the digital era were mentioned by some of the academic users, and those were added to the list, resulting in a total of 14 information seeking activities (see Appendix A).

Several problems, associated with information seeking and retrieval in the digital environment, were identified through the informal discussions. For example, how to choose information channels or sources, how to decide which are the best information channels or sources, how to formulate an appropriate query, what to do when too many or too few items have been retrieved, and so on. A number of recent studies have highlighted a range of information seeking problems faced by users. The following are just a few examples:

- 'A continuing problem is that users may be unaware of relevant resources in the library collection. In a survey at the University of Maryland, 31% of the faculty members reported never using electronic journals; the reasons cited were unfamiliarity with how to access the journals and a lack of need because of personal subscriptions' (Dillon & Hahn, 2002)
- 'Retrieving too much information is a problem mentioned by some as is getting lost on a tangent and not knowing when to quit searching' (EPIC 2001).
- 'There is still confusion over the variety and relative quality of e-resources, in particular among novice users or students' (Tenopir, Hitchcock, & Pillow, 2003)

- 'As the quantity of scientific literature continues to soar, scientists struggle to keep up with new findings, even in narrow areas of expertise. Although advances in information retrieval have eased the task of finding relevant articles, scientists now must face the challenge of aggregating information from within the retrieved set of documents' (Blake & Pratt, 2002).
- 'In the web, making judgments of information quality and authority is a difficult task for most users because overall, there is no quality control mechanism' (Rieh, 2002).
- 'There is much we still need to understand about the nature of the phenomenon of enough information and its relationship to what some researchers term the stopping rules which govern the decision to stop seeking further information….. factors including ill-structured problems, shifting goals, time stress and action-feedback loops influence information seeking' (Berryman, 2006).
- 'Information-seeking, -searching, and -gathering process to include how and when individuals stop looking for information, given a goal or a task that creates the need for information. Given the information glut, how do individuals manage information in such a way as to provide a sufficient answer?' (Prabha et al., 2007)

Based on the study of relevant literature, mentioned above and also those reviewed in Chapter 2, and through informal discussions with the small set of academic users from various departments (i.e. computer and information sciences, civil engineering, and economics) at the University of Strathclyde, a list of 21 information seeking problems was prepared (see Appendix B).

A list of commonly used information channels was prepared by consulting several sources including the university library websites and representative reference books such as *The new Walford guide to reference sources* (2005). The list was then verified, and modified as necessary, through informal discussions with the small set of academic users from various departments (i.e. computer and information sciences, civil engineering, and

economics) at the University of Strathclyde. Finally a list of 17 information channels was prepared (see Appendix C).

3.2.2 Data Collection Techniques

A number of techniques, i.e. online questionnaire, in-depth interviews, pre- and post-search questionnaire, task-based search, and talk aloud were used to collect data for this research. There are a number of reasons for using a combination of quantitative and qualitative methods for data collection. The researcher is able to identify different aspects of the same research question when two or more methods are employed (Gorman & Clayton, 2005). The researcher is able to compensate for inherent weaknesses and overcome any possible deficiencies or limitations in each approach by employing methods from different research paradigms (Fidel 1993; Gorman & Clayton, 2005). More specifically, Wildermuth (1993) stresses that combining methods can be more reliable and valid by combining the generalisability of quantitative methods with the details of qualitative techniques.

Banwell and Coulson (2004) stress that both quantitative and qualitative approaches need to be combined to produce 'both the holistic view and the robust data needed to triangulate and thereby validate data collected.' Especially while working in the web environment, combined methods can provide more accuracy and reliability in the information seeking and retrieval process (Wang, 1999; Kuhlthau, 2005) because the combined method allows the researcher to gather data quantitatively from respondents who may be remote, and verify and/or expand on the findings through personal interactions with some users through the qualitative approach. Wilson (2006a) suggests that both quantitative and qualitative methods complement each other and therefore, must be used depending on the context, purposes and the focus of the research.

In this research a combination of quantitative and qualitative approaches were for collection of data. The quantitative approach involved gathering of quantitative data through a web questionnaire survey in order to gather some baseline data in relation to

the first hypothesis, i.e. to find out whether uncertainty occurs due to a number of information seeking activities and information seeking problems amongst different categories of users in the academic community. The questionnaire survey enabled gathering of large quantitative data that could be analysed using various quantitative techniques including correlation studies to generate different set of findings based on statistical analyses. However, subsequently qualitative approaches were taken to validate some of the statistical findings, and also to probe further into some specific findings. Thus the triangulation approach to data collection used in this research facilitated generation of relatively large volume of data to facilitate statistical analyses, while the qualitative approach facilitated further analysis and validation of some findings through a small user sample where data were collected using a combination of qualitative methods as discussed in section 3.2.4 and its various subsections.

3.2.3 Quantitative Study: Web Survey

A web questionnaire survey was conducted for gathering quantitative data for this research. Online surveys have a profound influence on the survey process (Gunn, 2002). An online survey has several advantages: it is convenient, flexible, fast and timely; provides ease of data entry and analysis; allows for diversified questions and low cost administration; facilitates easy access to a large sample, and so on (Evans & Mathur, 2005; Gunn, 2002; Hogg, 2003; Jackson, 2003; Kapolowitz, Hadlock, & Levine, 2004; Schonlau, Fricker, & Elliott, 2001; Wilson & Laskey, 2003). The design of web surveys of information searching practices and preferences of users is a popular method (Martzoukou, 2005).

A web survey questionnaire (Appendix D) was used to collect data from the target population. There were three parts in the questionnaire focusing on: information seeking activities, information seeking problems, and access to specific types of information channels or sources. The structure of the questionnaire was designed based on some guidelines (Gaddis, 1998; Lumsden & Morgan, 2005; Lumsden et al., 2007; Spyridakis et al, 2005). The web questionnaire was designed using HTML coding and a CGI program

to receive the data, and was then placed on a server at the Department of Computer and Information Sciences, University of Strathclyde. Some minor corrections were made to the questionnaire, based on the comments of the respondents from the pilot study (discussed in sub-section 3.2.5), before submitting it online.

3.2.3.1 Participants for the Web Survey

A sample group of academic staff, research staff, and research students in the UK were taken as a target group for the quantitative survey. The target user group was chosen for two main reasons: 1) users in an academic environment use digital information resources extensively for their academic and research activities and, as Banwell (2001) states, the impact of electronic information systems and sources on academic users is potentially enormous in terms of supporting research, teaching, publishing and other activities; and 2) this research aimed to study the differences, if any, in terms of uncertainty in information seeking among academic staff, research staff, and research students from different disciplines.

A convenience sampling method was used which means the sample from the population was based upon accessibility and ease of selection. The sample is composed of self-selected web users. The national academic mailing list service, known as the *JISCmail* service, was used for this study. Eight different subject lists were chosen from *JISCmail* to cover users from different disciplines for the questionnaire survey. These eight mailing lists cover most of the major disciplines:

- BIOME (Medical, Biological and Health Sciences mailing list, *506 subscribers)*
- BUSINESS-HEACADEMY-NEWS (Business, Management, Accountancy and Finance Subject Centre e-news, *1,138 subscribers)*
- CP-UK (Cognitive Psychology UK mailing list, *54 subscribers)*
- ENGINEERING (The Engineering Subject Centre's information list,*717 subscribers)*

- MERSENNE (Which promotes discussion in the science studies community, *556 subscribers)*
- SCIENCE-EDUCATION (A forum for academics engaged in the study of science education, *159 subscribers)*
- HUMBUL (The Humbul Humanities Hub, *289 subscribers)*
- WICR (Women in Computing Research, *188 subscribers)*

Thus a total of 3607 people were invited to take part in the web survey.

3.2.4 Qualitative Study

Qualitative methodologies are especially well suited for exploring new areas of research as they allow for the examination of unknown factors and relationships without having to define these in advance (Komlodi, 2004). According to Miles and Huberman (1994), qualitative data is "expressed in words", and these are based on "observation, interviews or documents" that are collected in "close proximity to a local setting over a sustained period of time". Qualitative analysis helps us to develop a clear picture by organising data (McQueen & Knussen, 2006). Wilson (2006b) suggests that qualitative research is appropriate for studying the needs underlying information seeking behaviour.

In this research the qualitative study had three phases. The first two phases of study were conducted among a heterogeneous group of users, i.e., users from computer and information sciences, management science, and civil engineering departments at the University of Strathclyde. In the final phase of study, a homogeneous group of users, i.e. users from the Department of Computer and Information Sciences were invited to participate in two consecutive search sessions. The participants were briefed about the study at the beginning of each session. All the qualitative studies took place in the participant's office so that the subject was comfortable in his/her own atmosphere.

3.2.4.1 Qualitative Study Participants

Nielsen (1993) advocates the "discount" usability model for providing the maximum cost/benefit ratio. The model suggests that the best results come from testing no more than five users and running as many small tests as you can afford (Nielsen, 2000). It is stated that a small number of participants will yield about 80% of usability problems (Nielsen, 2000; Nielsen & Landauer ,1993; Virzi, 1992), and it is also suggested that five users will yield 80% of usability problems, and that three testers will reveal nearly 70% of these problems. Nielsen (2000) indicates that there is a law of diminishing returns, the third tester will do many things that have already been observed with the first or second user, and thus will generate a small amount of new data. He further suggests that after the fifth user 'you are wasting your time by observing the same findings repeatedly but not learning much new' (Nielsen, 2000). Nielsen's work suggests that 15 users will reveal all the known usability problems in a design, but recommends it will be more effective with three iterative tests with five users. Thus a qualitative study involves an in-depth understanding of various aspects of human behaviour and the number of participants is not a significant factor.

The participants in the first two phases of the qualitative study (i.e. interview and post-search questionnaire) were academic staff, research staff, and research students from management science, civil engineering, and computer and information sciences departments at the University of Strathclyde, Glasgow, UK. They were invited through group e-mails to participate in the qualitative research. A total of twenty participants from the above mentioned departments volunteered to take part in the qualitative study. Out of 20, nine interviewees were from computer and information sciences, six and five from management science and civil engineering departments respectively.

For the final phase of the qualitative study (the task based analysis), an invitation for participation was sent out to academic staff, research staff and research students within the Department of Computer and Information Sciences, and altogether 15 people – four academic staff, four research staff, and seven research students – took part in the study.

3.2.4.2 Data Collection Techniques

A combination of techniques was used for collection of data for the qualitative study.

3.2.4.2.1 Semi-structured Interviews

Personal interview offers the best opportunity for two-way interactions between interviewer and respondents (Alreck & Settle, 2004).

> 'Interviewing as used in qualitative research offers two important advantages. First, the person being interviewed is encouraged, by the use of open-ended questions or by non-directive listening, to highlight self-perceived issues or relationships of importance. This can be of inestimable value in understanding contexts and creating links that are such key aspects of qualitative research. Second, dialogue between researcher and subject allows the interaction to move in new and perhaps unexpected directions, thereby adding both depth and breadth to one's understanding of the issues involved. Such self-perceptions and enhanced understanding may be achieved in no other way, making this a cornerstone in qualitative research' (Gorman & Clayton, 2005, p 41).

As Gorman and Clayton (2005) mention, interviews also have a large number of potential advantages for a qualitative researcher, for example, it allows a researcher to receive an immediate response to a question and the interview may help to resolve any ambiguity between the interviewer and interviewee by exploring the meaning of questions posed and answers provided (Gorman & Clayton, 2005).

Denscombe (2003) comments that with semi-structured interviews, the interviewer has a clear list of issues to be addressed; however, the interviewer is prepared to be flexible in order to let the interviewee develop ideas and speak more widely on the issues raised by the interviewer. Open-ended questions may also lead to unexpected useful insights (Gorman & Clayton, 2005).

A total of 20 participants volunteered to take part in the semi-structured interviews. Each participant was interviewed (face-to-face) using a semi-structured interview schedule for approximately 50 minutes. During the interview session, the interviewer took notes of their comments and recommendations. Interviews took place at the workplace or office of the interviewees.

The initial study aimed to find out the degree of uncertainty and the type of uncertainty – positive or negative, and to develop an understanding of the user's experiences in the information seeking and retrieval process. The participants were asked to answer the questions (mostly semi-structured) (see Appendix E) regarding their uncertainty level, positive or negative, if any, while searching, retrieving, and/or accessing electronic information services. Participants were asked to comment or provide suggestions, if any, on any particular topic (see Appendix E). The interview questions were piloted as discussed in sub-section 3.2.5.

3.2.4.2.2 Post-search Questionnaire

A post search questionnaire was used to collect the participants' opinion on the search experience and the perceived task completeness in relation to the uncertainty in different aspects of information seeking and retrieval processes. The same participants who took part in the interview process also volunteered to contribute to this study.

A total of 20 participants volunteered to take part in this study. Participants were asked to search on a topic of their area of knowledge or expertise (but not factual information) and then were asked to provide some basic personal information and answer a set of questions, i.e. in completing a post-search questionnaire (see Appendix F) mainly by putting a number or cross wherever instructed. The entire search process and completing the post-search questionnaire took approximately 25 minutes to undertake for each participant. At the end of the search session the experimenter asked the participants to describe any problems they had experienced and provide recommendations, if any, and

this took about 15 minutes. Therefore, the entire session lasted for about a total of 40 minutes. The post-search questionnaire was piloted as discussed in sub-section 3.2.5.

3.2.4.2.3 Search Tasks

In the third phase, a homogeneous group of users from the Department of Computer and Information Sciences at the University of Strathclyde was used for this study. Three search tasks were designed, based on the findings of the earlier phases of the study (see sections 3.2.4.2.1 and 3.2.4.2.2), for collecting details of uncertainty in relation to users' real tasks and a total of eight uncertainty causing factors (see Appendix G) were identified from the earlier phases of the study for the tasks. The main reason for designing the questionnaire was to identify whether uncertainty changed (increased or decreased according to a specific scale) in the course of a series of information search sessions. The survey was then piloted and a total of 15 results were received from five users. Minor changes were made to the form, especially with respect to the order of tasks. The participants were asked to perform the tasks in the given order. A total of 15 users volunteered for this experiment and each of them performed three tasks, producing 45 sets of results. In the course of the search sessions, the participants were sometimes asked to explain their courses of action, and appropriate notes were taken.

Two search sessions with each user were held, and each session lasted for about 45 minutes. Although time varied from person to person for each task the variation was not very significant. Two consecutive days were involved so that the participants could remember and use some of the experiences gained through the previous tasks. Each participant was asked to carry out a total of three tasks and each task was followed by a short questionnaire (Appendix H). The questionnaire was piloted as discussed in sub-section 3.2.5.

The first search session began with familiarisation with the objectives of the work, taking about five minutes, followed by two tasks and filling in the post-search questionnaire, each taking about 20 minutes. The participant was asked to "talk aloud," commenting as

they proceeded with the tasks. The "talk aloud" method was used to supply verbal information that could support and justify their actions. Therefore the session took about 45 minutes to complete. In the course of the search session the participants were asked to explain their courses of action, and appropriate notes were taken.

Only one task was assigned to each user in the second search session. Completing the task and filling in the post-search questionnaire took about 25 minutes. The session ended with a general discussion that took another 20 minutes. The participant was asked to "talk aloud," commenting as they proceeded with the tasks. The "talk aloud" method was used to supply verbal information that could support and justify their actions. The session ended with a general discussion. Therefore the session took about 45 minutes to complete. In the course of the search sessions, the participants were sometimes asked to explain their courses of action, and appropriate notes were taken.

3.2.5 Pilot Studies

A total of four pilot studies were conducted to test run the data collection instruments. Before conducting the full scale web survey, a pilot test was conducted using respondents from computer and information sciences, civil engineering, and economics departments at the University of Strathclyde. A total of 11 responses were returned for the questionnaire survey. Some minor amendments were made to the questionnaire. The questionnaire took approximately 30 minutes to complete.

A second pilot study was conducted among a select set of respondents from three departments before conducting the in-depth interview. A total of six subjects from computer and information sciences, management science, and civil engineering departments volunteered to take part in the pilot study. The pilot study prompted some minor changes in terms of the wording of questions in the semi-structured interview schedule.

A third pilot study was conducted using respondents from the above mentioned departments to test the post-search questionnaire for the third phase of the study. A total

of six subjects from computer and information sciences, management science, and civil engineering departments volunteered to take part in the pilot study. No major corrections were necessary in the post-search questionnaire as a result of the pilot study.

The fourth and final pilot study was conducted among respondents from the Department of Computer and Information Sciences at the University of Strathclyde before conducting the task-based search experiment. A total of five subjects from the department volunteered to take part in the pilot study. Following the pilot study, minor changes were made in terms of the order and structure of the search tasks.

3.3 Data Analysis Methods

Different techniques and tools were used for presentation and analysis of the quantitative and qualitative data.

3.3.1 Analysis of Quantitative Data

Out of the total 3607 population, 668 (19%) valid responses were returned for the online survey. The results of quantitative study were analysed using various tools. Raw data was processed in Excel, and subsequently the SPSS software was used for the correlation studies. A series of correlation studies was conducted in order to find answers to a number of research questions mentioned in Chapter 1 (Section 1.4). More specifically the correlation studies were designed to find out:

- whether some demographic variables, such as age, gender and ICT skills of the users are correlated with those information seeking activities and information seeking problems that cause uncertainty among the users
- whether there is a correlation between user categories and user disciplines, and those information seeking activities and information seeking problems that cause uncertainty among the of users

- whether there is a correlation between those information seeking activities that cause uncertainty among the users
- whether there is a correlation between those information seeking problems that cause uncertainty among the users.

In order to facilitate discussions in Chapter 5 each of these was written in the form of a hypothesis and the Pearson's correlation coefficient was used to study whether there was any association between the chosen variables. A two-tailed analysis had been adopted to calculate the correlation because the direction of the association was not known beforehand. A two-tailed test allows the researcher to test whether there is a positive or negative correlation between two variables. In other words, a two-tailed analysis tests the absolute magnitude of the correlation.

3.3.2 Analysis of Qualitative Data

Presentation and analysis of qualitative data has always been a challenge, as Pickard comments:

> 'One of the most difficult aspects of qualitative analysis always appears to be presentation. This is usually because researchers are faced with vast amounts of evidence and it seems to be a momentous task to decide what to represent and how to represent it. Whatever you do, never be tempted to try and quantify your data……This is not why you chose to engage in qualitative data in the first place. We no longer have the comfort of a single, recognized graph or chart; a table is not going to be particularly useful, so what are we left with? Words! And lots of them' (Pickard, 2007, p 245).

There are a number of options open to the researcher for presenting qualitative data (Pickard, 2007):

- 'Without doubt the most common way of presenting qualitative analysis is the *story*, descriptive narrative used to tell our audience what we have found. This is a perfectly acceptable form of data presentation, your written theory and all of the evidence that contributed to the emergence of that theory.

- A *concept map* details the links and connection in your theory.
- A *rich picture* provides your reader with a very clear visual demonstration of your theory.' (p. 245)

The *story* is used to present the qualitative analysis in this study because this option allows the researcher to present descriptive narration of the findings.

However, in order to facilitate easy understanding and visual comparison, some of the data obtained through the qualitative analyses have been presented in the form of tables and charts, as appropriate, in this thesis. Thus, it may be stated that a semi-quantitative approach has been used for presentation and analyses of data in this research.

3.4 Summary

A combination of quantitative and qualitative methods and a variety of data collection techniques were used in this research. An online questionnaire survey was conducted to collect data from a large number of users in the academic institutions in UK. A number of statistical tools and techniques were used to present and analyse the quantitative data. The statistical data derived from the online questionnaire have been presented and discussed in Chapter 4, while results of a series of correlation analyses using Pearson's correlation coefficient have been presented and discussed in Chapter 5. Qualitative data were collected through two stages – through semi-structured interviews and post-search questionnaire among participants from different disciplines, and a task-based analysis and post-search questionnaire among participants from one specific department – and they are presented and analysed in chapters six and seven respectively.

Chapter 4

Data Analysis of the Web Survey

"Conceptual work is the greatest and most constant challenge for many researchers"

Fisher, Erdelez and McKechnie, 2006, p, xix)

4.1 Introduction

This chapter discusses the findings of the web survey. First, demographic information is presented followed by a discussion of uncertainty in relation to the 14 identified information seeking activities numbered as A1 to A14 (Appendix A). This chapter also presents uncertainty in relation to the 21 identified information seeking problems numbered as P1 to P21 (Appendix B) ; and uncertainty in relation to the 17 identified information channels or sources numbered as C1 to C17 (Appendix C).

4.2 Findings

A total of 668 responses to the questionnaire survey were received. Findings of the web survey are discussed in the following sections.

4.2.1 Demographic Information

The respondents came from a variety of subject areas but the number of respondents for some subject areas was very small. Keeping in mind the objectives of the research i.e., to find out the major differences between respondents from different disciplines – the respondents were grouped into five broad subject categories: business and management; computer and information sciences; arts and humanities; science, engineering, medical sciences and technology; and social sciences. The subject category of computer and information sciences was kept as a separate subject grouping because respondents of this discipline were assumed to be more conversant with the technology and, hence, might produce results that were different from the other user groups.

Most of the respondents (30%) were from business and management followed by social sciences (27%). The remainder were from arts and humanities (19%); science, engineering, medical sciences and technology (17%) and computer and information sciences (7%) (Table 4.1).

Table 4.1: Distribution of respondents across disciplines

Disciplines	**Frequency**	**Percentage (%)**
Business and management	200	(30%)
Social sciences	180	(27%)
Arts and humanities	124	(19%)
Science, engineering, medical sciences and technology	116	(17%)
Computer and information sciences	48	(7%)
Total	668	100%

Academic users belonging to three groups, i.e. academic staff, research staff, and research students in the UK were chosen for two main reasons as discussed in Chapter 3, sub-section 3.2.3.1. Out of the total of 668 responses, 67% were academic staff, 21% were research staff and 12% research students (Table 4.2). The survey being voluntary, there was no control over the exact distribution of respondents from different categories.

Table 4.2: Respondents by user category

User category	**Frequency**	**Percentage (%)**
Academic staff	448	67%
Research staff	140	21%
Research students	80	12%
Total	668	100%

Table 4.3 shows that most (31%) respondents were in the age group 51-60 followed by 41-50 (24%), 31-40 (19%), 30 and below (18%), 61 and over (8%) respectively.

Table 4.3: Respondents by age groups

Age group (years)	Frequency	Percentage (%)
≤ 30	120	18%
31 – 40	124	19%
41 – 50	164	24%
51 – 60	204	31%
61≤	56	8%
Total	668	100%

Out of the total of 668 respondents most were extremely confident (52%) in their ICT skills while 33% were very confident, 6% were confident, and the rest were less confident (4%) or not at all confident (5%) (Table 4.4).

Table 4.4: Respondents by ICT skills

ICT Skills	Frequency	Percentage (%)
Extremely Confident	348	52%
Very Confident	220	33%
Confident	40	6%
Not Very Confident	26	4%
Not at all Confident	34	5%
Total	668	100%

The respondents were distributed almost equally between male (49%) and female (51%) (Table 4.5).

Table 4.5: Respondents by gender

Gender	Frequency	Percentage (%)
Male	326	49%
Female	342	51%
Total	668	100%

4.2.2 Uncertainty and Information Seeking Activities

As shown in figure 4.1, information seeking activities that were identified by the respondents as causing uncertainty were as follows: *choosing appropriate information channels and sources* (36%), *formulating a search expression* (32%), *deciding when to stop a search and to begin to use the retrieved items (32%), making sure to remain up-to-date in a given field* (30%), and so on.

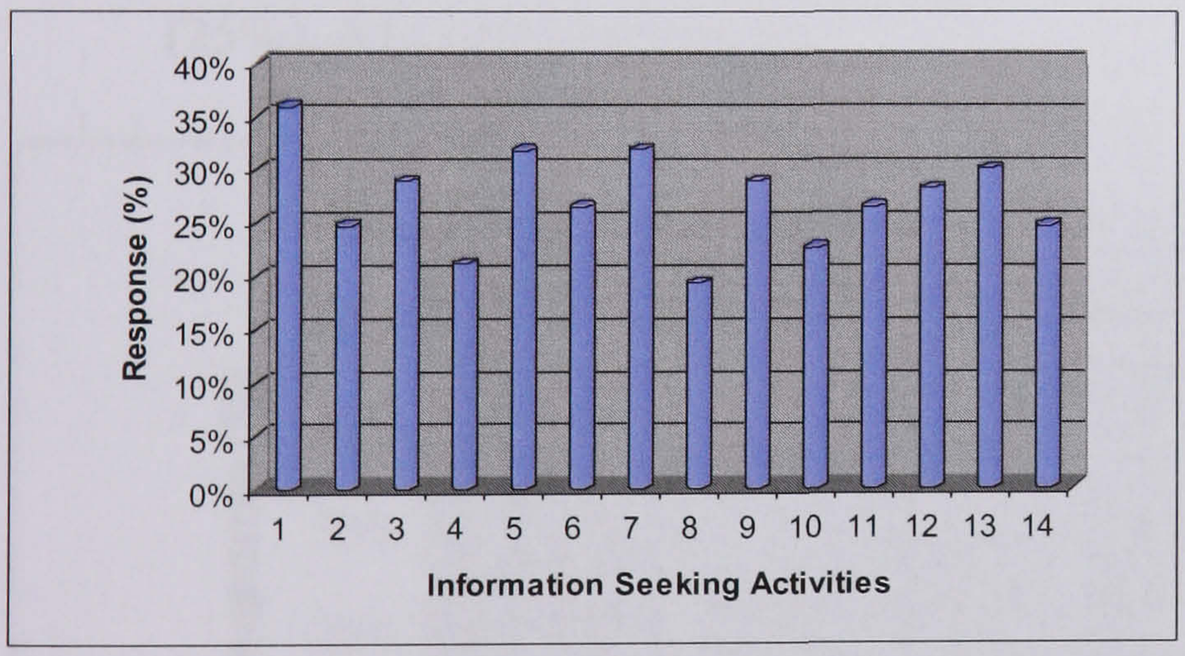


Figure 4.1: Uncertainty in relation to information seeking activities

4.2.2.1 Information Seeking Activities and Age Group

In order to establish whether there were any differences in uncertainty caused by information seeking activities among respondents from different age groups the respondents were grouped as: ≤ 30 (18%), 31-40 (19%), 41-50 (24%), 51-60 (31%) and

61+ (8%). Figure 4.2 shows the activities which caused most uncertainty across respondents in the various age groups.

There was a difference between age groups, for example, the information seeking activities (Appendix A) that caused uncertainty among respondents of various age groups were as follows:

- age group 30 and below: A1 (43%), A3 (38%), A5 (38%), A13 (38%), A14 (35%), A7 (31%), A11 (30%) and so on
- age group 31-40: A12 (38%) , A9 (33%), A2 (32%), A7 (32%), A3 (30%), A1 (29%), A10 (29%) and so on
- age group 41-50: A7 (46%), A1(43%), A9 (38%), A6 (33%), A12 (32%), A10 (31%), A3 (28%) and so on
- age group 51-60: A1 (36%), A5 (36%), A13 (35%), A6 (32%), A7 (31%), A9 (30%), A12 (29%) and so on
- age group 61+ : A5 (54%), A1(37%), A11 (33%), A2 (31%), A7 (27%), A4 (25%), A14 (25%) and so on.

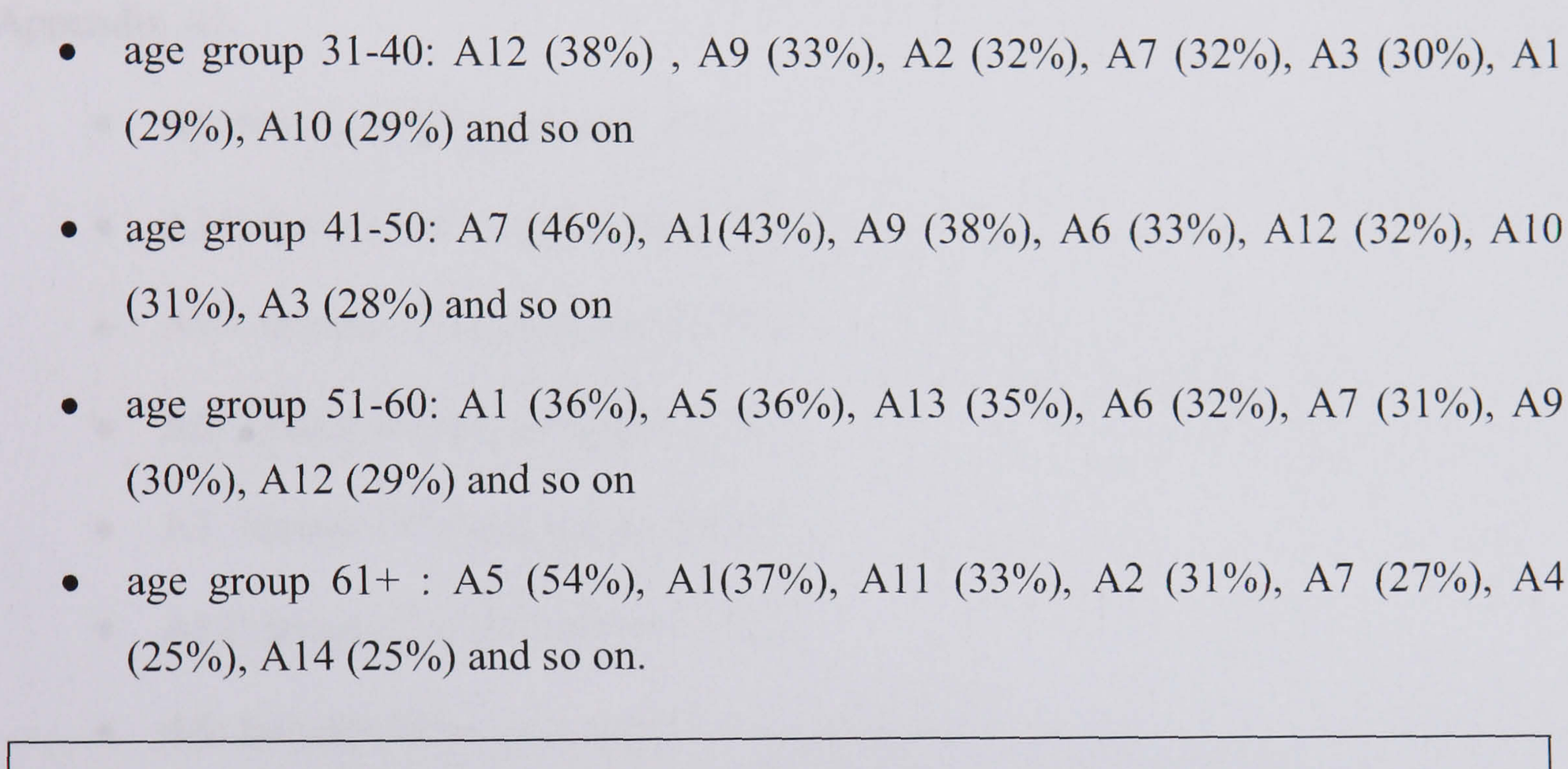


Figure 4.2: Uncertainty in relation to information seeking activities in different age groups

4.2.2.2 Information Seeking Activities and Gender

Out of the 668 respondents, 51% were female and 49% were male respondents. Figure 4.3 shows how uncertainty in relation to different information seeking activities varied between male and female respondents.

Uncertainty caused by certain information seeking activities differed between the male and female respondents as follows (for the list of information seeking activities see Appendix A):

- A1: female (46%) and male (6%)
- A14: female (36%) and male (23%)
- A13: female (35%) and male (20%)
- A9: female (34%) and male (23%)
- A3: female (33%) and male (24%)
- A12: female (31%) and male (22%)
- A6: female (30%) and male (22%) and so on.

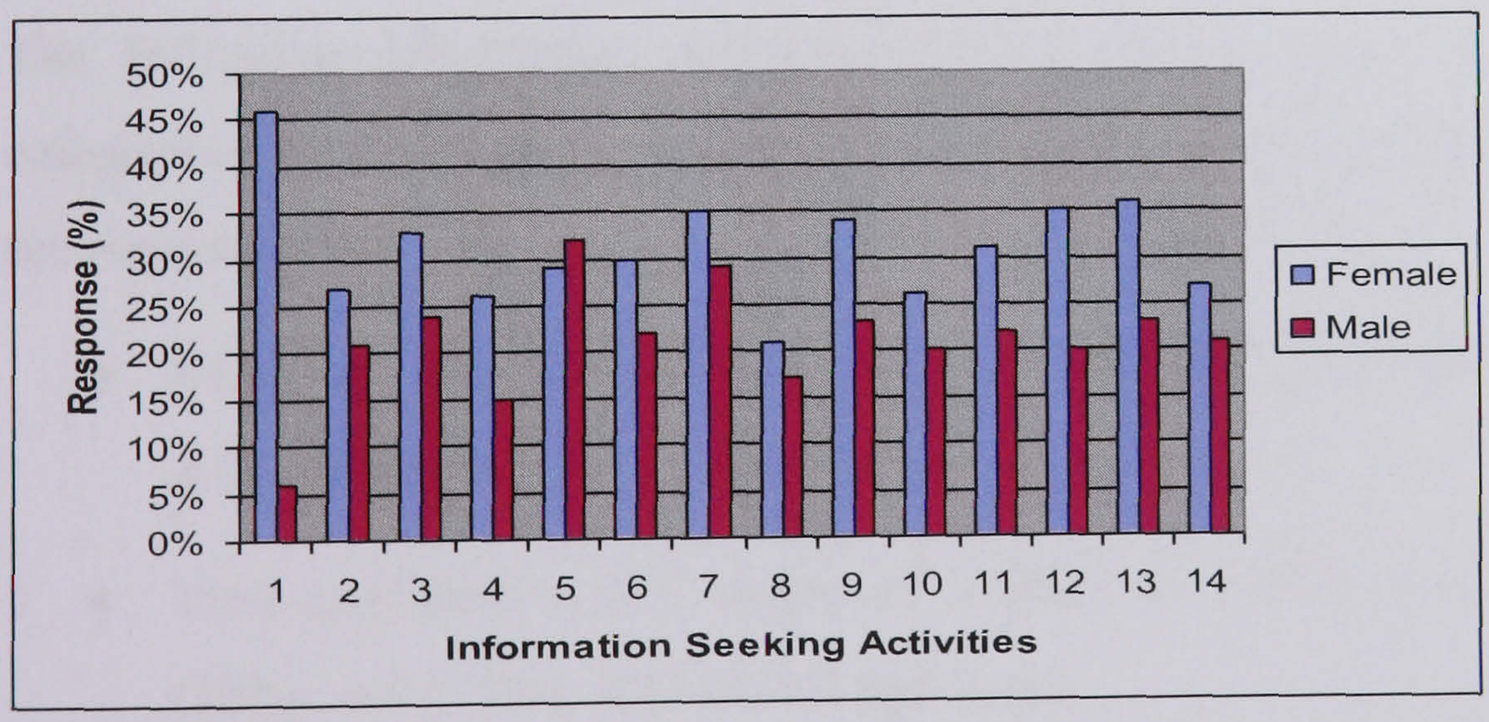


Figure 4.3: Uncertainty in relation to information seeking activities among male and female respondents

4.2.2.3 Information Seeking Activities and ICT Skills

People with different ICT skills may have differing levels of uncertainty in relation to certain information seeking activities. In this study, 52% of the respondents considered themselves to be extremely confident, 33% very confident, 7% confident, 4% fairly confident, and 4% not at all confident in their ICT skills. Figure 4.4 shows uncertainty in relation to information seeking activities among respondents with respect to their ICT skills.

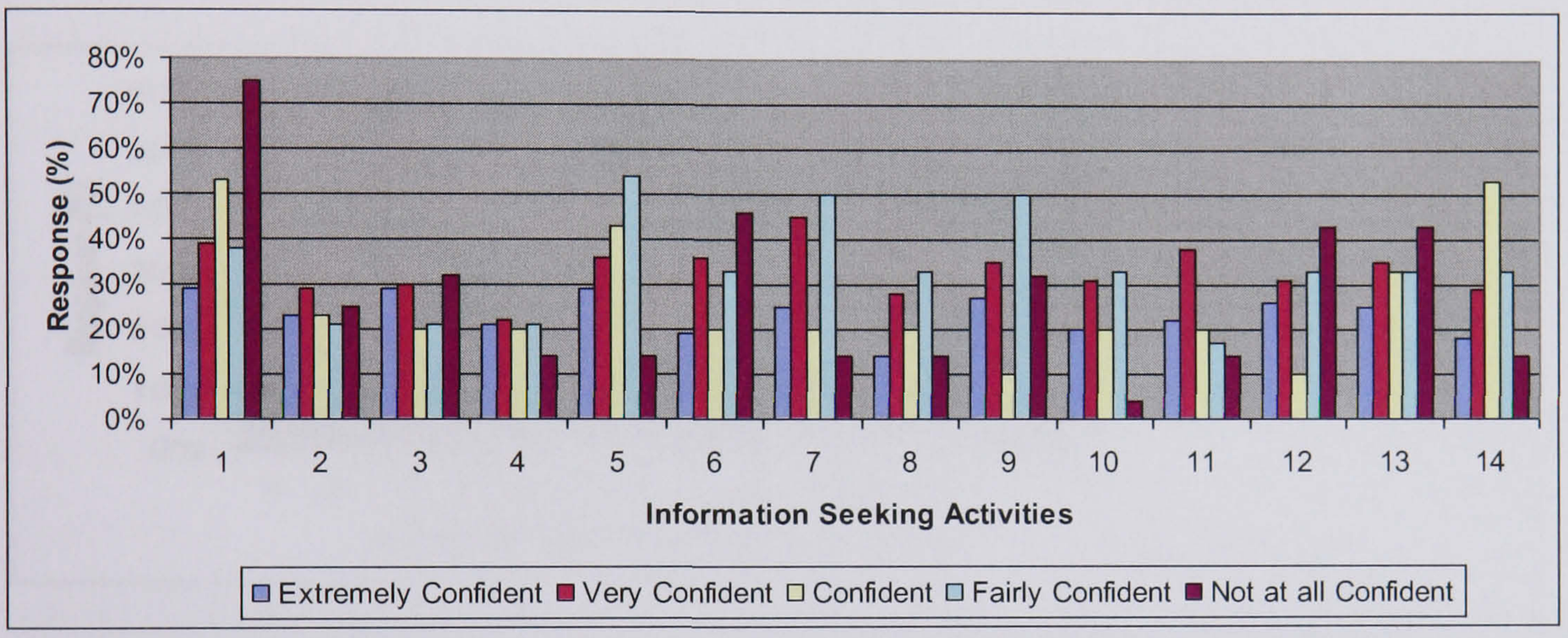


Figure 4.4: Uncertainty in relation to information seeking activities and ICT skills

The following information seeking activities caused uncertainty across respondents categorised by different levels of ICT skills (for the list of information seeking activities see Appendix A):

- Extremely confident in ICT skills: A1 (29%), A3 (29%), A5 (29%), A9 (27%), A12 (26%), A7 (25%), A13 (25%) and so on
- Very confident in ICT skills: A7 (45%), A1 (39%), A11 (38%), A5 (36%), A6 (36%), A9 (35%), A13 (35%) and so on
- Confident in ICT skills: A1 (53%), A14 (53%), A5 (43%), A13 (33%), A2 (23%), A3 (20%), A4 (20%), A6 (20%), A7 (20%), A8 (20%), A10 (20%), A11 (20%) and so on

- Fairly confident in ICT skills: A5 (54%), A7 (50%), A9 (50%), A1 (38%), A6 (33%), A8 (33%), A10 (33%) and so on
- Not at all confident in ICT skills: A1 (75%), A6 (46%), A12 (43%), A14 (43%), A3 (32%), A9 (32%), A2 (25%) and so on.

4.2.2.4 Information Seeking Activities and User Category

Figure 4.5 shows that users of all categories experienced uncertainty at different stages of information seeking.

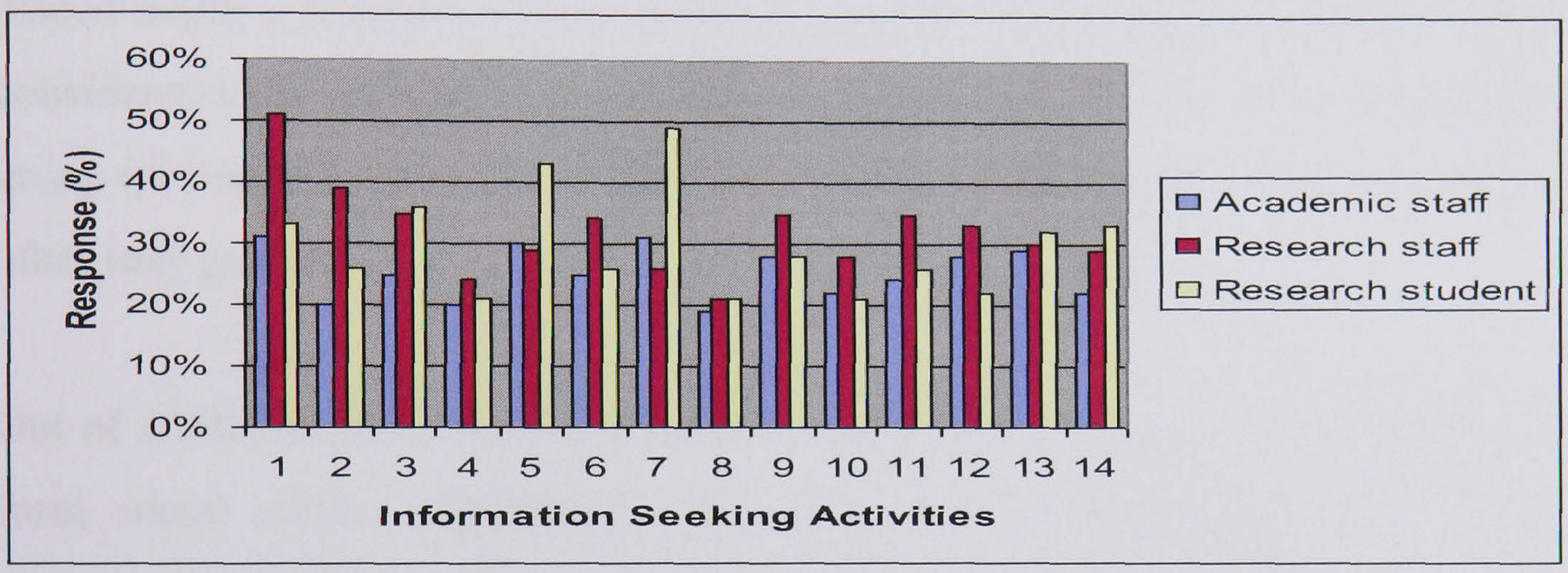


Figure 4.5: Uncertainty in relation to information seeking activities among the user categories

The following information seeking activities (for the list of information seeking activities see Appendix A) caused uncertainty across respondents.

- Among academic staff: A1 (31%), A7 (31%), A5 (30%), A13 (29%), A9 (28%), A12 (28%), A3 (25%), A6 (25%) and so on
- Among research staff: A1 (51%), A2 (39%), A3 (35%), A9 (35%), A11 (35%), A6 (34%), A12 (33%), A13 (30%) and so on
- Among research students: A7 (49%), A5 (43%), A3 (36%), A1 (33%), A14 (33%), A13 (32%), A9 (28%), A2 (26%), A6 (26%), A11 (26%), and so on.

4.2.2.5 Information Seeking Activities and Disciplines

The respondents were from a wide range of subject areas but the number of responses from some specific subjects was small compared to others. Therefore, keeping in view the objectives of the research, the respondents were grouped into five broad subject categories: business and management; computer and information sciences; arts and humanities; science, engineering, medical science and technology; and social sciences. The reason for grouping respondents under these broad categories was to find out whether uncertainty in relation to information seeking varied from one major discipline to another. Computer and information sciences was not included in the science group, but placed under a separate subject grouping, because respondents in these disciplines were considered to be quite conversant with the technology and hence, it was assumed that this group of respondents might produce results that would be significantly different from the other user groups.

Out of a total of 668 respondents, 30% were from business and management, 27% were from social science disciplines; 19% from arts and humanities; 17% from science, engineering, medical science and technology; and 7% from computer and information sciences. Figure 4.6 shows how the various information seeking activities caused uncertainty among respondents from different disciplines.

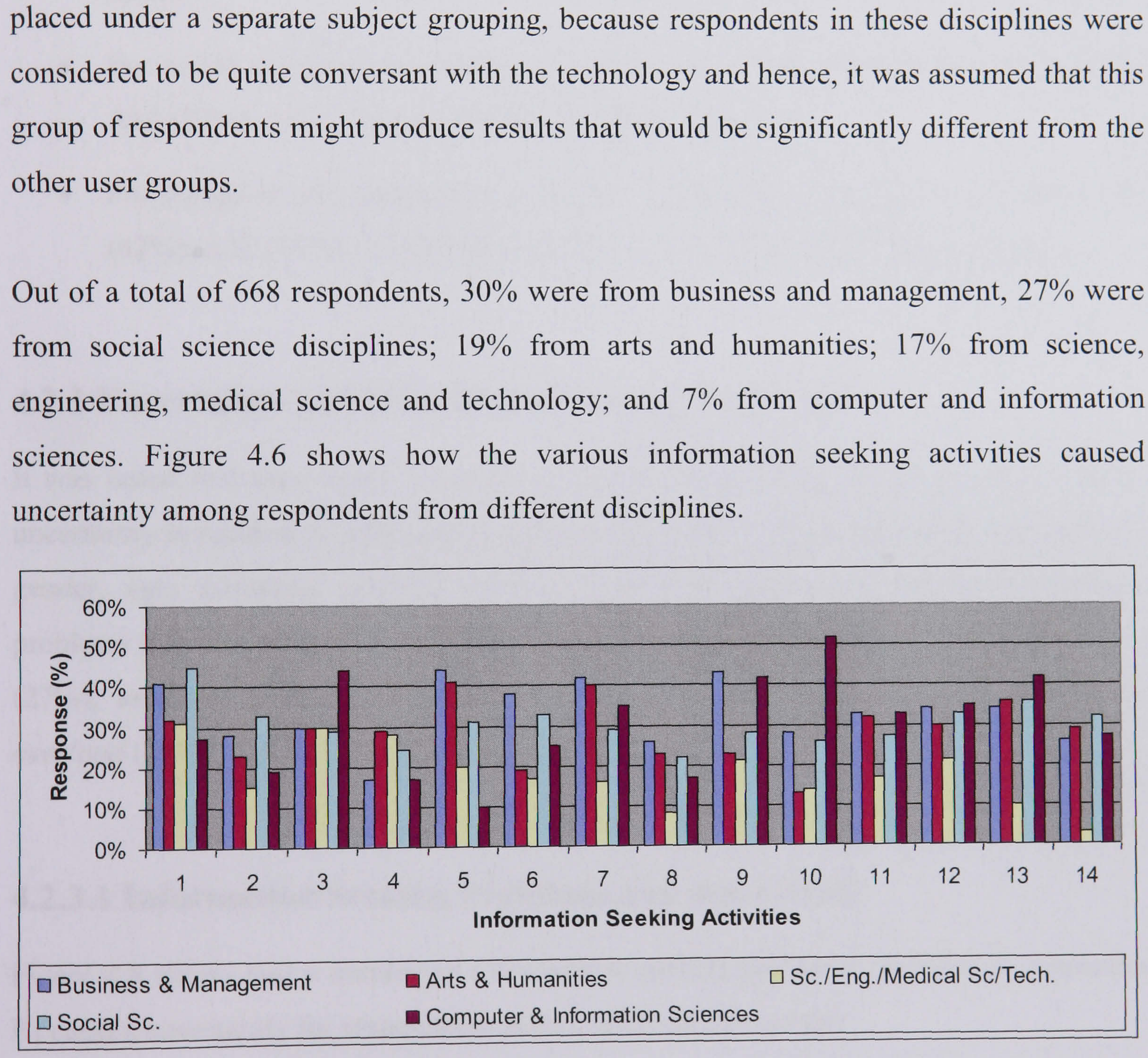


Figure 4.6: Uncertainty in relation to information seeking activities in different disciplines

In general, the information seeking activities (as listed in Appendix A) which caused uncertainty across respondents from different disciplines were:

- For business and management: A5 (44%), A9 (43%), A7 (42%), A1 (41%), A6 (38%), A12 (34%), A13 (34%), A11 (33%), A3 (30%), and so on
- For arts and humanities: A5 (41%), A7 (40%), A13 (36%), A11 (32%), A1 (32%), A3 (30%), A12 (30%), A4 (29%), A14 (29%), and so on
- For science/engineering/medical science/technology: A1 (31%), A3 (30%), A4 (28%), A9 (21%), A12 (21%), A5 (20%), A6 (17%), A11 (17%), A7 (16%), and so on
- For social sciences: A1 (45%), A13 (36%), A2 (33%), A6 (33%), A12 (33%), A14 (32%), A5 (31%), A3 (29%), A7 (29%), and so on
- For computer and information sciences: A10 (52%), A13 (45%), A3 (44%), A9 (42%), A12 (35%), A7 (35%), A11 (33%), A1 (27%), A14 (27%), and so on.

4.2.3 Uncertainty and Information Seeking Problems

It was noted that there were a number of information seeking problems which caused uncertainty in relation to information seeking and retrieval regardless of the respondents' gender, age, discipline, and ICT skills. Figure 4.7 shows the information seeking problems that caused uncertainty among the respondents: s*earch output is not exhaustive* (27%), *unaware of source or channel* (25%), *too much information or information overload* (24%), *unfamiliar with the source* (22%), and so on.

4.2.3.1 Information Seeking Problems and Age Group

Figure 4.8 shows that a number of information seeking problems (as listed in Appendix B) caused uncertainty for respondents across different age groups :

- age group 30 and below: P5 (47%), P6 (27%), P3 (24%), P17 (24%), P1 (20%) and so on

- age group 31-40: P1 (30%), P6 (30%), P7 (29%), P2 (23%), P5 (20%) and so on
- age group 41-50: P5 (33%), P6 (28%), P17 (26%), P7 (25%), P1 (23%), P2 (23%), P3 (23%), P10 (23%), and so on
- age group 51-60: P1 (30%), P5 (26%), P2 (24%), P6 (23%), P17 (22%), and so on
- age group 61+ : P1 (17%), P4 (15%), P6 (15%), P9 (15%), P8 (13%), and so on.

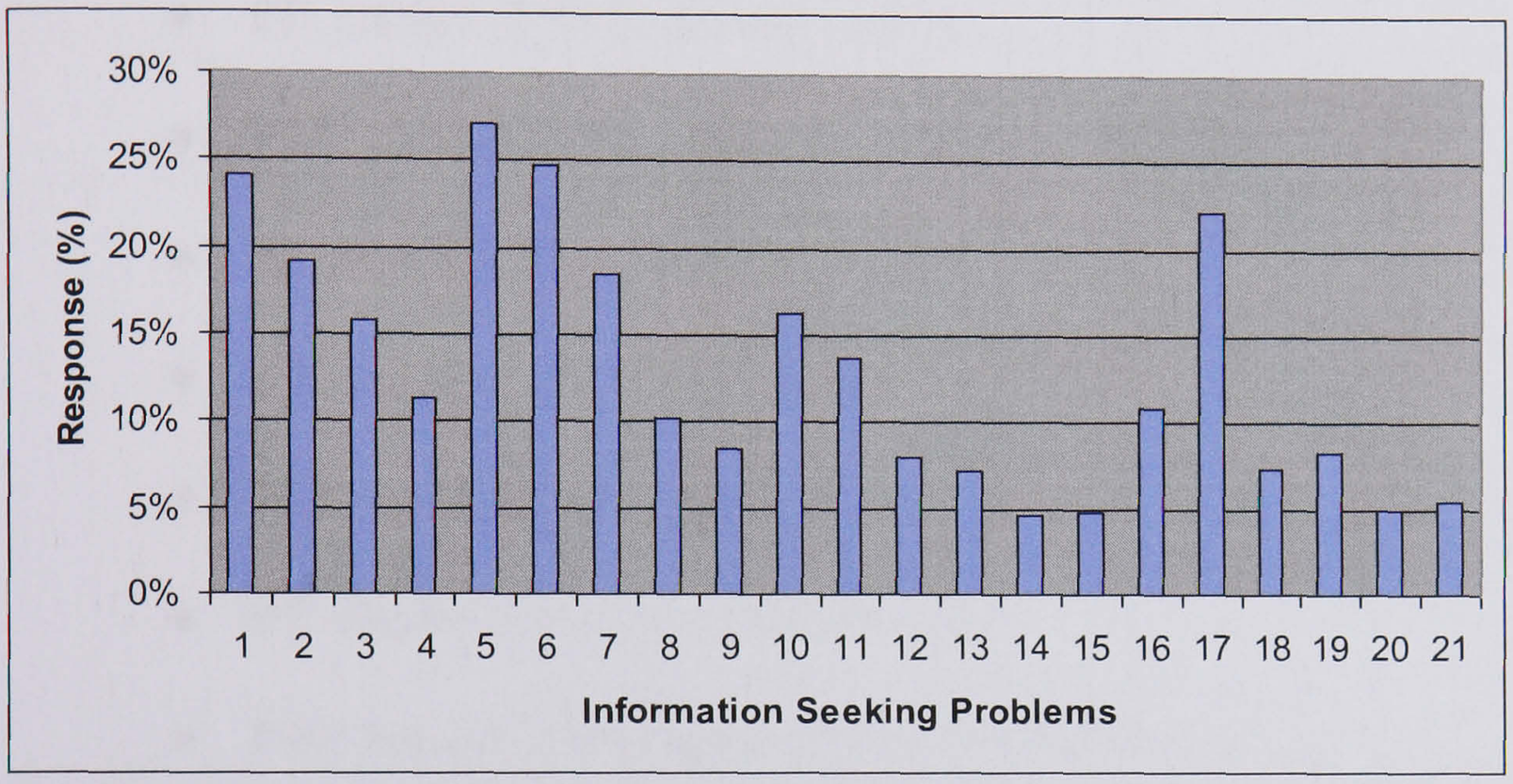


Figure 4.7: Uncertainty in relation to information seeking problems

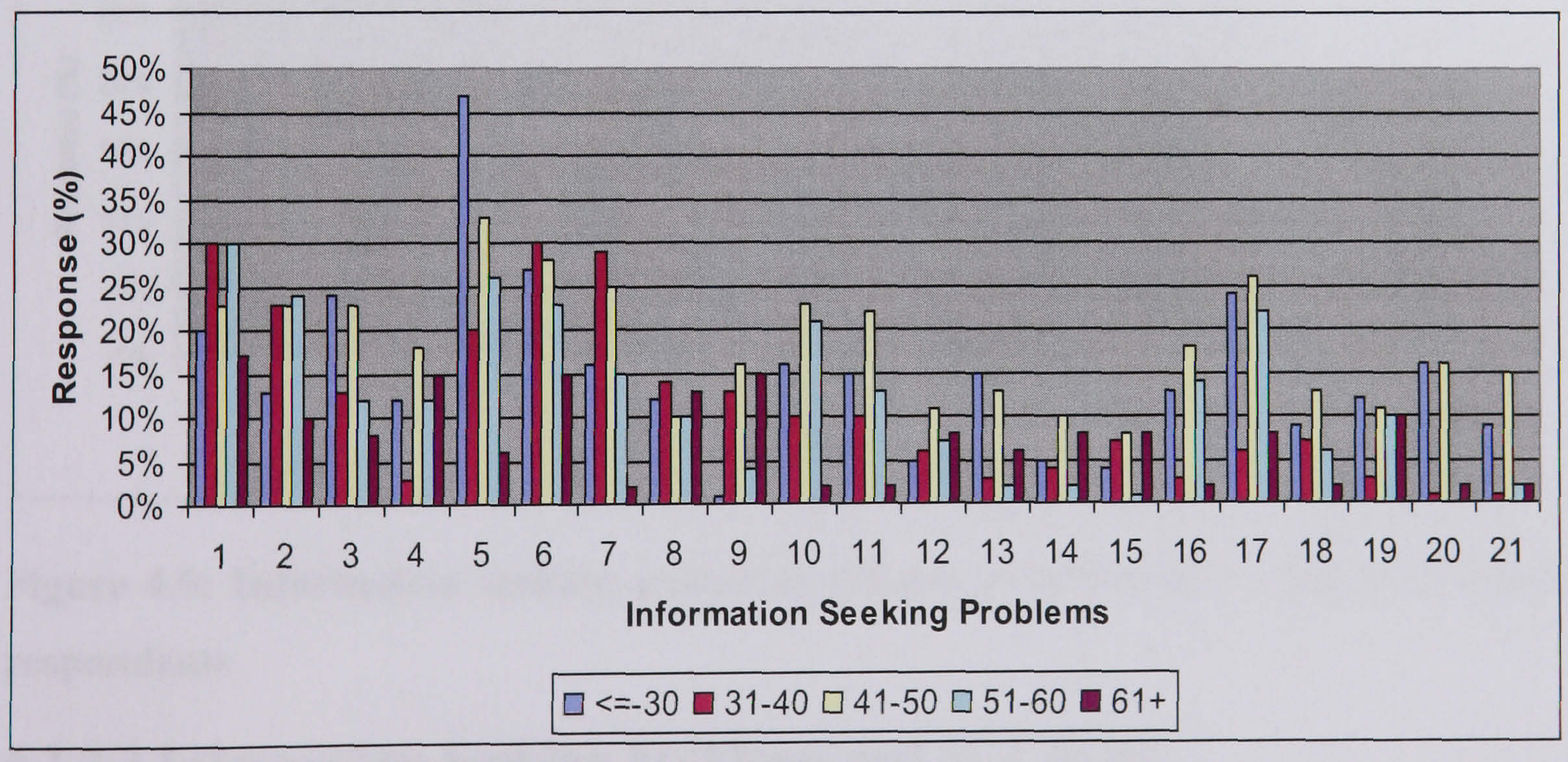


Figure 4.8: Uncertainty in relation to information seeking problems among different age groups

4.2.3.2 Information Seeking Problems and Gender

Figure 4.9 shows that the uncertainty caused by various information seeking problems varied between the genders. Different information seeking problems (listed in Appendix B) that caused uncertainty among male and female respondents varied as follows:

- P5: female (28%) and male (24%)
- P6: female (28%) and male (21%)
- P1: female (26%) and male (23%)
- P17: female (24%) and male (19%)
- P2: female (22%) and male (16%)
- P3: female (22%) and male (9%)
- P11: female (16%) and male (11%)
- P7: female (15%) and male (22%)
- P10: female (15%) and male (17%); and so on.

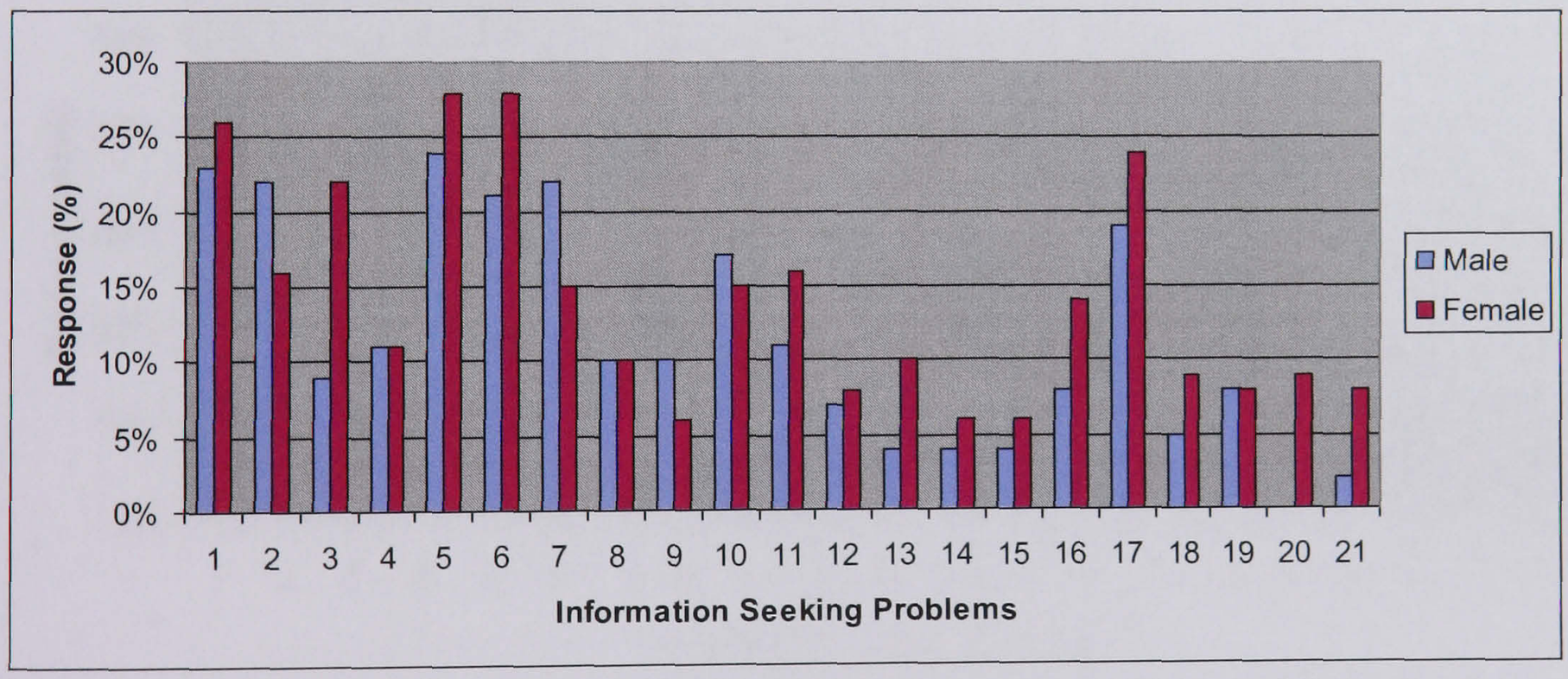


Figure 4.9: Information seeking problems causing uncertainty in male and female respondents

4.2.3.3 Information Seeking Problems and ICT Skills

Figure 4.10 shows how the responses with regard to the uncertainty caused by various information seeking problems varied across respondents with different levels of ICT

skills. Information seeking problems (listed in Appendix B) that caused uncertainty among people with different levels of ICT skills were as follows:

- Extremely confident in ICT skills: P1 (22%), P6 (22%), P17 (20%), P3 (18%), P5 (18%), P7 (16%) and so on
- Very confident in ICT skills: P5 (38%), P1 (30%), P2 (27%), P6 (27%), P7 (25%), P17 (25%), and so on
- Confident in ICT skills : P17 (43%), P1 (33%), P5 (30%), P10 (23%), P2 (20%), P6 (18%), and so on
- Fairly confident in ICT skills: P4 (54%), P2 (38%), P16 (38%), P5 (33%), P7 (33%), P6 (29%), and so on
- Not at all confident in ICT skills: P3 (46%), P6 (46%), P5 (43%), P11 (43%), P1 (32%), P10 (29%), and so on.

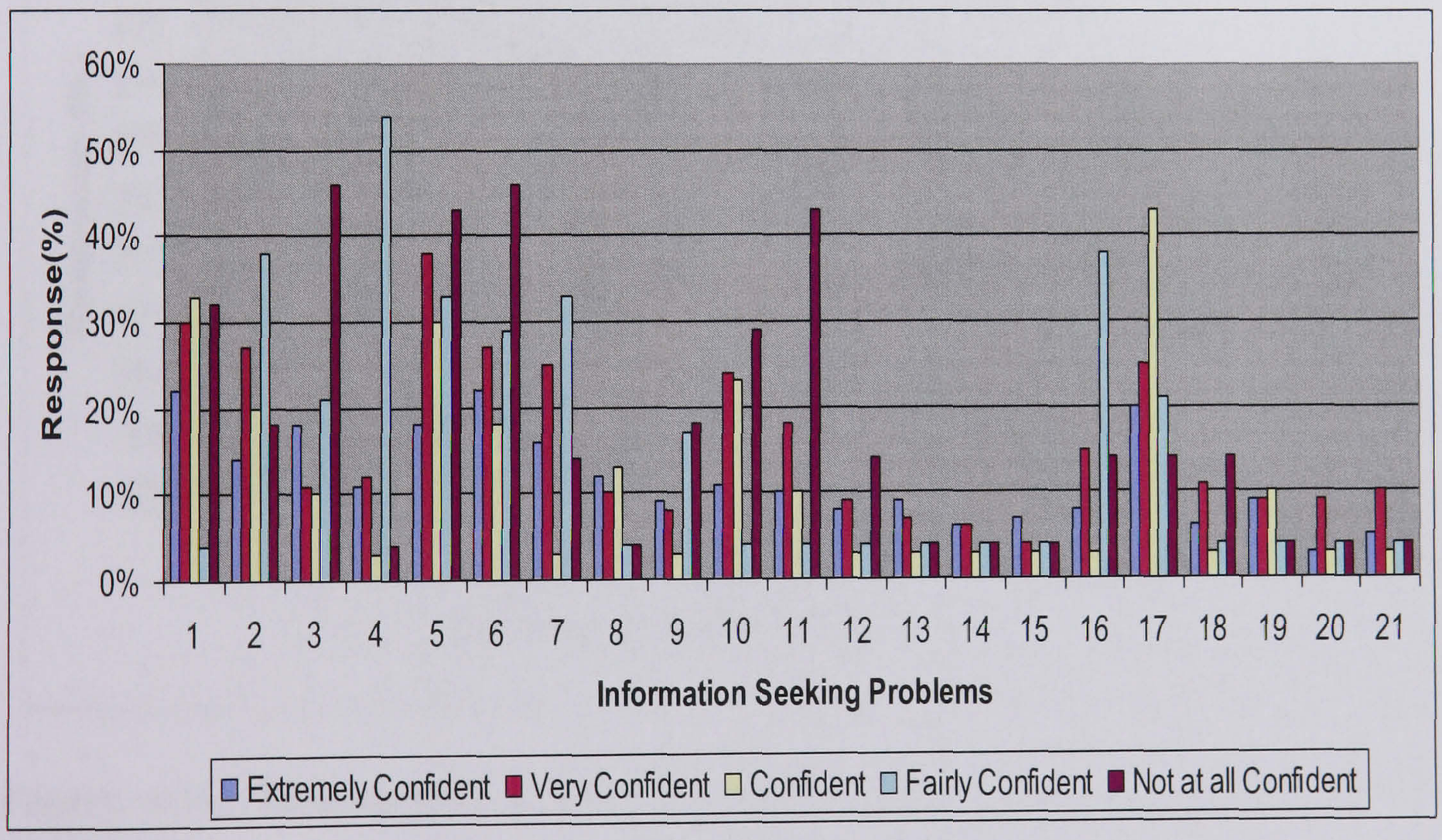


Figure 4.10: Information seeking problems causing uncertainty in respondents with different ICT skills

4.2.3.4 Information Seeking Problems and User Category

Figure 4.11 shows how the responses varied among academic staff, research staff, and research students with regard to the uncertainty caused by different information seeking problems. Information seeking problems (listed in Appendix B) that caused uncertainty among the respondents from different categories were as follows:

- For academic staff: P1 (26%), P5 (26%), P2 (21%), P6 (20%), P17 (19%), and so on
- For research staff: P17 (32%), P6 (26%), P10 (22%), P1 (21%), P5 (18%), P11 (18%), P16 (18%), and so on
- For research students: P7 (43%), P6 (42%), P5 (38%), P17 (29%), P3 (28%), and so on.

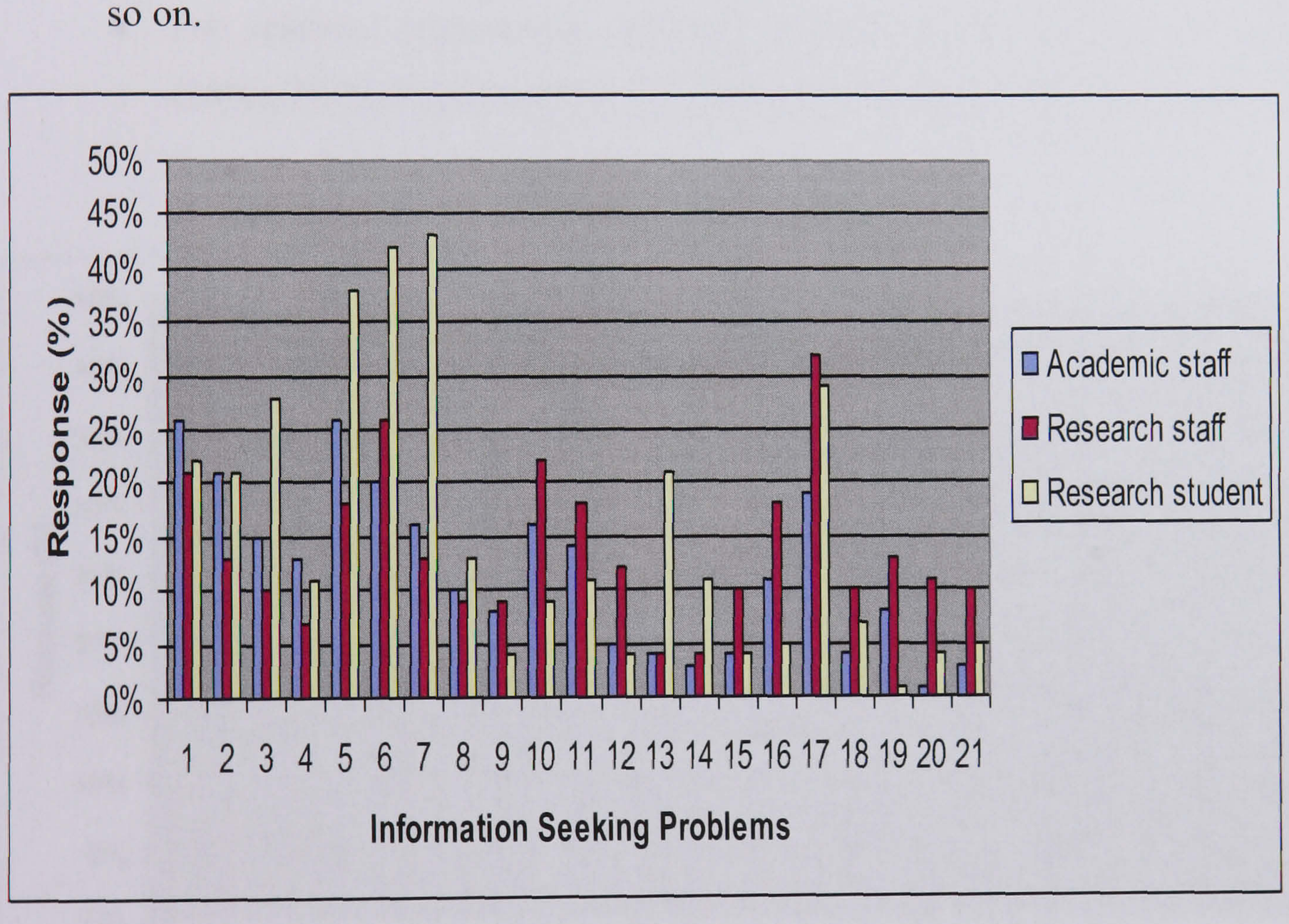


Figure 4.11: Information seeking problems causing uncertainty among different user categories

4.2.3.5 Information Seeking Problems and Disciplines

Figure 4.12 shows how uncertainty caused by various information seeking problems varied among respondents from different disciplines. Information seeking problems

(listed in Appendix B) that caused uncertainty among respondents from different disciplines were as follows:

- For business and management: P1 (39%), P6 (37%), P5 (35%), P10 (29%), P2 (28%), P17 (26%), P7 (25%), and so on
- For arts and humanities: P17 (30%), P5 (20%), P3 (19%), P7 (19%), P6 (17%), P11 (14%), P13 (13%), and so on
- For social sciences: P5 (33%), P1 (29%), P17 (27%), P6 (25%), P10 (20%) P7 (18%), P11 (18%), and so on
- For computer and information sciences: P1 (35%), P6 (35%), P5 (25%), P17 (25%), P14 (19%), P4 (19%), P12 (17%), and so on
- For science, engineering, medical science and technology: P5 (25%), P7 (24%), P6 (21%), P1 (18%), P2 (17%), P17 (15%), P19 (11%), and so on.

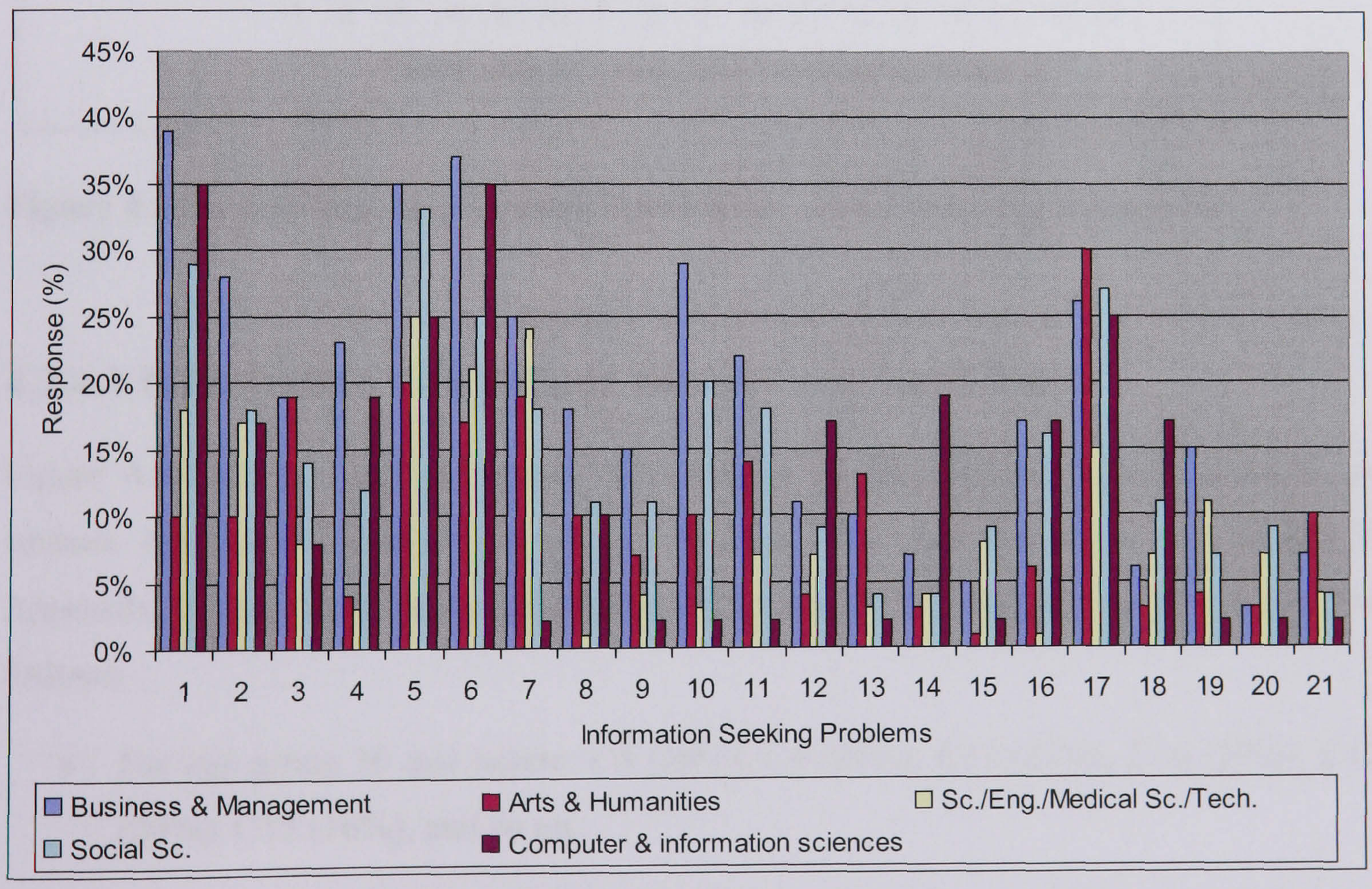


Figure 4.12: Information seeking problems causing uncertainty in different disciplines

4.2.4 Uncertainty and Electronic Information Channels or Sources

Respondents were asked to indicate whether they had experienced any uncertainty while seeking information from the specified information channels or sources irrespective of the causes of uncertainty. In general, 4.13 shows that very few respondents identified information channels or sources to be causing uncertainty.

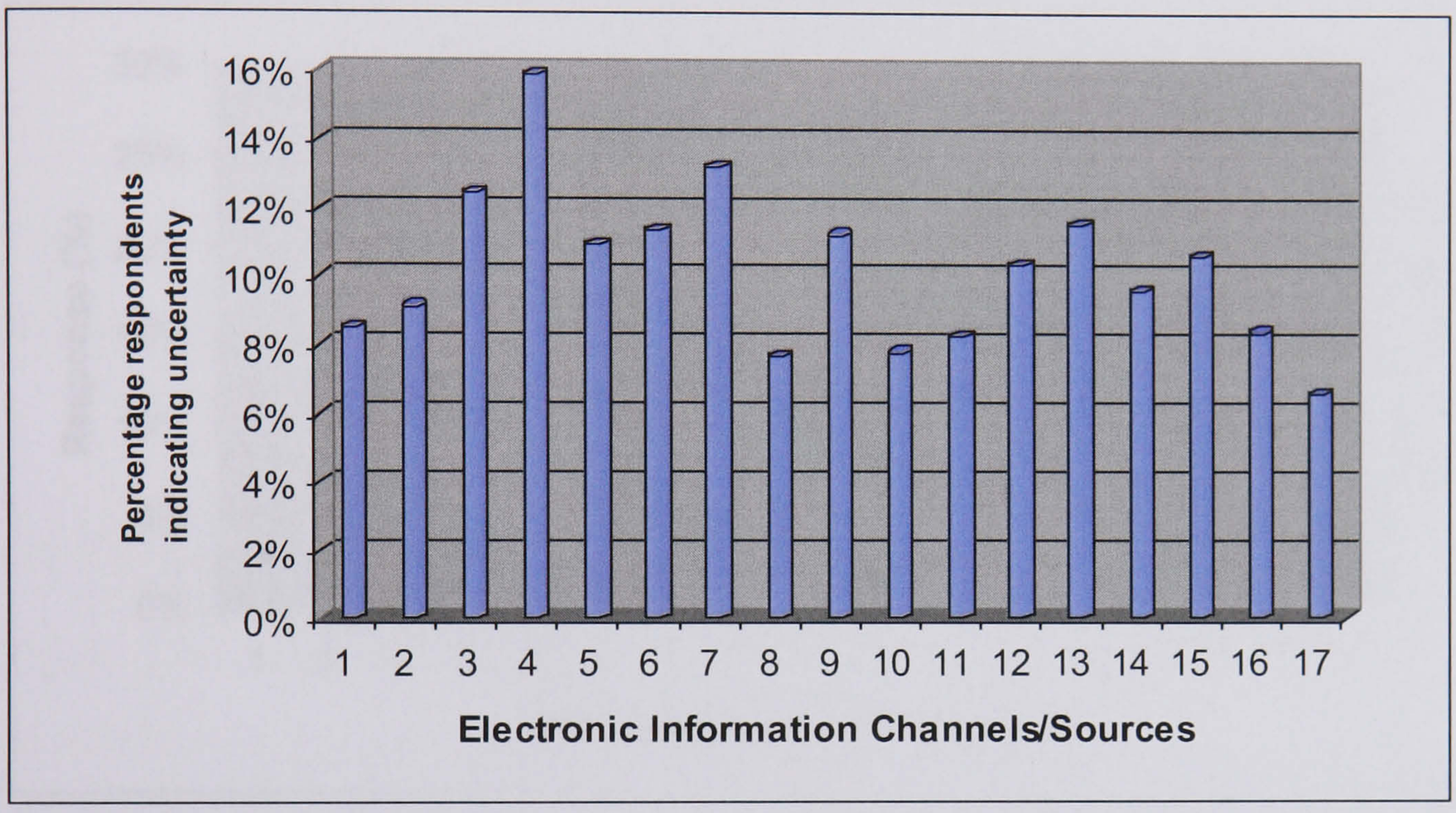


Figure 4.13: Electronic information channels or sources causing uncertainty

4.2.4.1 Information Channels or Sources and Age Group

Figure 4.14 shows how uncertainty with regard to specific information channels or sources was caused across various age groups. The channels or sources (listed in Appendix C) that caused uncertainty across respondents in different age groups were as follows:

- For age group 30 and below: C5 (28%), C4 (24%), C13 (23%), C16 (23%), C12 (20%), C15 (16%), and so on
- For age group 31-40: C3 (23%), C6 (19%), C15 (19%), C4 (17%), C11 (16%), C9 (15%), and so on

- For age group 41-50: C7 (18%), C4 (16%), C3 (13%), C5 (13%), C11 (13%),C14 (13%), and so on
- For age group 51-60: C9 (13%), C1 (12%), C4 (12%), C8 (12%), C2 (8%), C6 (8%), and so on
- For age group 61 and over: C7 (23%), C3 (17%), C2 (15%), C16 (13%), C1 (10%), C15 (10%), and so on.

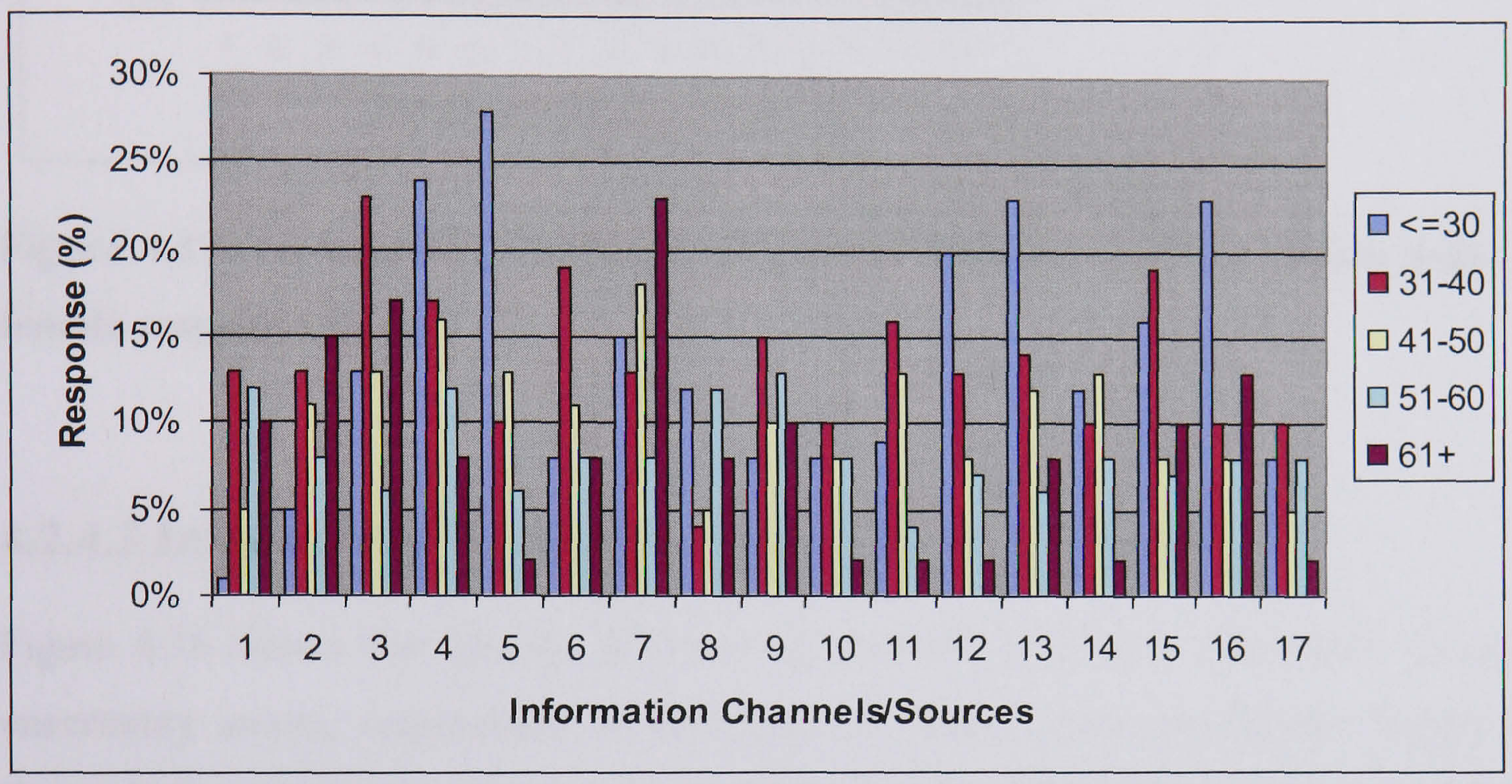


Figure 4.14: Uncertainty about information channels or sources in different age groups

4.2.4.2 Information Channels or Sources and Gender

Figure 4.15 shows that *websites of online bookstores* and *business websites* caused uncertainty among 17% and 15% male respondents respectively while *indexing and abstracting databases*, *personal collections*, and *meta-search engines* caused uncertainty among 21%, 16%, and 15% female respondents respectively. Other channels or sources (Appendix C) that caused uncertainty among 15% or more respondents were:

- For female: C4 (21%), C5 (16%), and C13 (15%); and
- For male: C9 (17%), and C7 (15%).

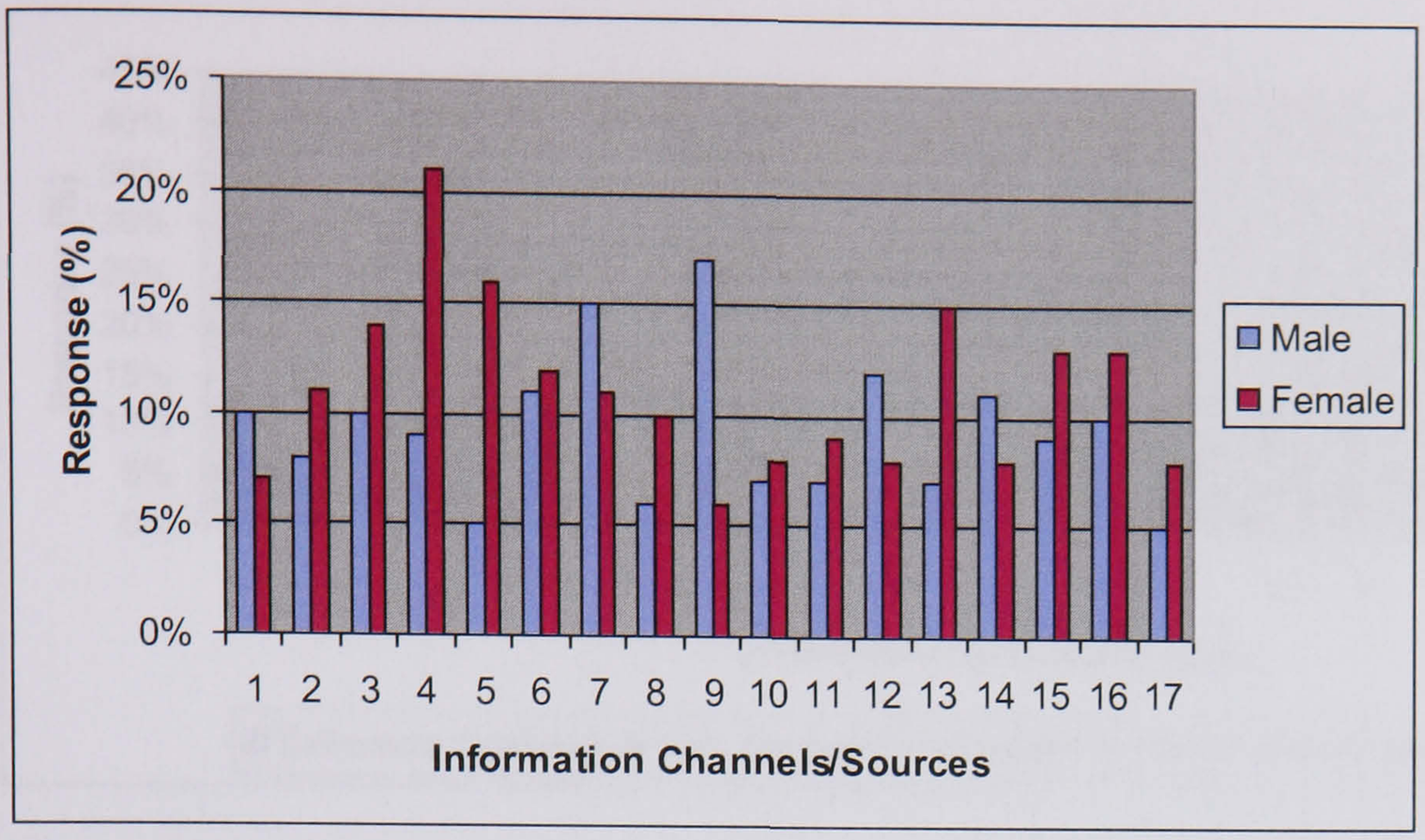


Figure 4.15: Uncertainty about information channels or sources among male and female respondents

4.2.4.3 Information Channels or Sources and ICT Skills

Figure 4.16 shows that specific information channels or sources (Appendix C) caused uncertainty among respondents of different ICT skills. More specifically, Figure 4.16 shows how uncertainty varied with regard to specific information sources or channels across respondents with different ICT skills:

- For respondents those are very confident in ICT skills: C4 (26%), C3 (20%), C7 (20%), C5 (18%), C13 (18%), C12 (17%), and so on
- For respondents those are confident in ICT skills: C4 (40%), C3 (33%), C11 (23%), C2 (20%), C15 (20%), C16 (20%), and so on
- For respondents those are fairly confident in ICT skills: C9 (38%), C3 (17%), C8 (21%), C14 (17%), C15 (17%), C13 (13%), and so on
- For respondents those are not at all confident in ICT skills: C13 (32%), C4 (29%), C14 (29%), C12 (18%), C15 (18%), C1 (14%), and so on.

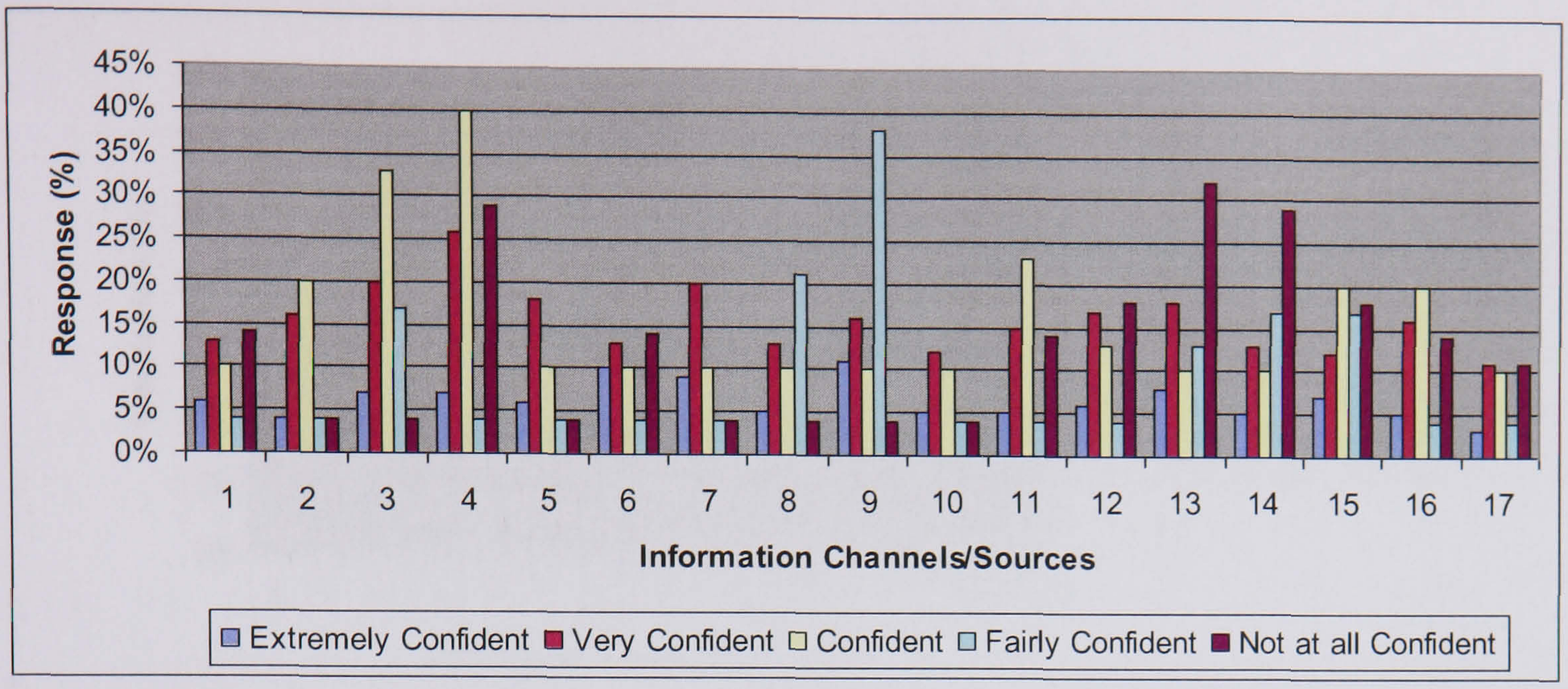


Figure 4.16: Uncertainty about information channels or sources in respondents with different ICT Skills

It was noted that information channels or sources caused very little uncertainty among respondents who were extremely confident in their ICT skills (≤ 11%).

4.2.4.4 Information Channels or Sources and User Category

Figure 4.17 shows the uncertainty caused by specific channels or sources among research students, research staff, and academic staff. It is important to note that specific information channels or sources caused very little uncertainty among academic staff (< 15%). For respondents from the two other categories the figures were as follows:

- For research students: C5 (33%), C7 (32%), C4 (28%), C6 (28%), C15 (28%), and so on
- For research staff: C13 (15%), C4 (13%), C6 (13%), C16 (13%), C2 (10%), and so on.

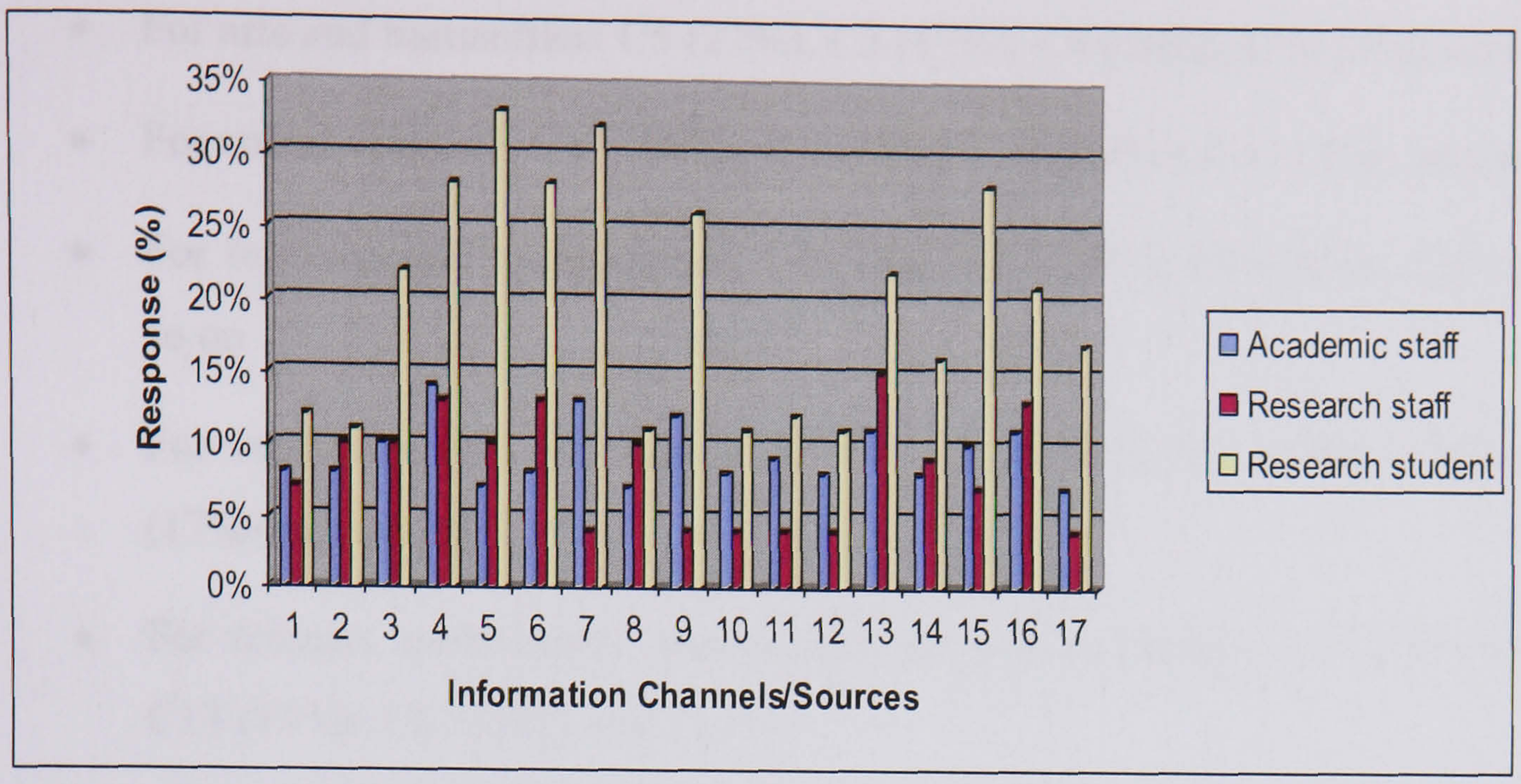


Figure 4.17: Uncertainty about information channels or sources among different user categories

4.2.4.5 Information Channels or Sources and Disciplines

Figure 4.18 shows how uncertainty was caused by specific information channels or sources for respondents from different disciplines.

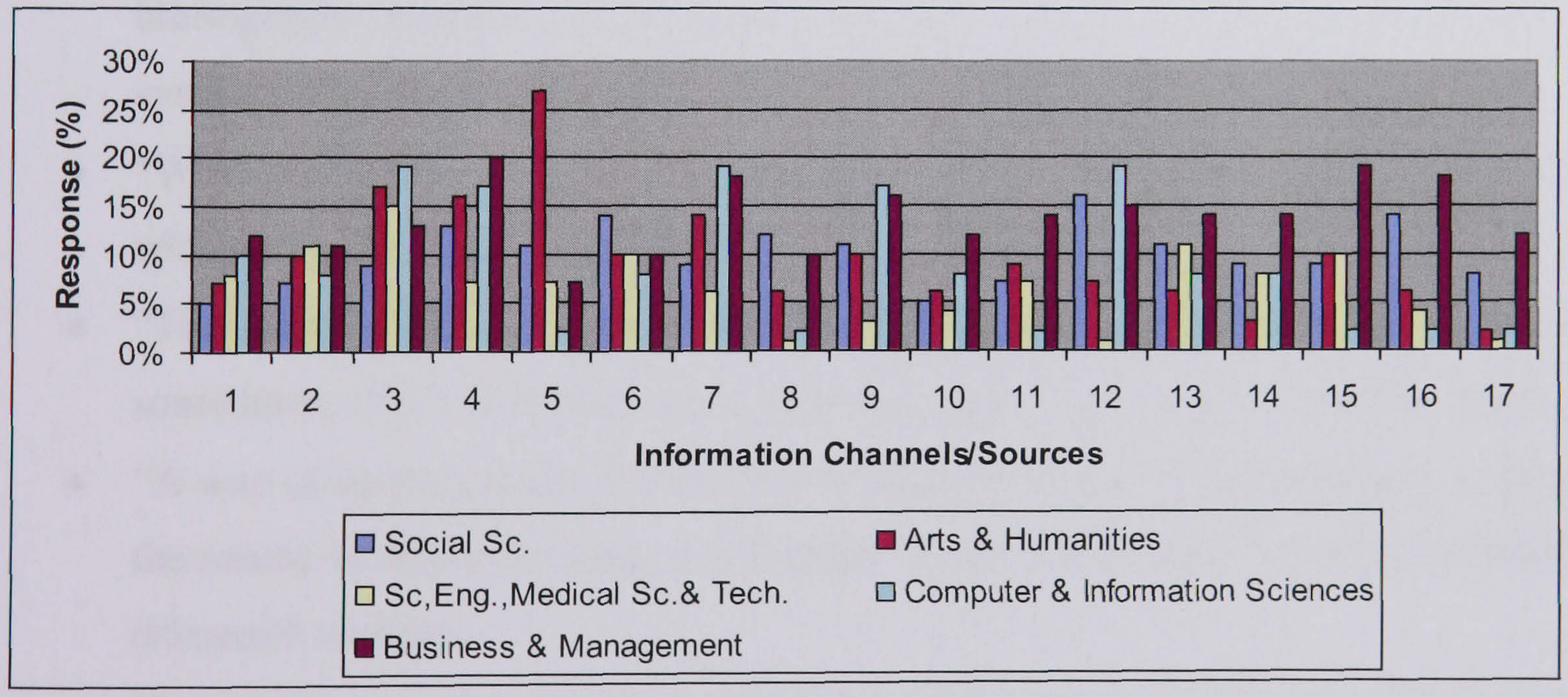


Figure 4.18: Uncertainty about information channels or sources in different disciplines

More specifically Figure 4.18 shows the disciplinary differences as follows:

- For arts and humanities: C5 (27%), C3 (17%), C4 (16%), C7 (14%), and so on
- For social sciences: C12 (16%), C6 (14%), C16 (14%), C4 (13%), and so on
- For business and management: C4 (20%), C7 (18%), C9 (16%), C12 (15%), and so on
- For computer and information sciences: C3 (19%), C7 (19%), C12 (19%), C4 (17%), and so on
- For science, engineering, medical science and technology: C3 (15%), C2 (11%), C13 (11%), C6 (10%), and so on.

4.3 Respondents' Comments

The following comments were made by some respondents in relation to information seeking and retrieval in the digital environment that provide a good indication of the problems they face and the underlying uncertainty in information seeking and retrieval:

- "It would be useful to have a common search system for every online bibliographic database so that you don't have to learn new techniques for different systems" (Research staff).
- "Why can't we have a central database with one password? I do not need to know which provider I am accessing" (Academic staff).
- "The only problem I have with electronic sources of information is that sometimes, I have to spend some time looking for what I want" (Academic staff).
- "A way of keeping track of what you've already seen and excluding that set from the results of future searches, for example "order by not seen" would be helpful" (Research student).
- "Standardise search terms, for example does 'windows' mean the operating system or the architectural element?" (Research staff).
- "Have one password for all protected academic sources. Reduce the number of databases used" (Research staff).

- "A single sign across resources would be a great asset. In addition the development of the creative commons should allow more material to be more consistently available within and without organisations" (Research student).
- "Academic and research staff could get free access to all university libraries and e-journals and databases (not sure if this is financially possible though)" (Research staff).
- "Access to more articles required especially for research. If they do charge, perhaps a one off payment (different from membership) rather than a payment for every article that you need" (Research student).
- "New models should be designed to tackle the problems" (Research staff).
- "My own search starts with my own theoretical perspectives and then what this tells me about sources - so I avoid anxiety by avoiding many of the sources stated and only using reputable ones based on print material. This then yields plenty of valuable material and I don't find electronic sources a problem" (Academic staff).
- "Sometimes I can't replicate a search that I know worked a month or so before" (Research student).
- "I always use only a few electronic sources those I consider are reliable and use the same sources to avoid uncertainty and unreliability" (Academic staff).
- "Uncertainty in relation to information seeking are contingent on what task I'm engaged in at the time, and hence what kind of information I need and also the time available" (Academic staff).
- "I tend to use information sources selectively -- If I don't like a channel, I drop it and go where I can get what I need." (Research staff).
- "The only really significant things for me are the overwhelming range of materials that are at my finger tips and the worry that I might miss something because I am not using the correct search expression, However these irritations are far outweighed by the benefits and I cannot see how I could possibly keep even vaguely up to date or do my job without access to electronic resources" (Research staff).
- "Difficult and time-consuming to find information on organisational websites" (Academic staff).

- "Frankly speaking, I try to avoid many channels or sources so that I can have more time to deal with the real problem. Because sometimes I spend more time but get very little information; it is very frustrating" (Research student).
- "I never use sources accessed by paid subscription or registration and password restricted. No matter how important they are, I never use them. I only use those which were referred by other people. As for the information retrieval and display, it does create trouble but we can't ask everyone to be a usability expert" (Research staff).
- "Better design of systems - embedding of HCI into search engines, etc will be helpful" (Research student).
- "A combination of a really broad coverage, such as Web of Knowledge together with ArticleLinker seems to work really well." (Research student).

4.4 Summary

> 'The World Wide Web has provided access to a diverse range of information sources and systems. People engaging with this rich network of information may need to interact with different technologies, interfaces, and information providers in the course of a single search task. These systems may offer different interaction affordances and require users to adapt their information seeking strategies. Not only is this challenging for users, but it also presents challenges for the designers of interactive systems, who need to make their own system useful and usable to broad user groups' (SIGIR, 2007) .

From the above position statement of ACM-SIGIR (American Computing Machinery Special Interest group in Information Retrieval) it is evident that information seeking is a challenging task in the context of the exponential growth of the web and electronic information channels and sources. The findings of this study, as discussed in this chapter, also support the above statement. As the quantity of information channels and sources continues to rise, users often struggle to keep up with new information, even in narrow areas of expertise (Blake & Pratt, 2002). Information seeking influences users' cognitive, affective and physical behaviour to a great extent. According to Kalbach (2004), information seeking on the web is an emotional experience, and that uncertainty

dominates over feelings of optimism and enthusiasm. It is clear from this research that uncertainty exists at various stages of information seeking and retrieval process in a digital environment. This is in conformity with the following comment of Fritz and Schiefer (2003) that 'given the complexity of the internet, the identification of appropriate information sources is a very challenging task'.

This study shows that there were some differences among respondents in various age groups in terms of the information seeking activities that caused uncertainty during their information seeking and retrieval process. However, *choosing appropriate information channels and sources* caused uncertainty for a considerable number of respondents of all age groups while *browsing or searching the chosen information sources or channels* and *making use of the retrieved items to perform the actual task* were the information seeking activities which caused uncertainty among the least number of respondents of all age groups.

In terms of gender difference it was noted that *formulating a search expression* and *deciding when to stop a search and to begin to use the retrieved items* were the common causes of uncertainty for respondents of both genders. However, *choosing appropriate information channels and sources* activity was the main cause of uncertainty among many female respondents (46%), but very low in significance for male respondents (6%). With a view to finding out whether respondents' ICT skills had any bearing on the uncertainty caused by information seeking activities, it was found that two activities, i.e. *choosing appropriate information channels and sources, and making sure to remain up-to-date in a given field* were identified as causes of uncertainty by 30% or more of respondents irrespective of the level of their ICT skills. It is also important to note that *judging quality of the sources, formulating a search expression, deciding how many of the retrieved items should be viewed when many items are retrieved,* and *ensuring that all the information required for a given task has been obtained* were selected as a cause of uncertainty by over 25% of respondents who were extremely confident in their ICT skills.

This study also showed that information seeking activities such as *choosing appropriate information channels and sources, formulating a search expression, deciding when to stop a search and begin to use the retrieved items,* and *making sure to remain up-to-date in a given field* caused uncertainty among at least 30% of the academic respondents. Most activities caused a degree of uncertainty among 30% or more research staff and students with *choosing appropriate information channels and sources* being at the top for research staff (identified by 51%), and *deciding when to stop a search and begin to use the retrieved items* being the top choice for research students (identified by 49%).

There appeared to be some differences in terms of respondents' disciplines. For example, most of the respondents from business and management, and arts and humanities, indicated that *formulating a search expression* was the cause of uncertainty in relation to information seeking activities while *choosing appropriate information channels and sources* was identified by a majority of respondents from the social sciences, and science, engineering, medical sciences and technology disciplines. *Deciding which retrieved items should be viewed for their content within the available time* was the prime cause of uncertainty among computer and information sciences respondents. Similarly, *deciding when to stop a search and begin to use the retrieved items* caused uncertainty among business and management, computer and information sciences, and arts and humanities respondents; and, *choosing appropriate information channels and sources* caused uncertainty among respondents from social sciences, business and management, arts and humanities, and science, engineering, medical sciences and technology.

However, in general, it can be said that the *choosing appropriate information channels and sources, formulating a search expression, deciding when to stop a search and begin to use the retrieved items, making sure to remain up-to-date in a given field, quality of the sources, deciding how many of the retrieved items should be viewed when many items are retrieved,* and *ensuring that all the information required for a given task has been obtained* were the information seeking activities which most commonly caused uncertainty among users regardless of their age, gender, ICT skills, user categories and disciplines.

With regard to information seeking problems, it was found that *too much information or information overload*, *unaware of source or channel* and s*earch output is not exhaustive* caused uncertainty among at least 20% respondents in all age groups except for those who were 61 and over; *too scattered information* caused uncertainty for majority of the respondents (within the range of 31-60 years age), while respondents of ≤ 30 and 61+ age considered it to be a minor problem. Technology related problems were identified by the majority of respondents in the age group 61 and over.

The four most common information seeking problems that caused uncertainty in both male and female respondents were s*earch output is not exhaustive, too much information or information overload, unaware of source or channel* and *unfamiliar with the source*. However, information seeking problems of *too scattered information*, *search results are not up-to-date* and *materials can be unreliable* caused uncertainty for 18-22% of the male respondents while *too much information or information overload, which channel or source to look for*, *search output is not exhaustive*, and *unaware of source or channel* were problems which caused uncertainty for 22%-28% of the female respondents.

Too much information or information overload, search output is not exhaustive, unfamiliar with the source, unaware of source or channel, and *too scattered information* were the most identifiable information seeking problems among 20% or more respondents irrespective of their ICT skills. However, it is interesting to note that respondents who were extremely confident in their ICT skills had some problems in common with people having relatively less confidence in their ICT skills.

Information seeking problems such as *too much information or information overload*, *search output is not exhaustive, unaware of source or channel* and *unfamiliar with the source* commonly caused uncertainty among all categories of respondents but to varying degrees. However, some information seeking problems caused uncertainty to a specific category of respondent, for example, *too much information or information overload*

caused uncertainty among most academic staff, *unfamiliar with the source* caused uncertainty among most research staff and *search results are not up-to-date* caused uncertainty among most research students.

Different information seeking problems caused varying degrees of uncertainty among respondents in different disciplines. For example, the problem of *too much information or information overload* and *unaware of source or channel* caused uncertainty among 35% respondents from computer and information sciences disciplines while the problem that *search output is not exhaustive* caused uncertainty among 33% respondents from social sciences. Similarly, 30% respondents from business and management, and arts and humanities disciplines felt uncertainty due to *too much information or information overload*, and u*nfamiliar with the source* respectively; and the problem that *search output is not exhaustive* was a cause of uncertainty among 25% respondents from science, engineering, medical science and technology. It may be noted that s*earch output is not exhaustive, unaware of source or channel* and *unfamiliar with the source* were the common information seeking problems that caused uncertainty among respondents across all disciplines. The problem of *too much information or information overload* caused uncertainty among the respondents from all disciplines except those from the arts and humanities whereas the problem *search results are not up-to-date* was a major cause of uncertainty for everyone except for the respondents from computer and information sciences.

In general, it was seen that the major information seeking problems that caused uncertainty were: s*earch output is not exhaustive*, *unaware of source or channel*, *too much information or information overload*, and *unfamiliar with the source* irrespective of respondents' age, gender, ICT skills, category or discipline.

Some research students appeared to have experienced uncertainty when accessing and using *personal collections, business websites, indexing and abstracting databases*, *government websites*, *OPAC of other institutions*, *websites of online bookstores*, *e-books*, *meta-search engines*, and *listservs and mailing lists.* However, very few respondents of

other categories, i.e., academic staff and research staff, indicated uncertainty to be caused by specific information channels or sources.

In general, uncertainty related to accessing different types of information channels and sources caused uncertainty among very few respondents: at the most 15% and much less in most cases (Figure 4.13). Because of this low score, the issue of uncertainty in relation to information channels or sources was not pursued further in this research.

However, in general the web survey revealed that a number of information seeking activities and information seeking problems caused uncertainty among a significant proportion of respondents from all categories. Hence, it was considered useful to study whether there were any correlations among those information seeking that caused uncertainty, and among those information seeking problems that caused uncertainty. Results of the correlation study are presented in Chapter 5.

Chapter 5

Correlation Study

5.1 Introduction

Raw data was processed in Excel and subsequently SPSS was used for the correlation study. Data was analysed at four different levels. Information seeking activities and information seeking problems that caused uncertainty were first identified and ranked according to their frequency. Correlation between these information seeking activities and information seeking problems with general demographic and other characteristics of users such as users' gender, category, ICT skills, etc., were then identified. These correlation studies were based on some specific hypotheses that are described along with the findings in the following sections. Correlations among the various information seeking activities and problems that caused uncertainty among the majority of the users were also studied. A two-tailed Pearson's correlation coefficient was used to identify whether there were any significant relationships between information seeking activities as well as between problems related to information seeking and retrieval processes. In some cases, nominal values are assigned to variables to facilitate calculations of correlations. In SPSS, nominal values can be assigned to variables, such as, gender, marital status, etc. where the values of the scale have no 'numeric' meaning in the way that we usually think about numbers.

5.2 Findings

The results reported in this thesis are based on the quantitative analysis of data derived from the survey. The results of this survey are discussed below; however, general demographics are already discussed in chapter 4 (sub-section 4.2.1).

5.2.1 Information Seeking Activities and Uncertainty

Table 5.1 shows the frequencies and percentages of the information seeking activities that caused uncertainty among users.

Table 5.1: Information seeking activities that caused uncertainty

Information Seeking Activities	Frequency of responses (n=668)	Percentage of responses*
Choosing appropriate information channels and sources	240	36.0
Formulating a search expression	212	31.7
Deciding when to stop a search and to begin to use the retrieved items	211	31.7
Making sure to remain up-to-date in a given field	200	30.0
Judging quality of the sources	192	28.7
Deciding how many of the retrieved items should be viewed when many items are retrieved	191	28.7
Ensuring that all the information required for a given task has been obtained	188	28.1
Taking a course of action following a search when a set of results appear on screen (Note that too many or too few items may be retrieved)	176	26.3
Deciding what to download or print	176	26.3
Judging quality of the channels	164	24.6
Making sure to remain competent in the given field in terms of information seeking and retrieval	165	24.6
Deciding which retrieved items should be viewed for their content within the available time	152	22.7
Browsing or searching the chosen information sources or channels	140	21.0
Making use of the retrieved items to perform the actual task	108	16.1

* The total of percentages (in the last column) exceeds 100 because users could choose more than one activity that caused uncertainty

Table 5.1 shows that at least 1 in 5 respondents indicated 13 information seeking activities that caused uncertainty. Hence, 13 instead of 14 information seeking activities have been used to study hypotheses 1 to 5 discussed below. These hypotheses were created on the bases of some questions that are commonly raised and have been discussed widely in the information science, and especially in the human information behaviour literature (see for example, Ingwersen & Jarvelin, 2005).

Hypothesis 1: There is a correlation between users' ICT skills and information seeking activities that cause uncertainty.

The volume of information available electronically these days is overwhelming and, therefore, users face a great challenge in assimilating, remembering and using it. In other words appropriate measures need to be taken to enable users to digest information more quickly, remember it more clearly and communicate it more effectively. ICT and information skills play a vital role in information seeking and retrieval in today's digital world, and this hypothesis was designed to test whether ICT skills (or the lack of them) and uncertainty in information seeking are associated or not. In the context of this paper these skills are described broadly as those that denote the users' abilities to recognise what type of information is required, to have the ability to formulate a search strategy to capture the information, and use the retrieved information for a specific purpose.

This hypothesis was supported by the results only to a limited degree. *Choosing appropriate information channels or sources, taking a course of action following a search when a set of results appear on screen*, and *making sure to remain competent in the given field in terms of information seeking and retrieval* had a negative correlation with different levels of ICT skills (Table 5.2). This means that as ICT skills increased, the uncertainty caused by the activities decreased and vice-versa. However, *making sure to remain up-to-date in a given field* had a positive correlation with ICT skills which means that the more skilled a user was in ICT, the greater the chance s/he would feel up-to-date in a given field. Apart from that, no significant association was found between ICT skills and any other information seeking activities.

Table 5.2: Correlations between information seeking activities and different levels of ICT skills

Information Seeking Activities	ICT Skills (Correlation Coefficient)	Sig. (2-tailed)
Choosing appropriate information channels and sources	-.161**	.000
Judging quality of the channels	+.006	.879
Judging quality of the sources	+.033	.388
Browsing or searching chosen information channels and sources	+.028	.470
Formulating a search expression	-.033	.400
Taking a course of action following a search when a set of results appear on screen	-.122**	.002
Deciding when to stop a search and to begin to use the retrieved items	-.070	.072
Deciding how many of the retrieved items should be viewed when many items are retrieved	-.030	.440
Deciding which retrieved items should be viewed for their content within the available time	+.017	.668
Deciding what to download or print	+.009	.822
Ensuring that all the information required for a given task has been obtained	-.040	.307
Making sure to remain up-to-date in a given field	+.086*	.026
Making sure to remain competent in the given field in terms of information seeking and retrieval	-.087*	.024

* Correlation was significant at the 0.05 level (2-tailed)

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 2: There is a correlation between age and information seeking activities that cause uncertainty

There is a common belief that young people are more adaptable to new and upcoming technologies especially in the context of ICT and the internet. Since information seeking and retrieval in the digital age is significantly dependent on ICT and the internet it was considered necessary to study whether information seeking activities that caused uncertainty were associated with the age of the users.

Table 5.3: Correlation between information seeking activities causing uncertainty and user age groups

Information Seeking Activities	**Age (Correlation Coefficient)**	**Sig. (2-tailed)**
Choosing appropriate information channels and sources	+.011	.780
Judging quality of the channels	-.004	.915
Judging the quality of the sources	-.001	.981
Browsing or searching chosen information channels and sources	+.039	.311
Formulating a search expression	+.155**	.000
Taking a course of action following a search when a set of results appear on screen	+.105**	.006
Deciding when to stop a search and to begin to use the retrieved items	+.057	.139
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.100**	.010
Deciding which retrieved items should be viewed for their content within the available time	+.120**	.002
Deciding what to download or print	+.054	.167
Ensuring that all the information required for a given task has been obtained	-.003	.942
Making sure to remain up-to-date in a given field	+.053	.174
Making sure to remain competent in the given field in terms of information seeking and retrieval	-.068	.080

** Correlation was significant at the 0.01 level (2-tailed).

This hypothesis was also supported by the results only to a limited degree. Nine of the 13 information seeking activities had no significant association with age, and only four had a positive correlation with age at the 0.01 level (2-tailed) (Table 5.3). For the purpose of this correlation study nominal values were assigned to denote user age groups: 1 for users in the lowest age group, 2 for the users in the next age group, and so on. Thus, this study shows that with increase in age of academic users, uncertainty increases with regard to the following activities: *formulating a search expression, taking a course of action following a search, deciding how many of the retrieved items should be viewed when many items are retrieved,* and *deciding which retrieved items should be viewed for their content within the available time.*

Hypothesis 3: There is a correlation between gender and information seeking activities that cause uncertainty

This hypothesis was designed to study whether there were any associations among activities that caused uncertainty among users of different gender. It was well supported with significant correlations either at the 0.01 level or 0.05 level (Table 5.4). For the purpose of this correlation study (and to meet the requirements of the software used for analysis, i.e. SPSS), nominal values were assigned to denote gender: 1 for male and 2 for female. It can be seen that only *formulating a search expression* had an inverse correlation with gender meaning that as the number for the gender increased the uncertainty due to the chosen activity decreased. Thus it may be stated that *formulating a search expression* caused more uncertainty among male compared to female respondents. The other activities had a positive correlation with gender which means that as the number for the gender increased, the uncertainty due to the activities also increased. Thus it may be stated that the following activities: *choosing information channels and sources, judging the quality of the sources, deciding how many of the retrieved items should be viewed when many items are retrieved, ensuring that all the information required for a given task has been obtained,* and *making sure to remain up-*

to-date in a given field caused more uncertainty among female compared to male respondents.

Table 5.4: Correlation between information seeking activities and gender

Information Seeking Activities	**Gender (Correlation Coefficient)**	**Sig. (2-tailed)**
Choosing appropriate information channels and sources	+.222**	.000
Judging quality of the channels	+.069	.076
Judging the quality of the sources	+.091*	.018
Browsing or searching chosen information channels and sources	+.153**	.000
Formulating a search expression	-.082*	.035
Taking a course of action following a search when a set of results appear on screen	+.037	.339
Deciding when to stop a search and to begin to use the retrieved items	+.036	.359
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.077*	.046
Deciding which retrieved items should be viewed for their content within the available time	+.058	.137
Deciding what to download or print	+.079*	.040
Ensuring that all the information required for a given task has been obtained	+.161**	.000
Making sure to remain up-to-date in a given field	+.169**	.000
Making sure to remain competent in the given field in terms of information seeking and retrieval	+.058	.137

* Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 4: There is a correlation between user category and information seeking activities that cause uncertainty

This hypothesis was designed to test whether different information seeking activities that caused uncertainty were associated with the category of users. It was only partially supported by the results.

Table 5.5: Correlation between information seeking activities that caused uncertainty and user category

Information Seeking Activities	**User category (Correlation Coefficient)**	**Sig. (2-tailed)**
Choosing appropriate information channels and sources	-.068	.077
Judging quality of the channels	-.123**	.001
Judging the quality of the sources	-.116**	.003
Browsing or searching chosen information channels and sources	-.036	.348
Formulating a search expression	-.072	.064
Taking a course of action following a search when a set of results appear on screen	+.035	.368
Deciding when to stop a search and to begin to use the retrieved items	-.072	.064
Deciding how many of the retrieved items should be viewed when many items are retrieved	-.020	.614
Deciding which retrieved items should be viewed for their content within the available time	-.008	.835
Deciding what to download or print	-.055	.158
Ensuring that all the information required for a given task has been obtained	+.011	.786
Making sure to remain up-to-date in a given field	-.022	.575
Making sure to remain competent in the given field in terms of information seeking and retrieval	-.103**	.008

** Correlation was significant at the 0.01 level (2-tailed).

Only three activities that caused uncertainty, i.e.. *judging the quality of the channels*, *judging the quality of the sources*, and *making sure to remain competent in the given*

field in terms of information seeking and retrieval, had a negative correlation with the user category (Table 5.5). For the purpose of this correlation study nominal values were assigned to denote user categories: 1 for research student, 2 for research staff, and 3 for academic staff. The correlation was negative which means that as the number of the user category increased, the uncertainty caused by the three concerned activities decreased. Thus it may be stated that the degree of uncertainty caused by information seeking activities in relation to *judging the quality of the channels and quality of information sources*, and *making sure to remain competent in the given field in terms of information seeking and retrieval* was less for academic staff compared to research staff and students.

Hypothesis 5: There is a correlation between disciplines and information seeking activities that cause uncertainty

This hypothesis aimed to test whether information seeking activities that caused uncertainty among users were associated with the discipline of the users. It was well supported by the results. Table 5.6 shows that the discipline to which a user belonged was statistically significant for eight of the 13 activities, viz. *choosing information channels and sources, judging the quality of the channel, browsing or searching the chosen information channels or sources, formulating a search expression, taking a course of action following a search when a set of results appear on screen, making a decision regarding when to stop a search and to begin to use the retrieved items, deciding how many of the retrieved items should be viewed when many items are retrieved*, and *making sure to remain competent in the given field in terms of information seeking and retrieval* caused uncertainty among the majority of respondents. For the purpose of this correlation study nominal values were assigned to denote disciplines: 1 = business and management, 2 = social sciences, 3 = arts and humanities, 4 = science, engineering, medical sciences and technology, and 5 = computer and information sciences. There is an inverse relationship which may be interpreted as follows: as the number for the discipline increased the uncertainty caused by the chosen activities decreased and vice versa. Thus it may be stated that for computer and information

sciences the degree of uncertainty caused by these activities was less compared to the other disciplines.

Table 5.6: Correlation between disciplines and information seeking activities that caused uncertainty

Information Seeking Activities	Disciplines (Correlation Coefficient)	Sig.(2-tailed)
Choosing appropriate information channels and sources	-.079*	.041
Judging quality of the channels	-.110**	.004
Judging the quality of the sources	+.070	.072
Browsing or searching chosen information channels and sources	+.085*	.029
Formulating a search expression	-.174**	.000
Taking a course of action following a search when a set of results appear on screen	-.137**	.000
Deciding when to stop a search and to begin to use the retrieved items	-.097*	.012
Deciding how many of the retrieved items should be viewed when many items are retrieved	-.085*	.029
Deciding which retrieved items should be viewed for their content within the available time	-.004	.926
Deciding what to download or print	-.023	.546
Ensuring that all the information required for a given task has been obtained	-.057	.139
Making sure to remain up-to-date in a given field	-.064	.096
Making sure to remain competent in the given field in terms of information seeking and retrieval	-.099*	.011

*Correlation was significant at the 0.05 level (2-tailed).

**Correlation was significant at the 0.01 level (2-tailed).

Correlations among information seeking activities that caused uncertainty among a large number of users

The top seven information seeking activities appearing in Table 5.1 were used to study correlations amongst each other. Since correlation of each activity with others was

studied, and since seven activities were chosen, this gave rise to seven hypotheses shown below as hypotheses six to twelve. In fact, all 13 information seeking activities that were identified by a significant number of respondents could be chosen for this correlation study, but that would give rise to a large number of variables. Therefore, in order to keep the number of variables for the correlation study within a manageable limit only the top seven information seeking activities were used for the correlation analysis, with the logic that if correlations among these uncertainty causing activities were found then that would meet the objective of this research, i.e. some of the information seeking activities that cause uncertainty are associated with each other.

Hypothesis 6: There is a correlation between *choosing information channels and sources* and other *information seeking activities* that cause uncertainty

This hypothesis was supported by the results. Uncertainty caused by all the information seeking activities except one had a statistically significant correlation, of varying degrees, with the *choice of information channels and sources* (Table 5.7). In other words, it can be stated that when users feel uncertain about which information channel or source to search, they also feel uncertain in relation to other information seeking activities such as judging the quality of the sources, formulating a search expression, and so on (Table 5.7).

Table 5.7: Correlation between choosing information channels and sources and other information seeking activities

Other Information Seeking Activities	**Choosing information channels or sources (Correlation Coefficient)**	**Sig. (2- tailed)**
Judging the quality of the sources	+.186**	.000
Formulating a search expression	+.088*	.023
Making a decision regarding when to stop a search and to begin to use the retrieved items	+.294**	.000
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.007	.847
Ensuring that all the information required for a given task has been obtained	+.380**	.000
Making sure to remain up-to-date in a given field	+.301**	.000

* Correlation was significant at the 0.01 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 7: There is a correlation between *formulating a search expression* and other *information seeking activities* that cause uncertainty

Table 5.8 shows that out of the six activities, four had a positive significant correlation with *formulation of a search expression*. Therefore, it can be seen that when users are uncertain about the activity of *formulating a search expression*, they may also be uncertain about other activities such as *choosing information channels and sources, making a decision regarding when to stop the search,* and so on (see Table 5.8).

Table 5.8: Correlation between formulating a search expression and other information seeking activities

Other Information Seeking Activities	Formulating a search expression (Correlation Coefficient)	Sig.(2-tailed)
Choosing information channels and sources	+.088*	.023
Making a decision regarding when to stop a search and to begin to use the retrieved items	+.113**	.003
Making sure to remain up-to-date in a given field	+.034	.375
Judging the quality of the sources	+.119**	.002
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.048	.220
Ensuring that all the information required for a given task has been obtained	+.117**	.002

*Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 8: There is a correlation between the activity of *making a decision regarding when to stop a search and to begin to use the retrieved items* and other *information seeking activities* that cause uncertainty

This hypothesis was also supported by the data. All the activities were correlated with the activity of *making a decision regarding when to stop a search and to begin to use the retrieved items;* however, correlation with the activity *deciding how many of the retrieved items should be viewed when many items are retrieved* was not statistically significant (Table 5.9).

Table 5.9: Correlation between deciding when to stop a search and to begin to use the retrieved items and other information seeking activities

Other Information Seeking Activities	Deciding when to stop a search and to begin to use the retrieved items (Correlation Coefficient)	Sig.(2-tailed)
Choosing information channels and sources	+.294**	.000
Formulating a search expression	+.113**	.003
Making sure to remain up-to-date in a given field	+.247**	.000
Judging the quality of the sources	+.086*	.026
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.074	.055
Ensuring that all the information required for a given task has been obtained	+.105**	.007

*Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 9: There is a correlation between ensuring the *up-to-dateness in the given field* and other *information seeking activities* that cause uncertainty

This hypothesis was also supported for five out of six activities (Table 5.10). Therefore, it can be said that when the activity in relation to ensuring *up-to-dateness in the given field* causes uncertainty, some other activities like *making a decision regarding when to stop a search and to begin to use the retrieved items, deciding how many of the retrieved items should be viewed when many items are retrieved, and ensuring that all the information required for a given task has been obtained* also cause uncertainty among users.

Table 5.10: Correlation between making sure to remain up-to-date in a given field and other information seeking activities

Other Information Seeking Activities	**Making sure to remain up-to-date in a given field (Correlation Coefficient)**	**Sig.(2-tailed)**
Choosing information channels and sources	+.301**	.000
Formulating a search expression	+.034	.375
Making a decision regarding when to stop a search and to begin to use the retrieved items	+.247**	.000
Judging the quality of the sources	+.163**	.000
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.108**	.005
Ensuring that all the information required for a given task has been obtained	+.093*	.016

*Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 10: There is a correlation between the activity of judging the *quality of the sources* and other *information seeking activities* that cause uncertainty

This hypothesis was supported, and four of the six activities i.e. *choosing information channels and sources, formulating a search expression, making sure to remain up-to-date in a given field,* and *making a decision regarding when to stop a search and to begin to use the retrieved items* had a significant correlation with the activity of *judging the quality of the sources.* (Table 5.11).

Table 5.11: Correlation between judging the quality of the sources and other information seeking activities

Other Information seeking activities	Judging the quality of the sources (Correlation Coefficient)	Sig.(2-tailed)
Choosing information channels and sources	+.186**	.000
Formulating a search expression	+.119**	.002
Making a decision regarding when to stop a search and to begin to use the retrieved items	+.086*	.026
Making sure to remain up-to-date in a given field	+.163**	..000
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.050	.194
Ensuring that all the information required for a given task has been obtained	+.040	.297

*Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Hypothesis 11: There is a correlation between *deciding how many of the retrieved items should be viewed when many items are retrieved* and other *information seeking activities* that cause uncertainty

This hypothesis was supported by the results. Table 5.12 shows that the activity *deciding how many of the retrieved items should be viewed when many items are retrieved* had a significant correlation with *making sure to remain up-to-date in a given field,* and ensuring *that all the information required for a given task has been obtained.* Positive coefficients indicate that when the uncertainty caused by *deciding how many of the retrieved items should be viewed when many items are retrieved* increases, the uncertainty caused by the activities *making sure to remain up-to-date in a given field*, and *ensuring that all the information required for a given task has been obtained* also increases.

Table 5.12: Correlation between deciding how many of the retrieved items should be viewed when many items are retrieved and other information seeking activities

Other Information Seeking Activities	**Deciding how many of the retrieved items should be viewed when many items are retrieved (Correlation Coefficient)**	**Sig.(2-tailed)**
Choosing information channels and sources	+.007	.847
Formulating a search expression	+.048	.220
Making a decision regarding when to stop a search and to begin to use the retrieved items	+.074	.055
Making sure to remain up-to-date in a given field	+.108**	.005
Judging the quality of the sources	+.050	.194
Ensuring that all the information required for a given task has been obtained	+.099*	.010

*Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 12: There is a correlation between the activity of *ensuring that all the information required for a given task has been obtained* and the other *information seeking activities* that cause uncertainty

This hypothesis was also quite well supported by the results. Table 5.13 shows that two of the six activities, viz. *choosing information channels and sources,* and *making a decision regarding when to stop a search and to begin to use the retrieved items* had a high degree of correlation at the 0.01 level. Two other activities, i.e. *making sure to remain up-to-date in a given field* and *deciding how many of the retrieved items should be viewed when many items are retrieved* had a correlation that was significant at the 0.05 level.

Table 5.13: Correlation between the activity of ensuring that all information required for a given task has been obtained and other information seeking activities

Other Information seeking activities	**Ensuring that all information required for a given task has been obtained (Correlation Coefficient)**	**Sig.(2-tailed)**
Choosing information channels and sources	+.380**	.000
Formulating of a search expression	+.117**	.002
Making a decision regarding when to stop a search and to begin to use the retrieved items	+.105**	.007
Making sure to remain up-to-date in a given field	+.093*	.016
Judging the quality of the sources	+.040	.297
Deciding how many of the retrieved items should be viewed when many items are retrieved	+.099*	.010

*Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

5.2.2 Information Seeking Problems and Uncertainty

Table 5.14 provides statistics for the information seeking problems that caused uncertainty amongst the chosen users. Table 5.14 shows that at least 1 in 5 respondents indicated that the following information seeking problems caused uncertainty: *too much information or information overload* (24%), *too scattered information* (20%), *search output is not exhaustive* (27%), *unaware of source or channel* (25%), *search results are not up-to-date* (20%), and *unfamiliar with the source* (22%) .

Correlations of these six information seeking problems with ICT skills and general demographic variables, i.e. age, gender, user category, and discipline, were studied

based on hypotheses 13-17, and the findings are discussed below. The cut-off point of 20% was chosen to keep the number of variables, and therefore the number of tables, to a manageable limit.

Table 5.14: Information seeking problems that caused uncertainty

Information seeking problems	Frequency of responses (n=668)	Percentage of responses (%)*
Search output is not exhaustive	180	26.9
Unaware of source or channel	164	24.6
Too much information or information overload	162	24.2
Unfamiliar with the source	148	22.2
Too scattered information	136	20.3
Search results are not up-to-date	133	19.9
Materials can be unreliable	108	16.2
Which channel or source to look for (i.e. you know the channel or source is there but don't know how to look for it)	104	15.6
Not enough relevant materials	92	13.8
Fast changing technology	76	11.4
Lack of ICT skills	72	10.8
Time-consuming	68	10.2
Too many technological problems	56	8.4
Too many irrelevant results	56	8.4
Too many different passwords needed to access a range of sources	52	7.8
Hard to read or to view on the screen	48	7.2
Poor quality of information	48	7.2
Restricted access to information from elsewhere	36	5.4
Poor quality display of text or graphics	32	4.8
Slow downloading of pages	32	4.8
Having to pay for access to sources	32	4.8

* The total of percentages (in the last column) exceeds 100 because users could choose more than one activity that caused uncertainty

Hypothesis 13: There is a correlation between the user's ICT skills and information seeking problems that cause uncertainty

This hypothesis was supported. The relationships between users' ICT skills and uncertainty caused by three of the six information seeking problems: *too scattered information*, s*earch output is not exhaustive* and *unaware of source or channel* was statistically significant (Table 5.15). There was an inverse relationship meaning that when the user's ICT skills increased, the uncertainty due to *too scattered information*, s*earch output is not exhaustive,* and *unaware of source or channel* decreased and vice versa.

Table 5.15: Problems related to information seeking process and ICT skills

Information seeking problems	**ICT Skills (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information or information overload	-.015	.848
Too scattered information	-.080*	.039
Search output is not exhaustive	-.157**	.000
Unaware of source or channel	-.094*	.015
Search results are not up-to-date	-.017	.654
Unfamiliar with the source	-.024	.530

* Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 14: There is a correlation between age and problems related to the information seeking process that cause uncertainty

This hypothesis was supported only to a very limited degree. Only two problems related to the information seeking process: *too much information or information overload* (sig.= .019) and *too scattered information* (sig.=.037), had a correlation with age at the 0.05 level (2-tailed) (Table 5.16).

Table 5.16: Information seeking problems and age

Information seeking problems	**Age (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information or information overload	+.091*	.019
Too scattered information	+.081*	.037
Search output is not exhaustive	-.068	.077
Unaware of source or channel	+.006	.867
Search results are not up-to-date	-.038	.325
Unfamiliar with the source	-.012	.748

* Correlation was significant at the 0.05 level (2-tailed).

Hypothesis 15: There is a correlation between information seeking problems that cause uncertainty and user category

This hypothesis was well supported by the results. Three activities viz. *unaware of source or channel*, *search results are not up-to-date,* and *unfamiliar with the source* had a significant correlation with the user category (Table 5.17).

Table 5.17: Correlation between information seeking problems and user category

Information seeking problems	**User category (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information or information overload	+.030	.435
Too scattered information	+.022	.573
Search output is not exhaustive	-.065	.092
Unaware of source or channel	-.163**	.000
Search results are not up-to-date	-.167**	.000
Unfamiliar with the source	-.101**	.009

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 16: There is a correlation between gender and information seeking problems that cause uncertainty

This hypothesis was also well supported by the results. The uncertainty caused by information seeking problems was statistically significant for four of the six problems. Interestingly, two of these i.e. s*earch output is not exhaustive,* and *unaware of source or channel* - had a positive correlation, while *too scattered information* and *search results are not up-to-date* had a negative correlation with gender (Table 5.18).

Table 5.18: Correlation between information seeking problems and gender

Information seeking problems	**Gender (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information or information overload	-.018	.645
Too scattered information	-.094*	.015
Search output is not exhaustive	+.080*	.038
Unaware of source or channel	+.087*	.024
Search results are not up-to-date	-.114**	.003
Unfamiliar with the source	+.048	.216

* Correlation was significant at the 0.05 level (2-tailed).

**Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 17: There is a correlation between disciplines and information seeking problems that cause uncertainty

This hypothesis was partially supported by the results. Discipline was statistically significant for three of the six problems related to the information seeking process viz. *too much information or information overload, too scattered information,* and *search output is not exhaustive*. However their significance levels were different (Table 5.19). All had an inverse relationship meaning that when discipline numbers increased (for this analysis nominal values were assigned as follows: 1 = business and management, 2 = social sciences, 3 = arts and humanities, 4 = science, engineering, medical sciences and

technology, and 5 = computer and information sciences) the uncertainty caused by problems lessened and vice versa.

Table 5.19: Correlation between information seeking problems and disciplines

Information seeking problems	Disciplines (Correlation Coefficient)	Sig.(2-tailed)
Too much information or information overload	-.095*	.014
Too scattered information	-.100**	.010
Search output is not exhaustive	-.082*	.035
Unaware of source or channel	-.067	.085
Search results are not up-to-date	-.060	.118
Unfamiliar with the source	-.065	.093

* Correlation was significant at the 0.05 level (2-tailed).

** Correlation was significant at the 0.01 level (2-tailed).

Correlations among information seeking problems that caused uncertainty among most users

Correlations among the six information seeking problems that caused uncertainty among most of the users were studied in the following section. In order to study the correlation of each of the six problems with others, six hypotheses (18 to 23 in the following sections) were created.

Hypothesis 18: There is a correlation between *too much information or information overload* and other information seeking problems that cause uncertainty

This hypothesis was well supported by the results. All the problems identified by the majority of respondents had a high degree of correlation with the problem *too much information or information overload* (Table 5.20). This positive correlation shows that when uncertainty caused by the problem *too much information or information overload* increased, the other information seeking problems also increased.

Table 5.20: Correlation between too much information or information overload and other information seeking problems that caused uncertainty

Information seeking problems	**Too much information or information overload (Correlation Coefficient)**	**Sig.(2-tailed)**
Too scattered information	+.368**	.000
Search output is not exhaustive	+.102**	.008
Unaware of source or channel	+.267**	.000
Search results are not up-to-date	+.165**	.000
Unfamiliar with the source	+.174**	.000

** Correlation was significant at the 0.01 level (2-tailed).

Table 5.21: Correlation between too scattered information and other information seeking problems that caused uncertainty

Information seeking problems	**Too scattered information (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information and information overload	+.368**	.000
Search output is not exhaustive	+.047	.223
Unaware of source or channel	+.146**	.000
Search results are not up-to-date	+.198**	,000
Unfamiliar with the source	+.107 **	.006

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 19: There is a correlation between *too scattered information* and other information seeking problems that cause uncertainty

This hypothesis was well supported by the results. All the problems identified by the majority of respondents except *search output is not exhaustive* had a high degree of significant correlation with the problem *too scattered information* (Table 5.21).

Hypothesis 20: There is a correlation between *search output is not exhaustive* and other information seeking problems that cause uncertainty

This hypothesis was well supported by the results. All the problems identified by the majority of respondents except *too scattered information* had a high degree of significant correlation at the 0.01 level (Table 5.22).

Table 5.22: Correlation between search output is not exhaustive and other information seeking problems that caused uncertainty

Information seeking problems	**Search output is not exhaustive (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information or information overload	+.102**	.008
Too scattered information	+.047	.223
Unaware of source or channel	+.281**	.000
Search results are not up-to-date	+.265**	.000
Unfamiliar with the source	+.163**	.000

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 21: There is a correlation between *unaware of source or channel* and other information seeking problems that cause uncertainty

This hypothesis was well supported by the results. All the problems identified by the majority of respondents had a highly significant correlation with the problem *unaware of source or channel* (Table 5.23). When uncertainty caused by *unaware of source or channel* increased, uncertainty related to other problems such as *too much information or information overload, too scattered information, search output is not exhaustive, search results are not up-to-date,* and *unfamiliar with the source* also increased.

Table 5.23: Correlation between unaware of source or channel and other information seeking problems that caused uncertainty

Information seeking problems	Unaware of source or channel (Correlation Coefficient)	Sig.(2-tailed)
Too much information or information overload	+.267**	.000
Too scattered information	+.146**	.000
Search output is not exhaustive	+.281**	.000
Search results are not up-to-date	+.300**	.000
Unfamiliar with the source	+.500**	.000

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 22: There is a correlation between *search results are not up-to-date* and other information seeking problems that cause uncertainty

This hypothesis was well supported by the results. All the problems identified by the majority of respondents had a highly significant correlation with the problem *search results are not up-to-date* (Table 5.24). When uncertainty caused by the problem *search results are not up-to-date* increased, uncertainty related to other problems like *too much information or information overload, too scattered information, search output is not exhaustive, unaware of source or channel*, and *unfamiliar with the source* also increased.

Table 5.24: Correlation between search results are not up-to-date and other information seeking problems that caused uncertainty

Information seeking problems	**Search results are not up-to-date (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information or information overload	+.165**	.000
Too scattered information	+.198**	.000
Search output is not exhaustive	+.265**	.000
Unaware of source or channel	+.300**	.000
Unfamiliar with the source	+.227**	.000

** Correlation was significant at the 0.01 level (2-tailed).

Hypothesis 23: There is a correlation between *unfamiliar with the source or channel* and other information seeking problems that cause uncertainty

This hypothesis was well supported by the results. All the problems identified by the majority of respondents had a highly significant correlation with the problem *unfamiliar with the source* (Table 5.25). When uncertainty caused by the problem *unfamiliar with the source* increases, uncertainty related to other problems such as *too much information or information overload, too scattered information, search output is not exhaustive, search results are not up-to-date,* and *unaware of source or channel* also increased.

Table 5.25: Correlation between unfamiliar with the source and other information seeking problems that caused uncertainty

Information seeking problems	**Unfamiliar with the source (Correlation Coefficient)**	**Sig.(2-tailed)**
Too much information or information overload	+.174**	.000
Too scattered information	+.107**	.006
Search output is not exhaustive	+.163**	.000
Unaware of source or channel	+.500**	.000
Search results are not up-to-date	+.227**	.000

** Correlation was significant at the 0.01 level (2-tailed).

5.3 Summary

This study has identified a number of information seeking activities that caused uncertainty in the course of information seeking and retrieval.

Table 5.26: Significant correlation among information seeking activities

Information seeking activity	**Information seeking activities with which there was a significant correlation**
Choosing information channels and sources	Formulating a search expression*, and Ensuring that all the information required for a given task has been obtained**
Formulating a search expression	Choosing information channels and sources *, Deciding when to stop a search and to begin to use the retrieved items**, and Judging the quality of the sources **
Deciding when to stop a search and to begin to use the retrieved items	Judging the quality of the sources*, Formulating a search expression**, Making sure to remain up-to-date in a given field**, and Assuring that all the information required for a given task has been obtained**
Making sure to remain up-to-date in a given field	Assuring that all the information required for a given task has been obtained*, Deciding when to stop a search and to begin to use the retrieved items**, and Deciding how many of the retrieved items should be viewed when many items are retrieved**
Judging the quality of the sources	Deciding when to stop a search and to begin to use the retrieved items*, and Formulating a search expression**
Deciding how many of the retrieved items should be viewed when many items are retrieved	Assuring that all the information required for a given task has been obtained*, and Making sure to remain up-to-date in a given field **
Assuring that all the information required for a given task has been obtained	Deciding how many of the retrieved items should be viewed when many items are retrieved *, Choosing information channels and sources **, and Deciding when to stop a search and to begin to use the retrieved items**

*Correlation was significant at the 0.05 level (2-tailed).

**Correlation was significant at the 0.01 level (2-tailed).

It can be seen from the results discussed above that some of the activities that caused uncertainty had a significant correlation with each other. Table 5.26 shows the most significant associations, of varying degrees, between the information seeking activities that were identified for the purpose of the survey. It also shows that those information seeking problems that caused uncertainty had a significant relationship with each other (Table 5.27).

Table 5.27: Significant correlation among information seeking problems

Information seeking problem	**Information seeking problems with which there was a significant correlation**
Too much information or information overload	Too scattered information**, Search output is not exhaustive**, Unaware of source or channel**, Search results are not up-to-date**, and Unfamiliar with the source**
Too scattered information	Too much information or information overload**, Search output is not exhaustive**, Unaware of source or channel**, and Unfamiliar with the source**
Search results are not up-to-date	Too much information or information overload**, Unaware of source or channel**, Search output is not exhaustive**, and Unfamiliar with the source**
Unaware of source or channel	Too much information or information overload**, Too scattered information**, Search output is not exhaustive**, Search results are not up-to-date**, and Unfamiliar with the source**
Search output is not exhaustive	Too much information or information overload**, Too scattered information**, Unaware of source or channel**, Search results are not up-to-date** , and Unfamiliar with the source**
Unfamiliar with the source	Too much information or information overload**, Too scattered information**, Unaware of source or channel**, Search output is not exhaustive**, and Search results are not up-to-date**

** Correlation was significant at the 0.01 level (2-tailed).

It may be noted that there was a correlation between information seeking activities and gender and disciplines as opposed to information seeking activities and age, ICT skills, and user categories, where there was a very little correlation. The study also shows that there was a correlation between information seeking problems and ICT skills, gender and user categories but very little correlation with age. Interestingly, information seeking activities as well as information seeking problems had a significant correlation with disciplines and gender. However, it is seen that for computer and information sciences, uncertainty caused by information seeking activities was less compared to the other disciplines.

Nevertheless, such uncertainty may not always be negative or undesirable. Uncertainty may prompt users to find information from a vast collection and at the same time may be exciting in terms of discovering new information channels and sources, etc. It may also provide useful insights for future search. This coincides with Cole's (1993, p.204) assertion that 'an improbable selection might lead to things like insight or a turning point in the person's research'. On the other hand, negative or undesirable uncertainty may result in negative feelings, such as frustration, anxiety, lack of confidence, etc., in users.

The next chapter discusses findings of the qualitative analysis that aimed to determine the extent of uncertainty in information seeking and retrieval identified through qualitative analyses.

Chapter 6

Data Analysis of the Interview and Post-search Questionnaire Study

"*Individual .....Interviewing can obtain detailed, in-depth information from subjects who know a great deal about their personal perceptions of events, processes and environments*."

(G.E. Gorman and P. Clayton, 2005, p.41)

6.1 Introduction

Analyses of quantitative data presented in chapters four and five show that uncertainty persists in information seeking and retrieval, and some of the information seeking activities and problems that cause uncertainty amongst users are correlated to each other. This chapter presents analysis of data produced by the second and third phases of the research (Figure 3.1). The second phase comprised in-depth interviews amongst selected participants to study how uncertainty in any form persists in the information seeking and retrieval processes. The third phase comprised analysis of a post-search questionnaire that aimed to find out how the participants perceived uncertainty caused by some problems associated with an information seeking and retrieval process.

In the second phase, participants were asked, through a semi-structured interview, about the degree of uncertainty in information seeking and retrieval and their views and concerns about it. In the third phase, the participants were asked to conduct a search on a topic from their own subject area and then fill in a post-search questionnaire which was designed to investigate the issues and concerns with regard to uncertainty caused by some problems associated with an information seeking and retrieval process as experienced through an actual search.

Participants in this research were academic staff, research staff, and research students from departments of management science, civil engineering, and computer and information sciences at the University of Strathclyde, Glasgow, UK. An invitation was sent through e-mails to participate in this qualitative research. Twenty volunteers from the chosen departments took part in these phases of research. Out of 20, nine participants were from computer and information sciences, and six and five were from management science and civil engineering departments respectively. Out of the total 20 volunteers, six were academic staff, and seven each were research staff and research students respectively. Interviews were transcribed and analysed immediately following the interviews so that all the important points could be noted down.

Table 6.1: Distribution of interviewees

Category	Computer and Information Sciences	Management Science	Civil Engineering
Academic staff	2	2	2
Research staff	4	1	2
Research students	3	3	1
Total	9	6	5

6.2 Interviews

In this study, a semi-structured interview (Appendix E) method was adopted because 'with semi-structured interviews, the interviewer still has a clear list of issues to be addressed and questions to be answered', and the interviewer has the flexibility 'in terms of the order in which the topics are considered and, perhaps more significantly, to let the interviewee develop ideas and speak more widely on the issues raised by the researcher' (Denscombe, 2003, p.167).

6.3 Uncertainty in relation to Choice of Information Channels or Sources

In response to a question on how the users choose information channels and sources, it was noted that the participants used a variety of ways to choose them, such as

- through their own experiences and knowledge,
- through references from other publications, and
- sometimes with the help of colleagues and contacts.

The participants mentioned that other factors such as the university library website, research groups, conference proceedings also influenced the selection of information channels or sources. Some differences were also noted among the three categories of users. For example, most academic staff emphasised that selection of information channels or sources was largely dictated by the search topic, or the task, on hand, whereas research students and research staff mentioned that they always use the same channels or sources and most of the time they would begin with Google.

When asked about if they *ever feel uncertain about which information channel to choose to begin a search,* a mixed response was received (Figure 6.1). Most of the participants, irrespective of their category, said that they always felt some degree of uncertainty:

- Four (out of six) academic staff said that they felt a high degree of uncertainty while the rest felt an average degree of uncertainty.
- Five (out of seven) research staff indicated that they felt an average degree of uncertainty while the others felt little or no uncertainty.
- Three (out of seven) research students felt an average degree of uncertainty while the others felt little or no uncertainty.

Furthermore, through discussions it was revealed that the research students appeared to have felt uncertainty on this issue especially during the early period of their research. Those from management science appeared to have felt uncertainty especially when

looking for company information and statistical information on different countries especially developing or least developed countries.

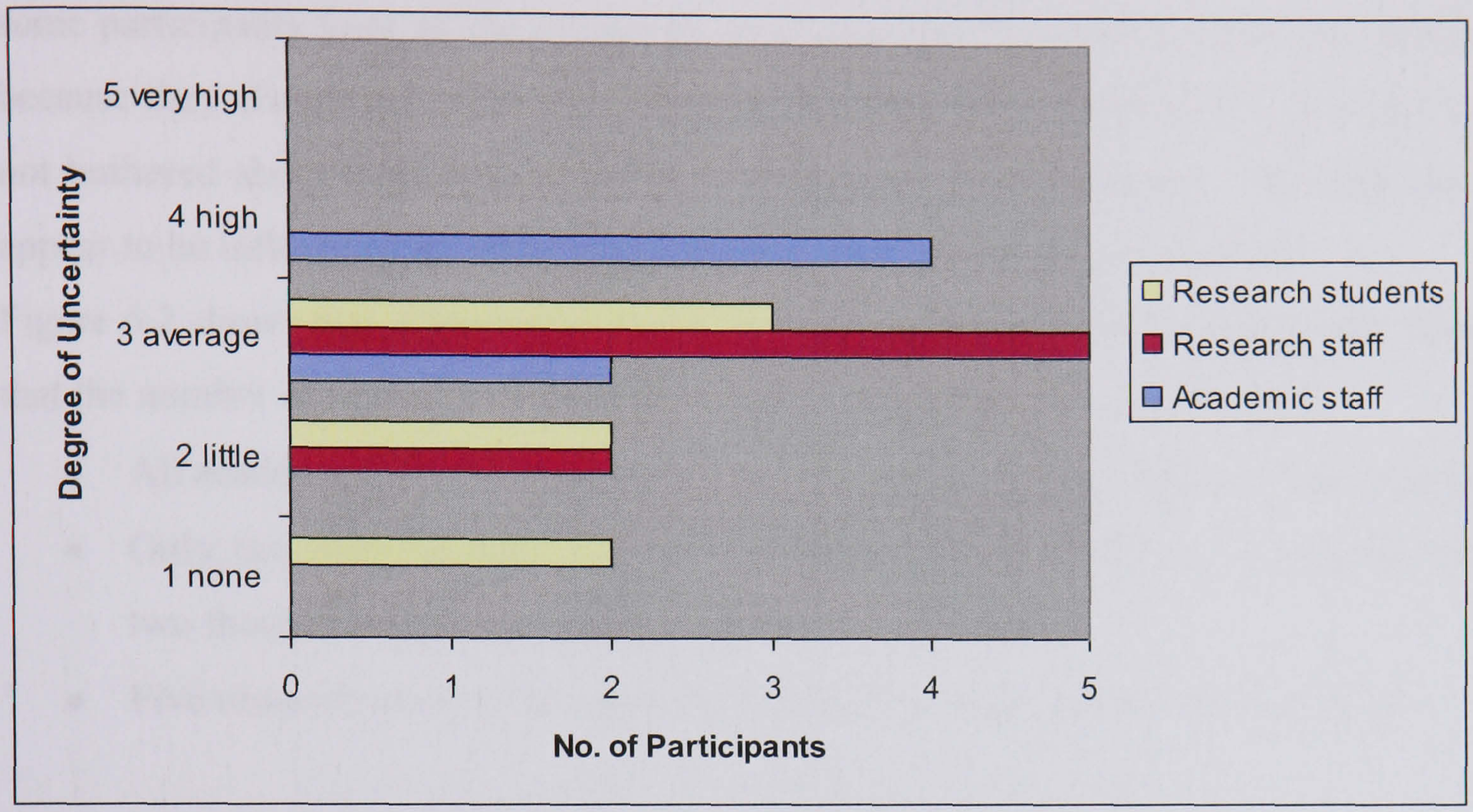


Figure 6.1: Degree of uncertainty with regard to the choice of information channels or sources

However, some sort of uncertainty might have been hidden and not obvious because of the specific information seeking behaviour of the users. For example, some research staff and research students mentioned that they would not feel uncertain because their searches were usually limited to some selected small number of databases. They also indicated that they did not mind working with a small number of sources and that they never felt they were missing out any important sources.

In general, the participants, regardless of their category, mentioned that they felt some degree of uncertainty *about what should be the best channel to choose with regard to a specific information source*. A number of research students mentioned that they felt uncertain mainly in the first year when they would try to focus on a specific research topic and read the relevant literature. In the later years they would be quite focused on a number of selected sources and therefore the degree of uncertainty decreases.

In some cases uncertainty in relation to choosing the best information channels might not have been obvious because of information seeking behaviour of the users. For example, some participants from all the categories mentioned that they did not have any problems because they always used the same databases that they were familiar with, and they were not bothered about the coverage and up-to-dateness of the databases. Thus they did not appear to be influenced by information proliferation or information overload.

Figure 6.2 shows that when asked about the degree of uncertainty caused by the thought that the number of channels or sources that have been chosen are not enough,

- All academic staff felt that this caused a high or very high degree of uncertainty.
- Only two research staff felt that this caused a high degree of uncertainty while two thought it was of an average degree.
- Five research students felt that this caused an average degree of uncertainty.

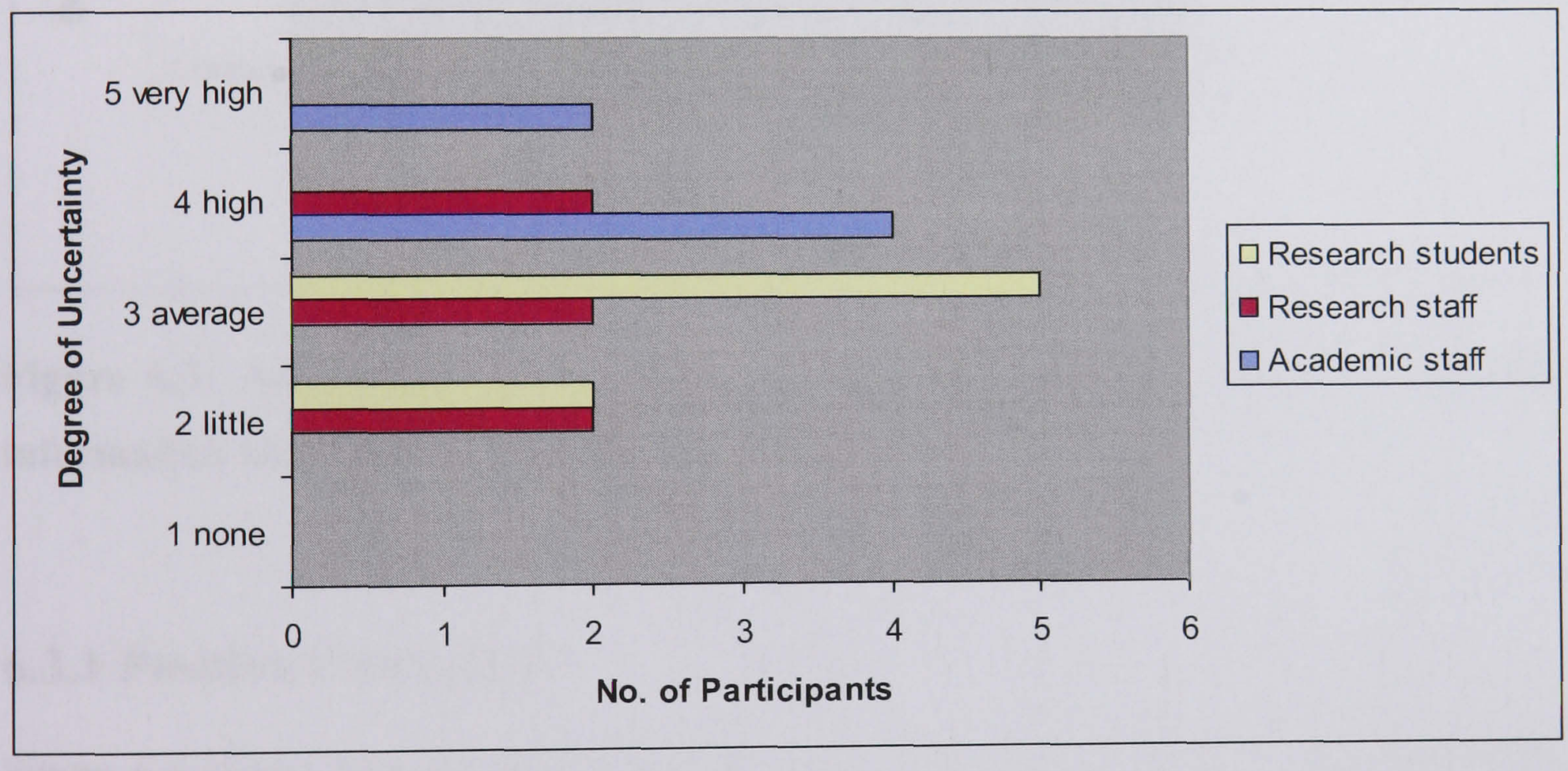


Figure 6.2: Degree of uncertainty caused by the thought that the chosen number of information channels or sources is not enough

The fact that research staff, and research students to a greater extent, felt relatively less uncertain about the wider coverage of the information channels and sources, corroborates the finding mentioned before that research staff and students usually focused on a small selected number of information channels and sources, and most of them were not concerned with the wider coverage of the selection. However, this was not so for the

academic users for whom wider coverage of the information channels and sources was an important issue, because of the nature of their work and thus a significant amount of uncertainty was associated with this issue. Nevertheless, as shown in Figure 6.3, most academic staff and some research staff and research students would have preferred a guide for selection of the most appropriate information channels and sources provided by the information systems or services concerned.

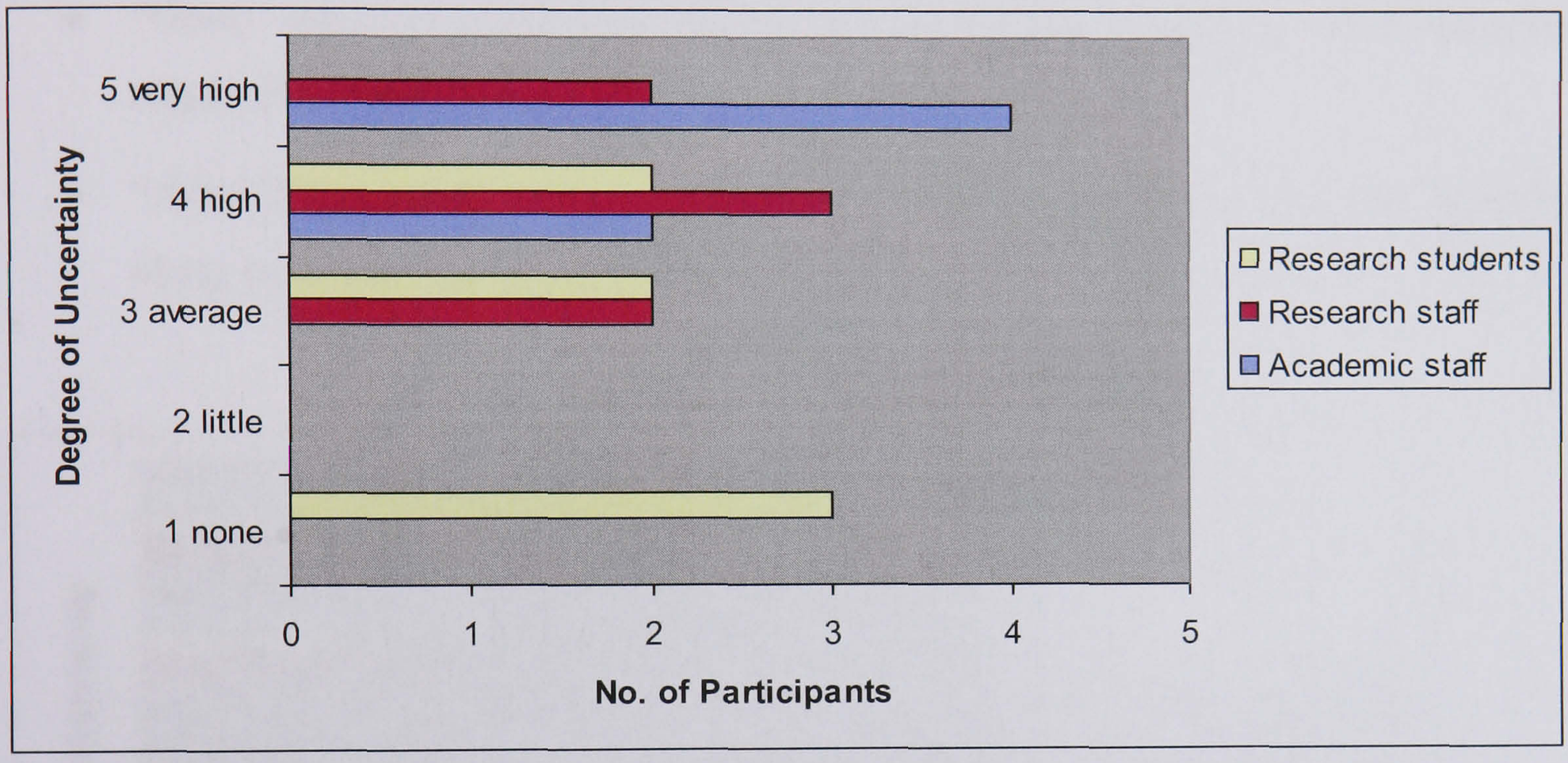


Figure 6.3: Advantages of having a guide for the selection of the best possible information channels or sources for a search topic

6.3.1 Positive Uncertainty

Figure 6.4 shows how the participants felt about the positive impact of the uncertainty (such as an accidental discovery of useful information better known as serendipity) associated with the choice of information channels or sources. Although one research student thought that accidental discovery of information would cause distraction, others, irrespective of the categories, emphasised that discovering an information channel or source accidentally due to information overload or proliferation was certainly a positive aspect of uncertainty. The following are some comments of the participants that show

how they felt about the positive impact of uncertainty through accidental discovery of information:

- "It opens up a new avenue and gives some insight into a research" (Research staff).
- "Sometimes it broadens up the area of research to fit in some new concepts. It often happens in the first year of research and is very helpful" (Research student).
- "Once I discover something accidentally, I remember it and use it and whenever required" (Academic staff).
- "After discovering the new information, I can prioritise the task and continue along with that" (Research student).

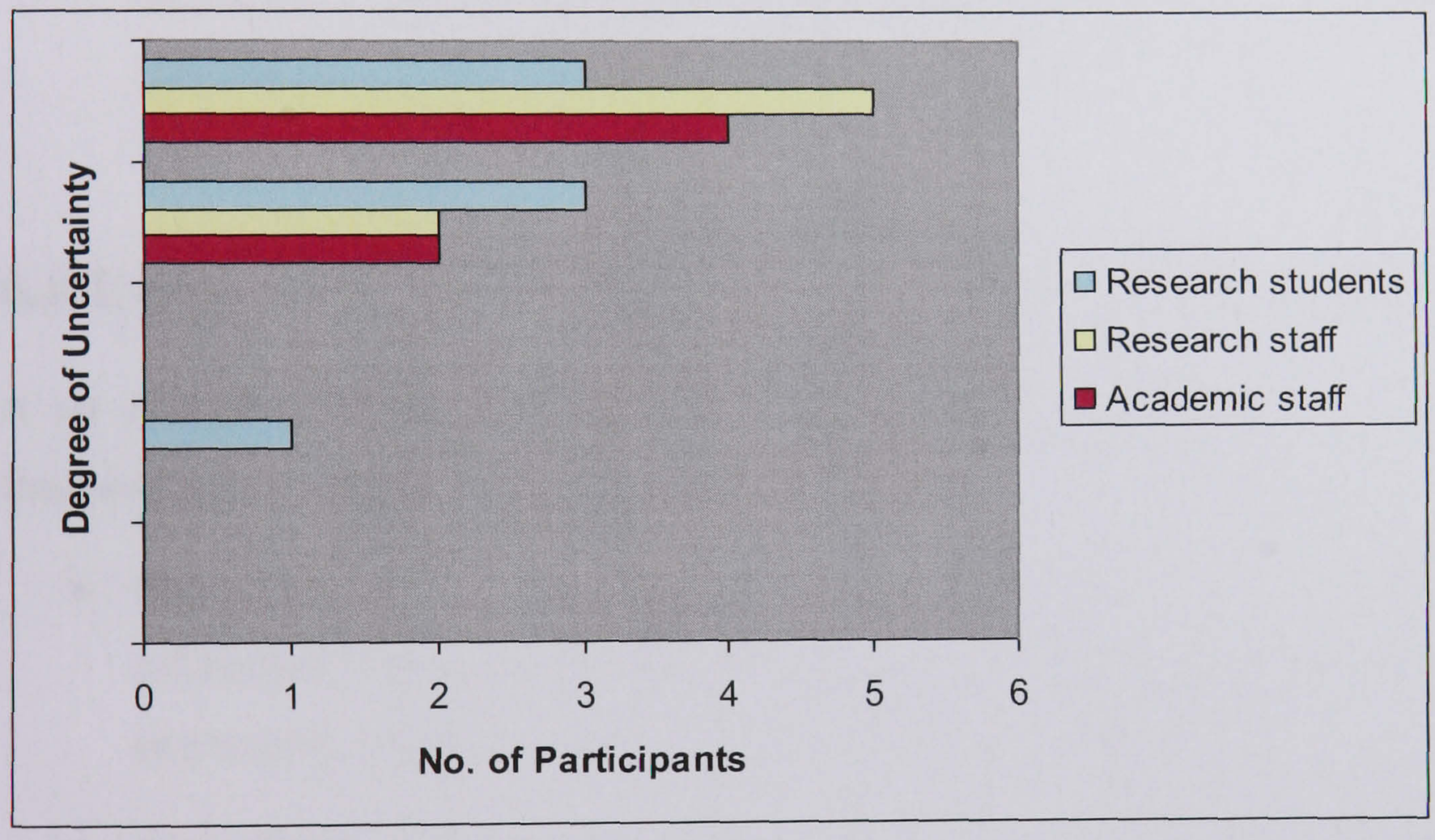


Figure 6.4: Positive uncertainty in relation to choice of information channels or sources

6.3.2 Problems

The following are some problems, mentioned by the participants, associated with the choice of information channels or sources,

- "Finding e-journals for interdisciplinary research topics is difficult" (Academic staff).

- "Sometimes the retrieved information is not enough but I am not sure where and how more relevant information can be found" (Research student).

- "Moving from one information channel to another often requires additional log-in and passwords, etc., which I feel is time-consuming and cumbersome" (Academic staff).

- "Sometimes the site moves or disappears making it difficult to read or download the retrieved information at a later point in time" (Research staff).

- "Finding statistical information on specific countries is often a problem; sometimes countries do not have up-to-date official websites for statistical information and in such cases deciding which channel to choose for such information is often a difficult task" (Research student).

6.4 Uncertainty in relation to Formulation of a Search Query

A set of mixed responses was obtained on the point of uncertainty in relation to the formulation of a search expression (Figure 6.5):

- Half (three out of six) of the academic staff indicated that a high degree of uncertainty was associated with the problem of formulating an appropriate search expression, while two indicated this to be of an average degree

- Two (out of seven) research staff indicated that a high degree of uncertainty and one indicated an average degree of uncertainty was associated with the formulation of an appropriate search expression. The rest had no or little uncertainty

- Most (six out of seven) research students faced a considerable amount of uncertainty – ranging from average to very high – associated with the problem of formulating an appropriate search expression.

Figure 6.5 shows that more than half of the research staff indicated there was little or no uncertainty associated with the problem of formulating a search expression. This is due to the fact that they usually worked on projects that were on a very specific area with a clearly defined set of research problems and issues, and therefore they seldom needed to conduct a comprehensive information search. However, all the research students found it difficult to formulate appropriate search expressions especially towards the beginning of their research studies, and data in Figure 6.5 supports this.

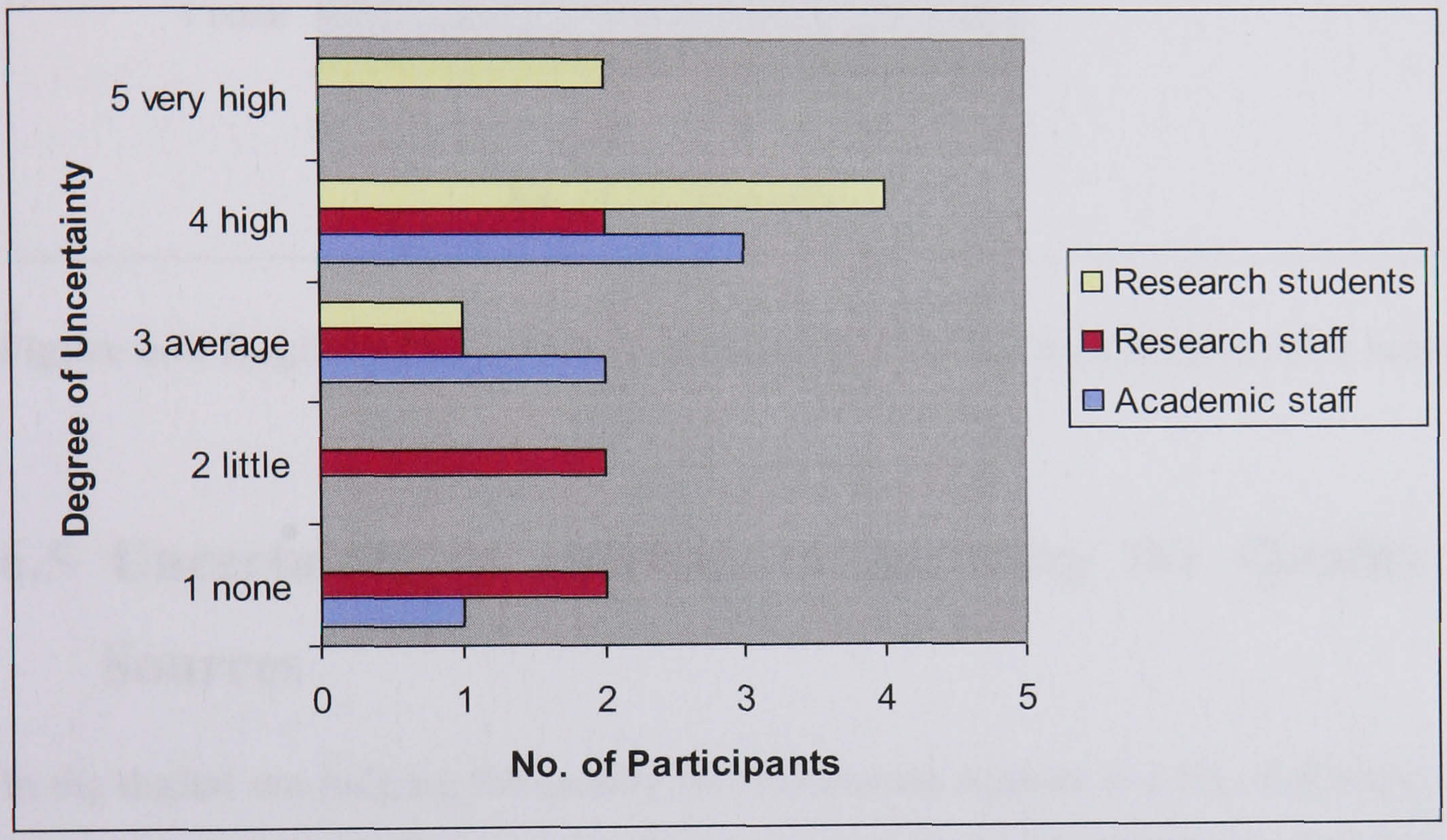


Figure 6.5: Uncertainty caused by the problem associated with the formulation of an appropriate search formulation

Figure 6.6 shows that most of the academic staff (five out of six) and research staff (six out of seven) felt between average to high degrees of uncertainty associated with the formulation of a search expression. The figure is even higher for research students and all of them felt some form of uncertainty – ranging from average to very high – associated with the formulation of a search expression.

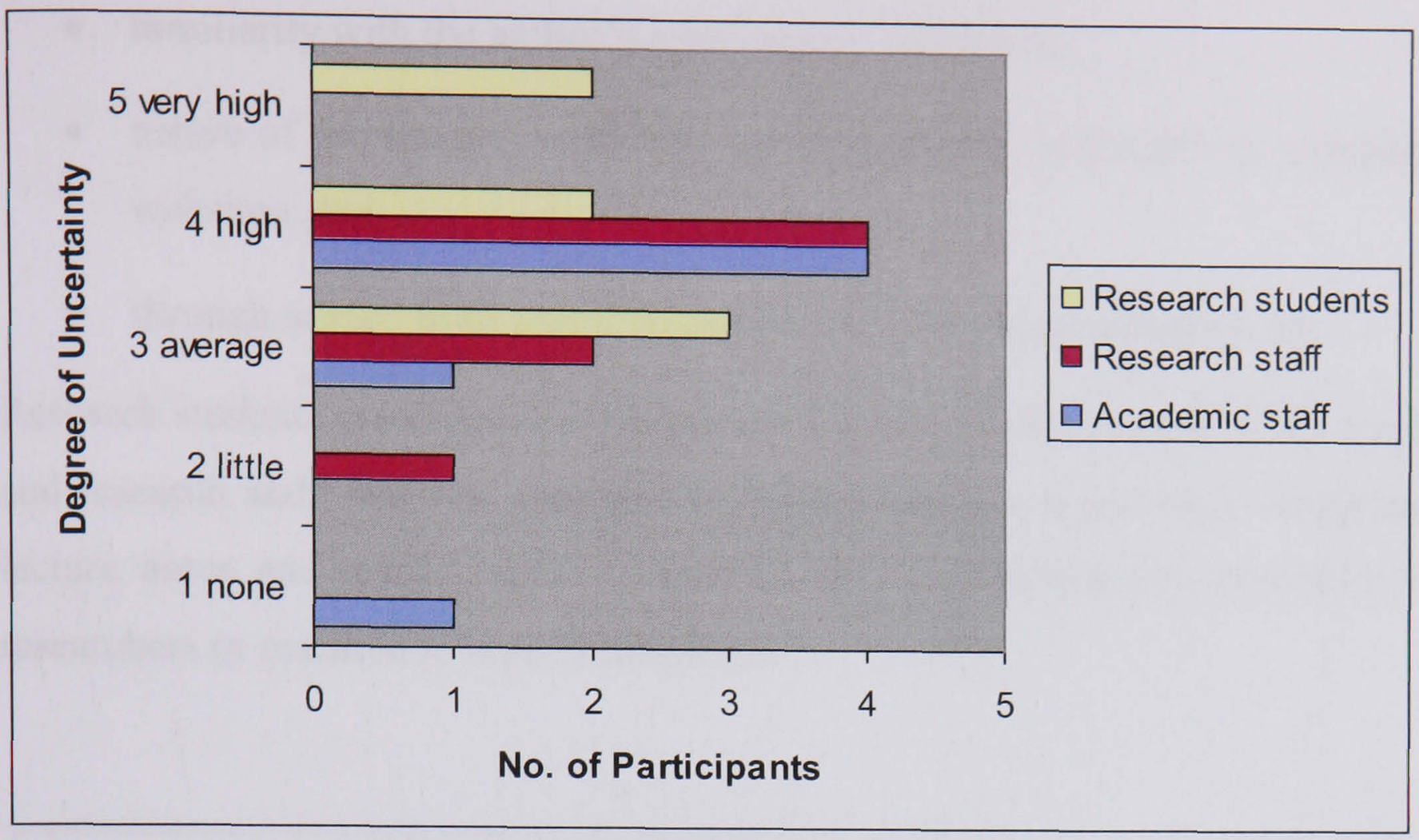


Figure 6.6: Degree of uncertainty associated with the formulation of a search query

6.5 Uncertainty in relation to Assuring the Quality of the Sources

In the digital era judging the quality of information sources is a big challenge, and it was noted that the participants used their own criteria to judge the quality. For example, participants from the academic staff category mentioned that they judged the quality:

- by the name of institution producing the information;
- by whether the information appeared in a refereed journal;
- by whether the author is well-known and experienced in the given field;
- through the abstract;
- through the name of conference; and
- through the citations.

Research staff judged the quality by using such criteria as:

- familiarity with the journal or conference titles;

- familiarity with the author's name and/or institution;
- nature of the specific websites, e.g. government, institution or company/industry websites; and
- through advice from senior researchers or peer group members, etc.

Research students used almost the same set of criteria as those used by the academic staff and research staff, but also appeared to depend on their supervisors' recommendations, lecture notes and reading lists or specific subject bibliographies produced by leading researchers or research groups or projects.

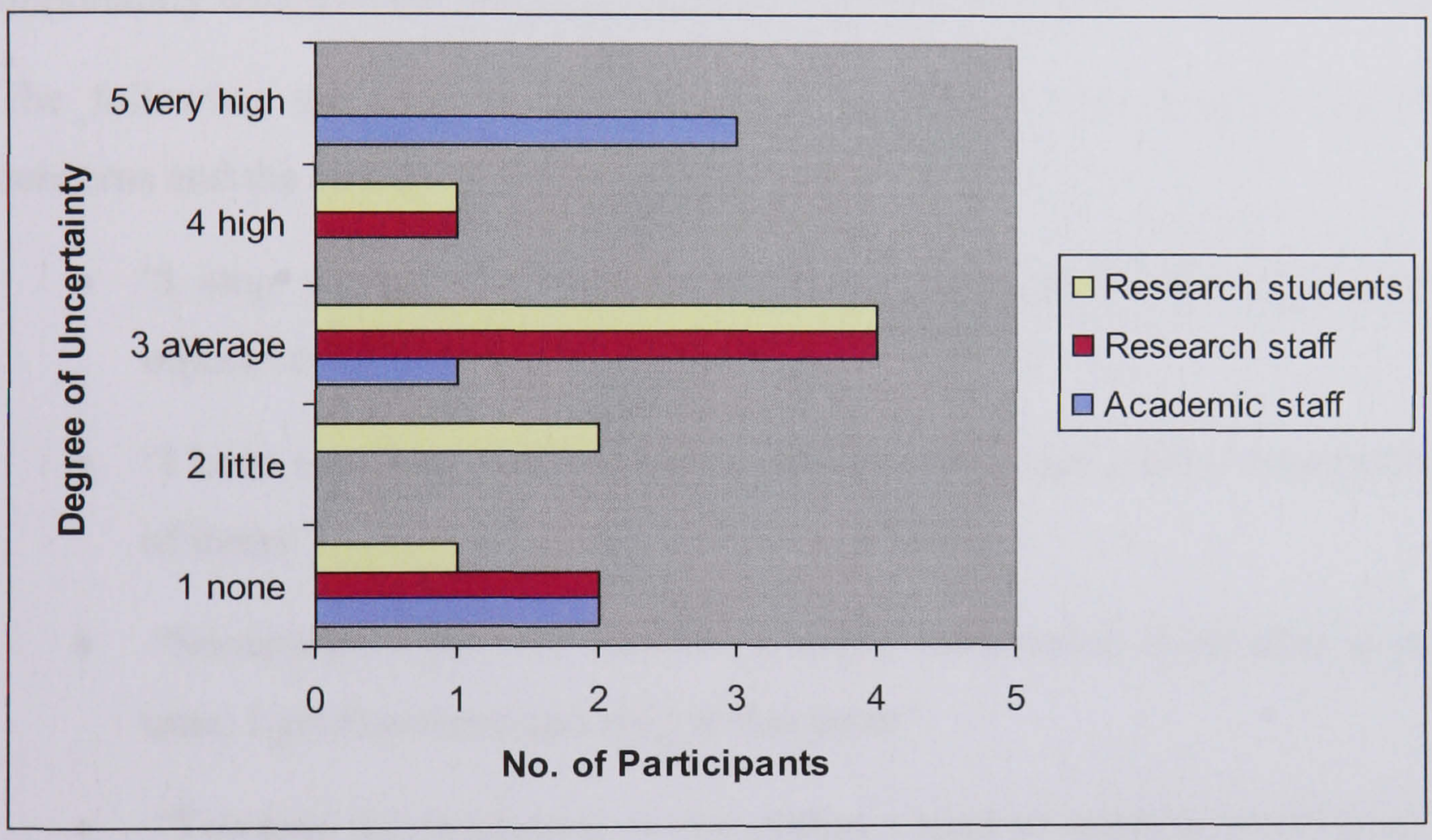


Figure 6.7: Degree of uncertainty in relation to quality of sources

Figure 6.7 shows that half of the academic staff strongly felt that uncertainty was associated with determining the quality of the information sources, whereas only one out of seven research staff and research students felt a high degree of uncertainty associated with judging the quality of the information sources. More than half (four out of seven) research staff and research students felt uncertainty of an average degree in relation to the quality of information sources. However, some of the research staff and research students (two and four respectively) felt little or no uncertainty in this regard. This corroborates earlier findings presented in this chapter that often research staff and research students

focused on a small selected set of information sources, and therefore did not face the uncertainty that was associated with judging the quality of the information sources from amongst a large number of retrieved items.

6.6 Uncertainty in relation to the Use of the Retrieved Items

Due to information overload, users sometimes retrieve a vast number of information sources, and thus need to spend a lot of time and effort to choose the desired information from the vast amount of retrieved items (Wilson, 2001). So when and how do the users decide when to stop a search and begin to use the retrieved information, and more importantly which of the retrieved items do they decide to use?

The following are some comments made by the research students that show their concerns and the course of action that they take:

- "I stop when I feel that the collected information will meet my immediate objectives"
- "I keep searching and narrowing it down until I get a small manageable number of items"
- "Sometimes I get very little or no useful information at all after spending some time; I get frustrated and stop at that point"
- "Towards the beginning of my studies I used to spend a lot of time, and often used to get lost in the process; but now I know where to look for and stop going any further after spending five or ten minutes".

All the research students mentioned that time was a major constraint and that they did not want to spend an awful lot of time in searching because that would affect their actual research time. The same feeling was also expressed by the research staff. However, some interesting approaches adopted by research staff were also noted, for example:

- "I stop after a few minutes if I find that the information obtained so far is useful"
- "I stop when I find that some relevant information has been found"

- "I start working as soon as I get some useful information, and go back to the same channel later to look further."

The fact that time is the major constraint was also mentioned by the academic staff who also emphasised that the duration of a search depends largely on the task in hand. For example, all of them mentioned that they ran a quick search when they needed to gather some general or preliminary information on a topic, but a significant amount of uncertainty existed when they had to do a comprehensive literature review, for example for writing a research proposal or a review paper.

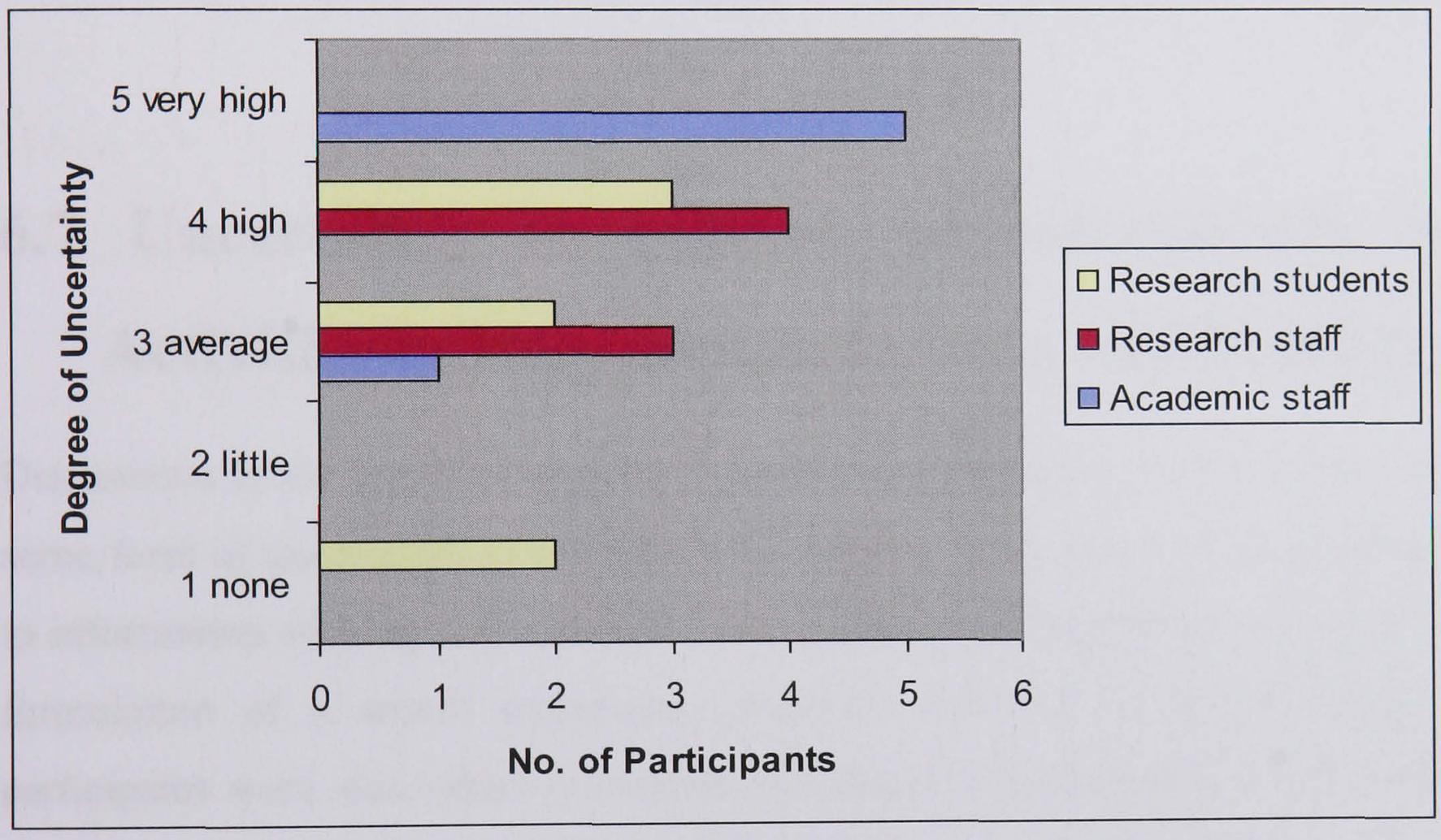


Figure 6.8: Degree of uncertainty and decision to stop and use the retrieved items

All the participants, except for two research students, indicated that some degree of uncertainty was associated with the decision to stop a search (Figure 6.8):

- Most of the academic staff (five out of six) strongly indicated a high degree of uncertainty
- Four research staff indicated a high degree of uncertainty while the rest indicated an average degree of uncertainty

- Three research students (out of seven) indicated a high degree of uncertainty while two indicated an average degree of uncertainty associated with the decision to stop a search.

The very high degree of uncertainty indicated by the academic staff may be explained by the nature of some of their tasks. For example, for writing a research proposal, a review paper, etc., academic staff need to conduct exhaustive searches, and thus face a high degree of uncertainty because it is not often easy to decide when to stop searching, or to make sure that all the relevant items have been retrieved. Such situations may not occur for all the research students and staff, though some felt that a degree of uncertainty was associated with the decision to stop a search and begin to use the retrieved items.

6.7 Uncertainty in relation to Information Seeking Activities in Information Seeking and Retrieval

Discussions in the previous sections indicate that participants from all the categories felt some form of uncertainty in relation to the various information seeking activities related to information seeking and retrieval, such as choice of information channels or sources, formulation of a search expression, selection and use of search results, etc. The participants were also asked to indicate the degree of uncertainty that they faced in the overall information seeking and retrieval process.

Figure 6.9 shows that some degree of uncertainty was present with the information seeking and retrieval process for most of the users. It may be noted that all the academic staff felt an average degree of uncertainty in the entire information seeking and retrieval process, while more than half of the research staff and students felt an average or high degree of uncertainty in information seeking and retrieval.

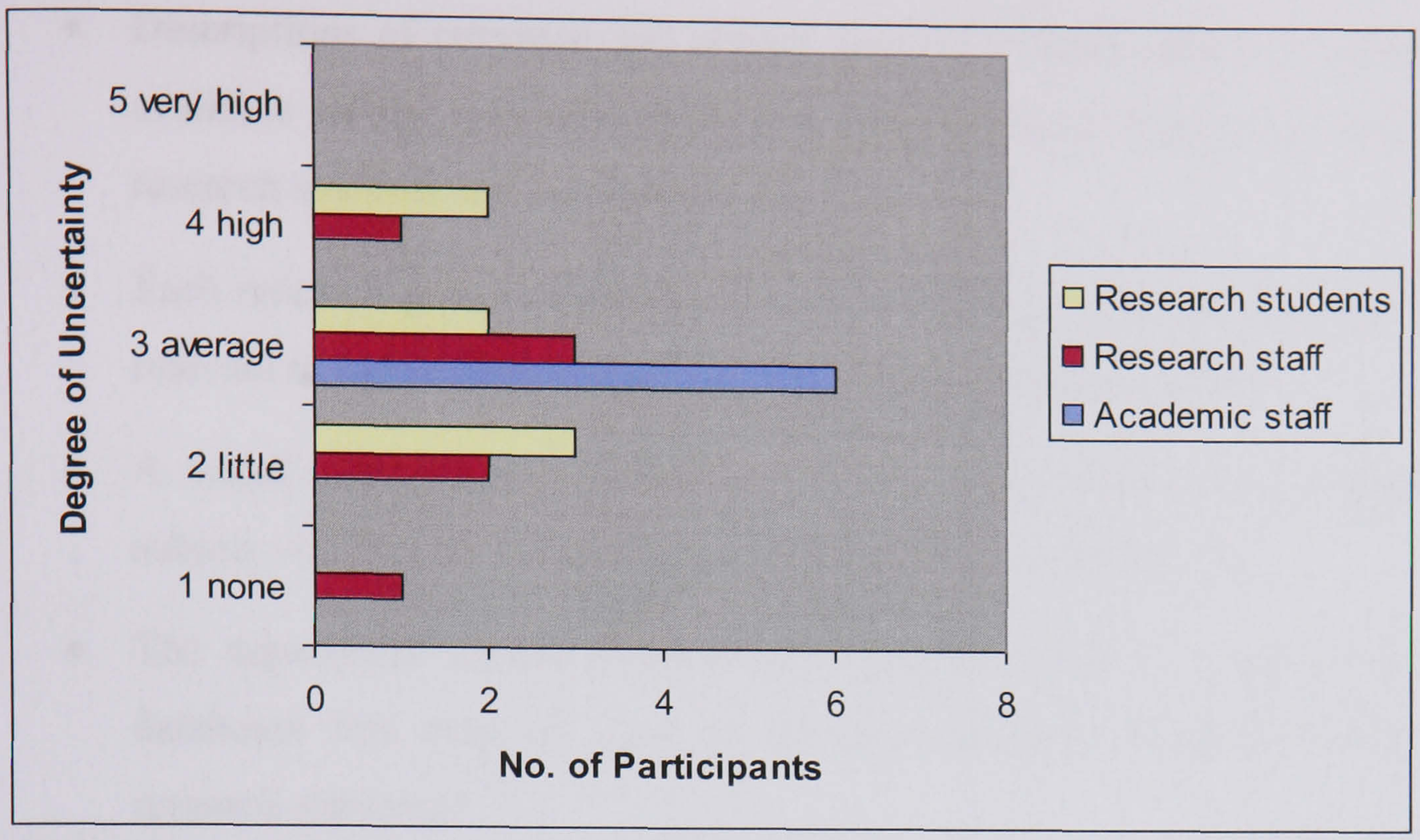


Figure 6.9: Degree of uncertainty in the information seeking process

Through the semi-structured interview, the participants were also asked to provide some suggestions that could help reduce uncertainty in relation to the various information seeking activities. Overall all the participants felt that finding and using the right information quickly and easily was a problem. Nevertheless, there was a general feeling that more help was required to guide the users in choosing information channels within a specific discipline. All the research students mentioned that some databases and e-journals would ask for a payment at the point of use, or otherwise they would restrict access to the retrieved information sources; they suggested that appropriate payment and access mechanisms should be developed and used to avoid this. Two academic staff suggested that examples of good queries from other people on the same or related topic could be stored and made available to reduce the uncertainty with regard to the formulation of a search; they cited the example of the Ask search engine service. One academic staff also mentioned the need to use the relevance feedback mechanism with every database. Participants from all the categories mentioned that some form of help with regard to the choice of terminology should be provided, and one academic and one researcher suggested the use of some form of vocabulary mapping and visual interface. Some more specific suggestions made by the participants are mentioned below:

- Descriptions of coverage and unique features of each database should be made available easily, possibly through a pop-up menu (suggestion made by two research students and one researcher)

- Each research group should have a list of highly relevant journals and databases relevant to the projects (suggestion made by two research staff)

- A visual map showing the content and coverage of the various databases in a subject will be very helpful (suggestion made by an academic)

- The department should produce and maintain a list of company and country databases that may be used for research purpose (suggestion made by two research students)

- The library website should provide a cross-database search facility so that the user need not have to choose one information channel or database to search at a time (suggestion made by two research staff and two students)

- A subject guide along with a list of journals and conferences ranked according to their impact factor should be made available to the users so that they can decide which journals and conferences are the best (suggestion made by two academic staff)

- Representative review papers on a specific research topic should be used to focus on specific journals, conference, etc. to search (suggestion made by two academic staff).

- A list of expert authors and research groups in every subject may be prepared and made available through the search interface (suggestion made by an academic and a researcher).

- Sets of results from a successful search may be saved for future reference so that the user does not have to search on the same topic again and again within a short span of time (suggestion made by an academic and a researcher)

- Automatic search agents may be used to conduct the search on chosen topics and bring back results at specific intervals (suggestion made by an academic)

- Good filtering mechanisms based on user tasks could be developed to assist users in automatically filtering out unwanted materials so that more time can be spent on using the retrieved information (suggestion made by two academic and two research staff).

6.8 Post-search Questionnaire

In this phase of the research, the participants were asked to search on a topic of their area of knowledge or expertise (but not factual information) and then were asked to provide some basic personal information and answer a set of questions, i.e. by completing a post-search questionnaire (Appendix F) mainly by putting a number or cross wherever instructed. The intention here was to check the degree of uncertainty among all user categories while looking for research information in their field of study.

6.9 Uncertainty in relation to Information Seeking Problems in Information Seeking and Retrieval

Figure 6.10 shows the degree of uncertainty facing the participants in relation to the problem of information overload:

- Most of the academic staff (five out of six) indicated that some form of uncertainty (an average degree or more) was associated with the problem of information overload
- Four out of seven research staff indicated the uncertainty associated with this issue is of a high or very high degree, and
- Five out of seven research students indicated some form of uncertainty – ranging from an average to a high and very degree.

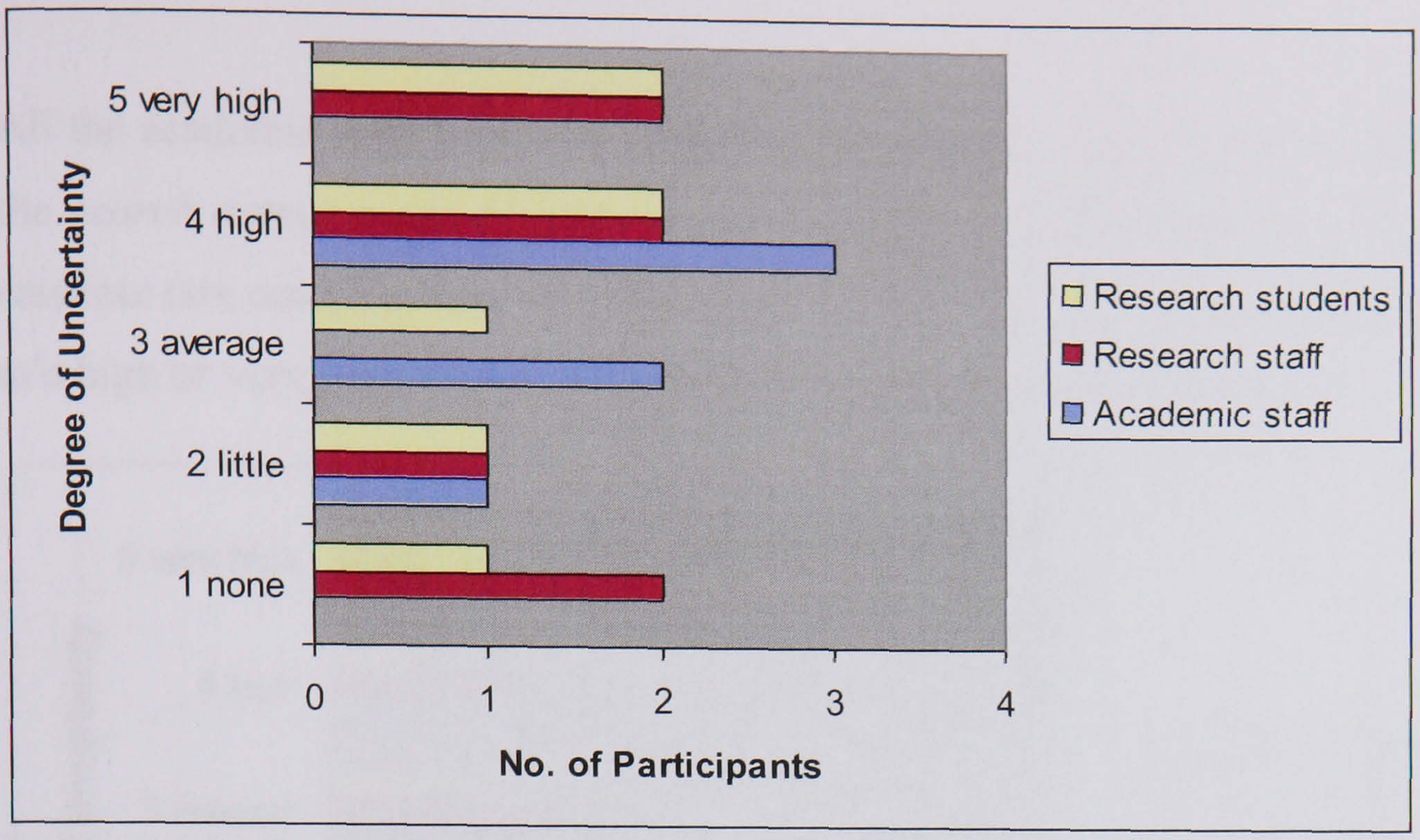


Figure 6.10: Degree of uncertainty with regard to too much information or information overload

As shown in Figure 6.11, all the academic staff indicated a high to very high degree of uncertainty caused by the problem that information is often too scattered. Five out of the seven academic staff also indicated a high or very high degree of uncertainty caused by this problem, while five out of seven research students indicated different degrees of uncertainty ranging from average to high and very high.

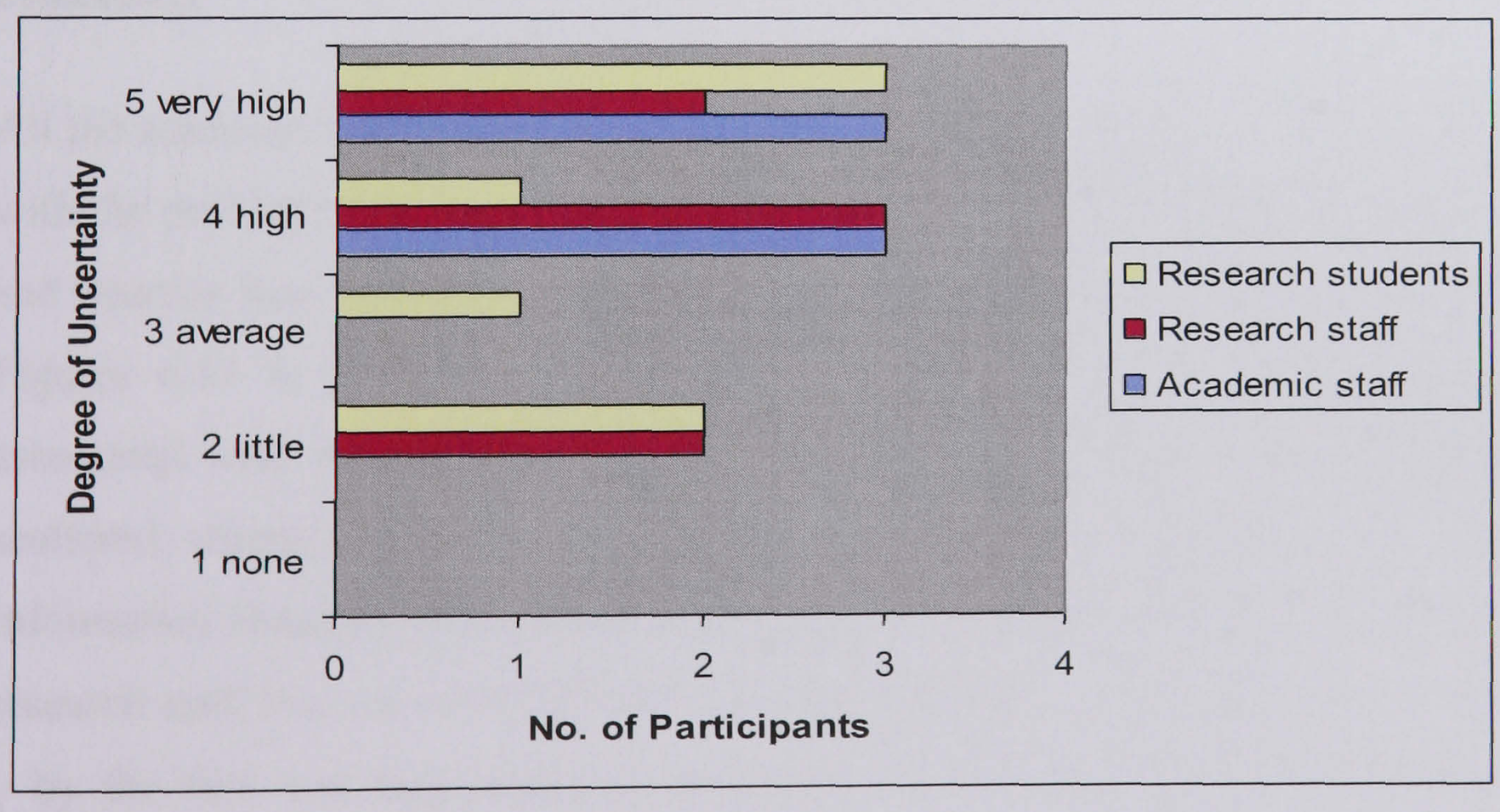


Figure 6.11: Degree of uncertainty caused by the problem of too scattered information

All the academic staff indicated a high degree of uncertainty caused by the problem that the *search output is not always very exhaustive* while almost all the research staff and students (six out of seven) identified some form of uncertainty, ranging from an average to a high or very high degree, associated with this problem (Figure 6.12).

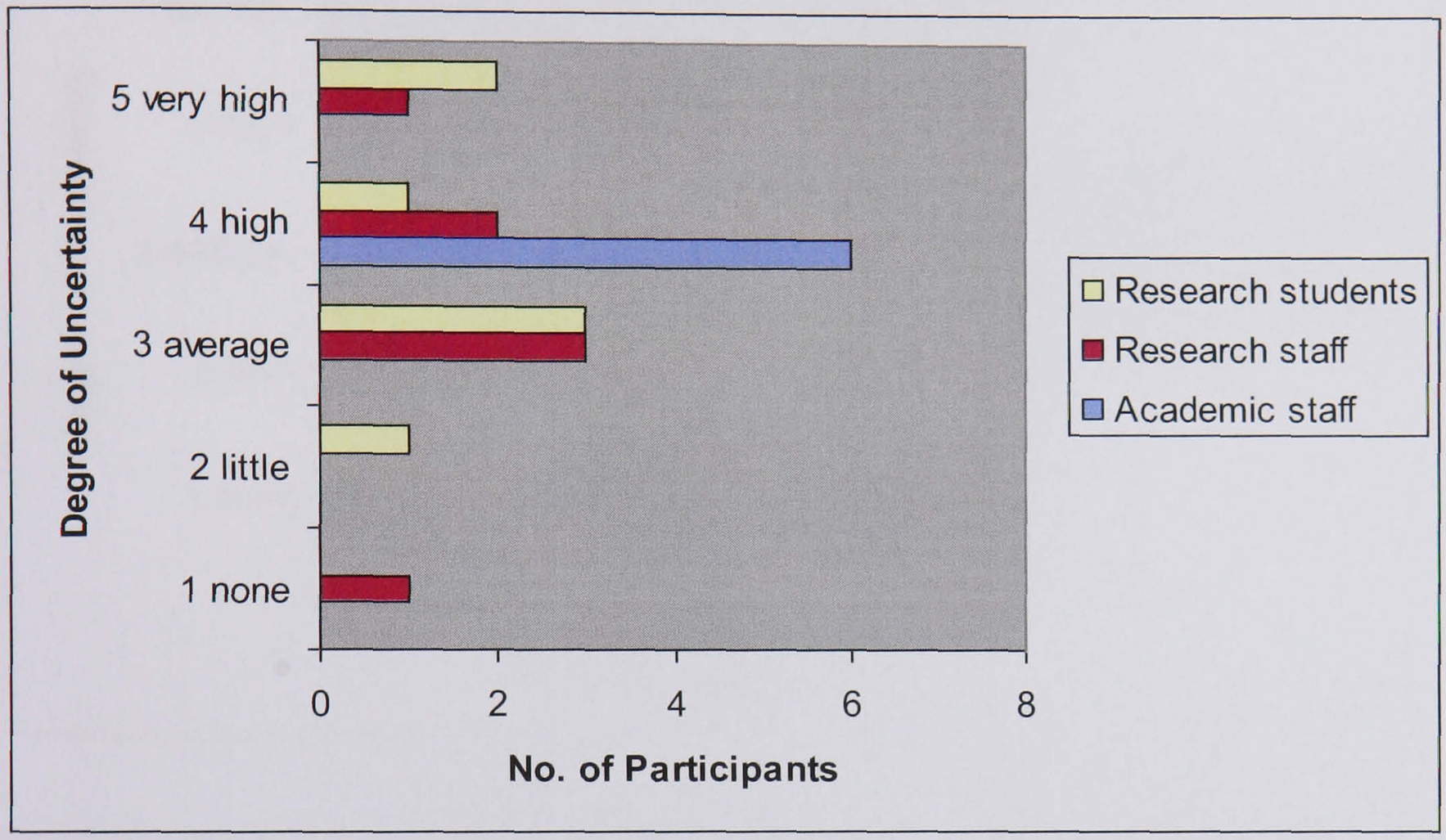


Figure 6.12: Degree of uncertainty with regard to search output is not always exhaustive

All the academic staff also indicated a high or very high degree of uncertainty associated with the problem that they were not always aware of the variety of information channels and sources that should be looked for on a research topic. Thus, it may be noted from Figures 6.11 to 6.13, academic staff felt a high or very high degree of uncertainty associated with such information seeking and retrieval problems as information is too scattered, search output is not exhaustive and a lack of awareness of the best possible information channels and sources for a given research topic. Figure 6.13 shows that most research staff (six out of seven) also felt quite uncertain – of a high or an average degree – by the fact that they were not aware of the best possible information channels or sources. Comparatively this uncertainty was less amongst research students, and this is

because of the fact that they are not always concerned with the comprehensiveness of the search results, and often deal with a limited number of information channels and sources.

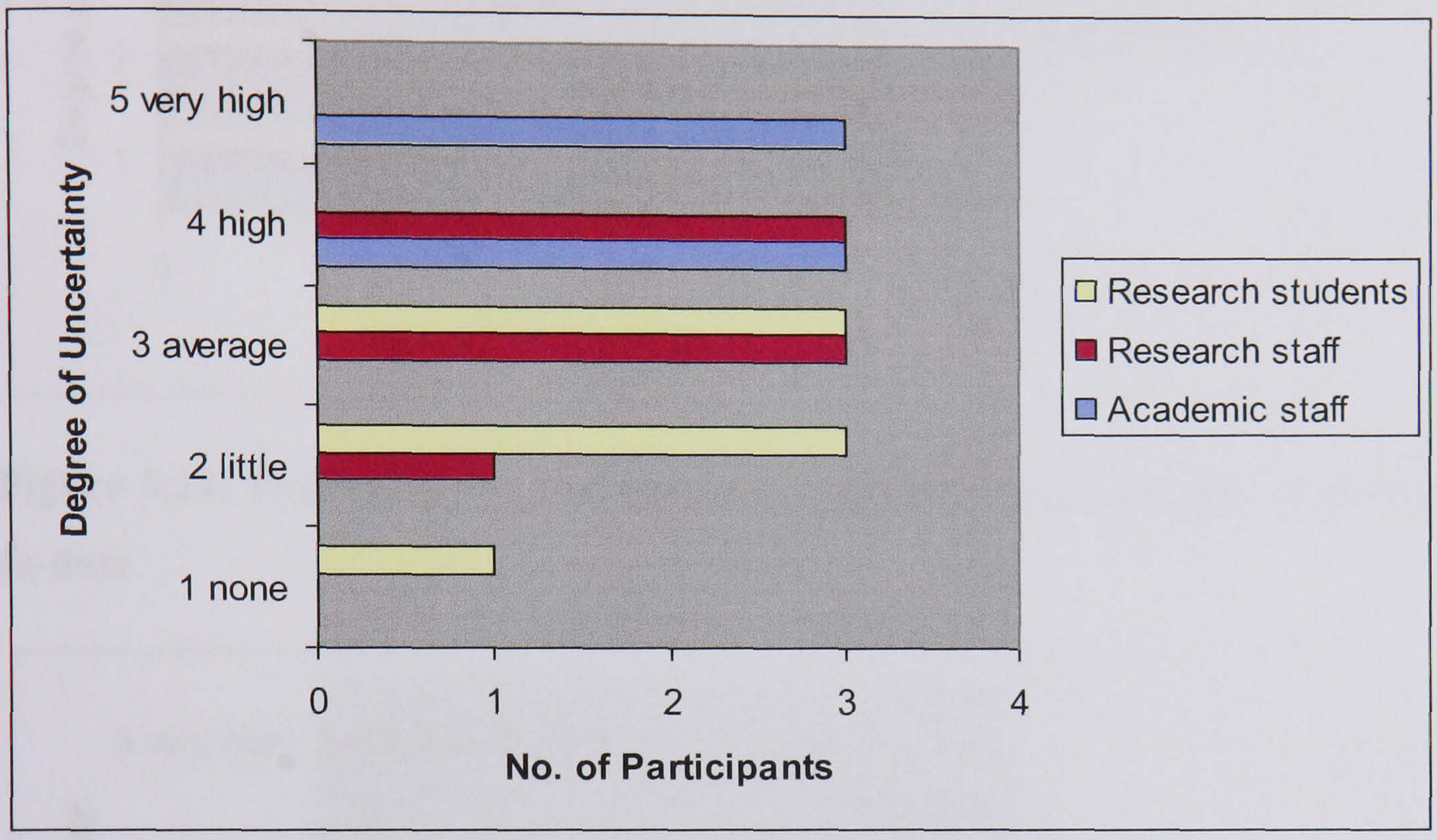


Figure 6.13: Degree of uncertainty with regard to unaware of source or channel

It may be noted from Figure 6.14 that the academic staff opinion about the degree of uncertainty caused by the problem that the retrieved information is not up-to-date is split – for some it is a major concern while for others it is not. Almost similar observations can be made for the two other categories of participants – research staff and students. This is perhaps explained by the discipline and nature of work of the participants; it is due to the fact that for some disciplines and activities the currency of information is not a major issue and the information required is more basic scientific theories and equations or historical, and does not change fast. For others it is the opposite, currency of information is important for their research purposes, and hence the difference of opinion.

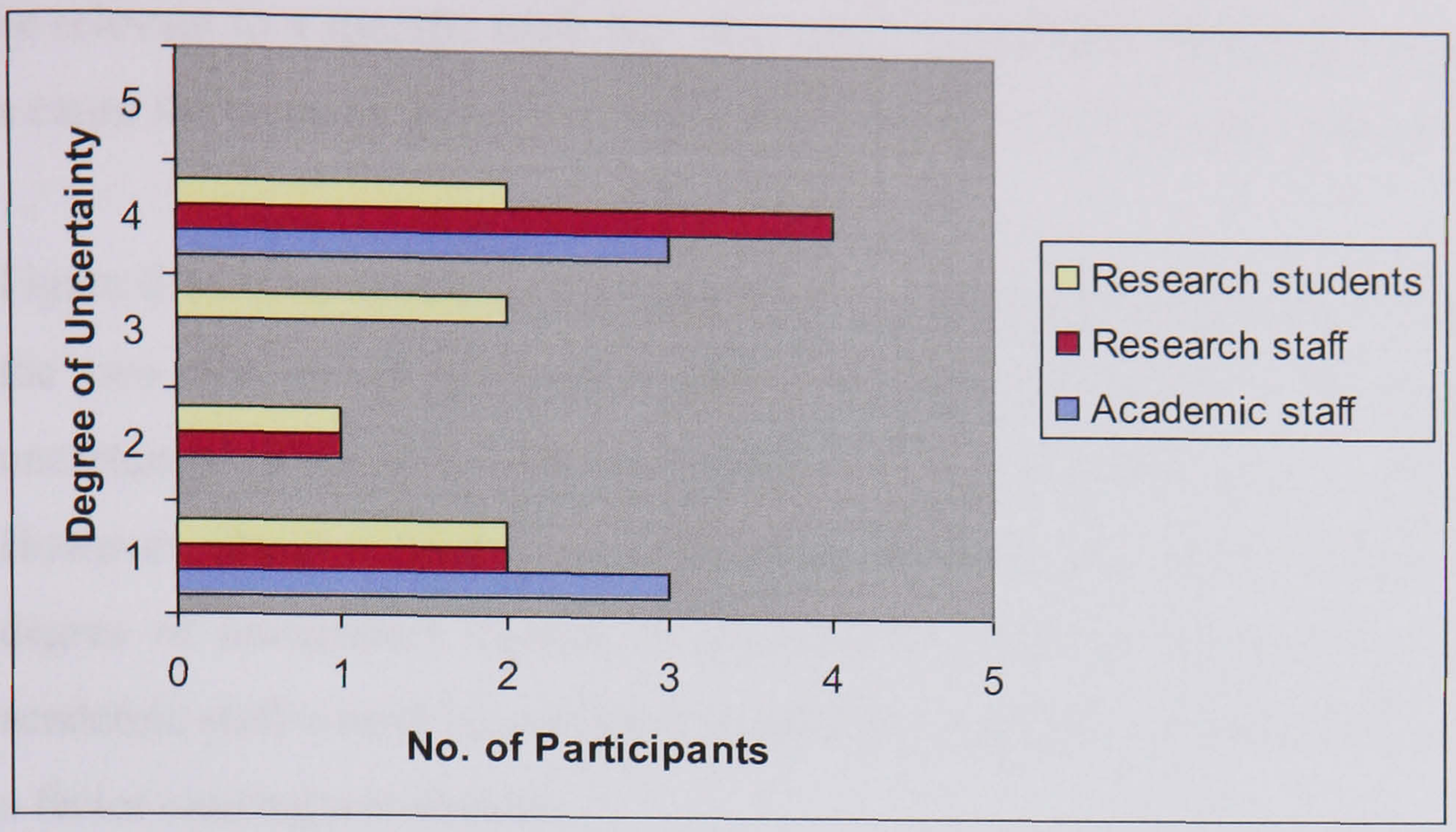


Figure 6.14: Degree of uncertainty with regard to search results are not always up-to-date

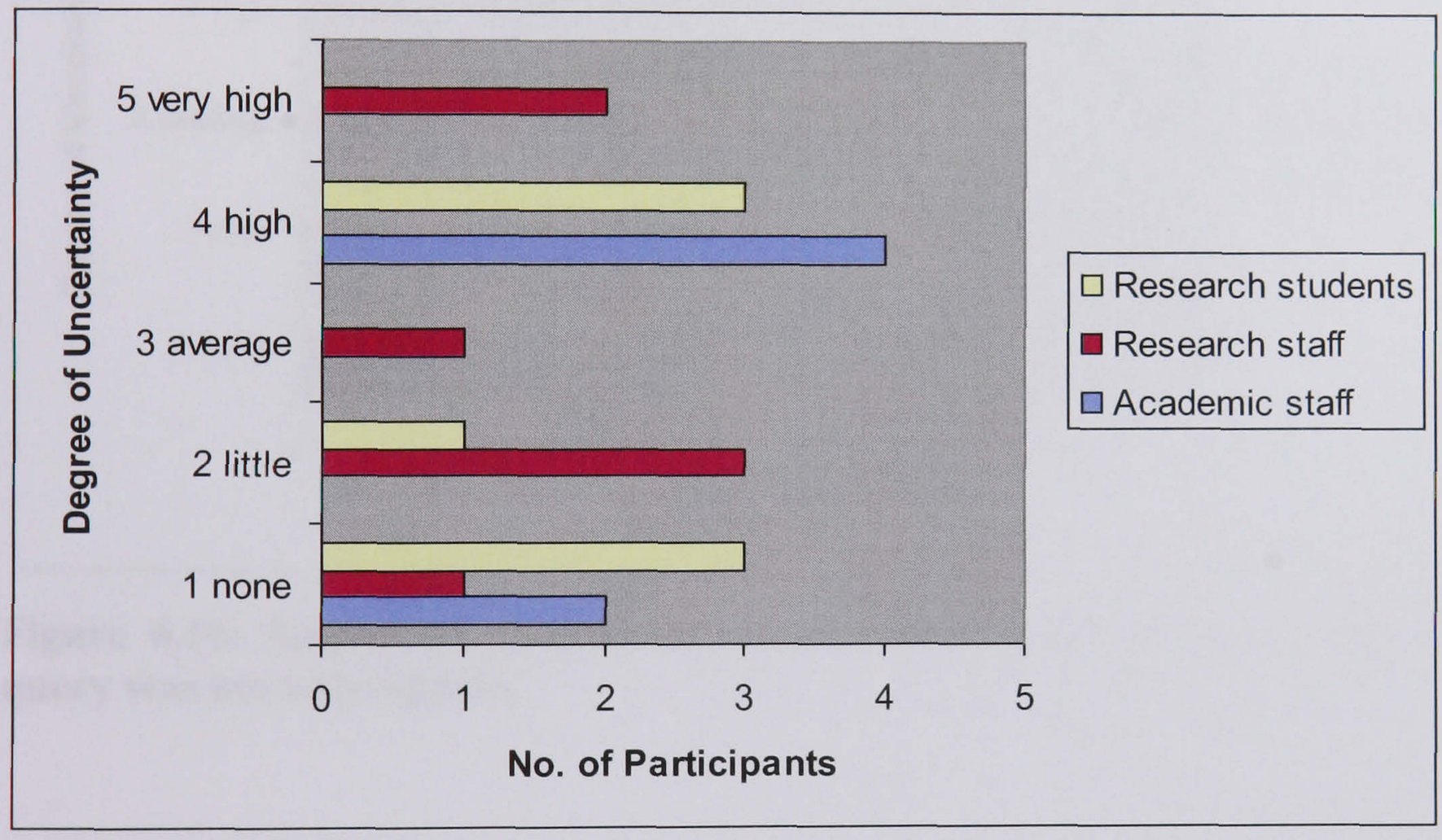


Figure 6.15: Degree of uncertainty associated with the problem of unfamiliarity with the source

While most of the academic staff were concerned with the uncertainty caused by their unfamiliarity with the information sources, with a very high degree of uncertainty indicated by four out of six participants in Figure 6.15, there is almost an equal split among both the research staff and research students. This is explained by most of the academic staff that from their experience they were aware of several sources that would

be relevant to a specific topic but they were not familiar with those sources and this was a cause for concern. However, this is true only for some research staff and students.

Figure 6.16 reveals that a good proportion of participants from each category (expect for the two out of seven research staff) indicated that there was relatively less or no uncertainty associated with the problem that the search query was not appropriate. However, about a third or more participants from each category indicated an average degree of uncertainty caused by this problem. This is explained by the fact that the academic staff would be confident in formulating queries and therefore did not see this as a factor causing uncertainty.

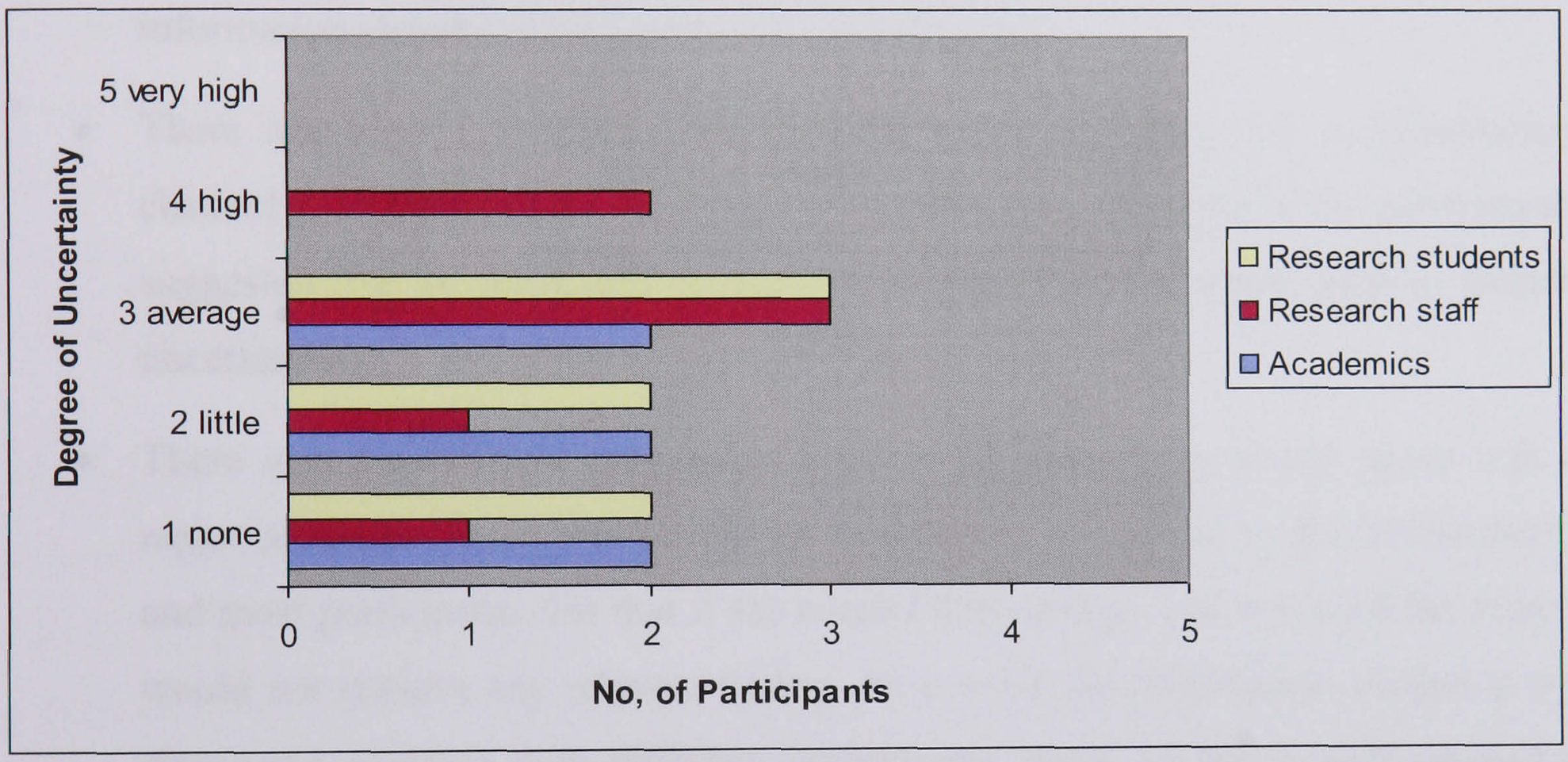


Figure 6.16: Degree of uncertainty associated with the problem that the search query was not appropriate

6.10 Summary

The two phases of qualitative research reported in this chapter provide some useful insights into the issue of uncertainty facing academic users in the course of the information seeking and retrieval processes. The in-depth interviews have shown how academic users from different categories viewed and rated uncertainty associated with various information seeking activities. While the findings showed that the degree of uncertainty associated with some activities were rated almost equally by all categories of

users, there were some differences too. In general, academic staff appeared to be more concerned with uncertainty associated with certain issues. This is due to the fact that they, despite being more experienced, often needed the most comprehensive and relevant information compared with participants from other categories. Findings from the post-search questionnaire also reveal that the participants felt some form of uncertainty, often to a significant extent, caused by some information seeking problems associated with the information seeking and retrieval process.

Interestingly, in general the participants of all categories mentioned that:

- It would have been helpful if there was a guide for selection of the best possible information channels and sources for a search topic.
- There was always an uncertainty associated with the choice of an information channel to begin a search, especially on a new topic, and some of the participants suggested that an integrated database with one password could help to reduce uncertainty.
- There was a consensus that formulation of an appropriate search query was a major problem. There was always an uncertainty in relation to the terminology, and most participants felt that if the correct terminology was not used the search would not retrieve any relevant source. As a result the participants needed to try alternative searches with different terminology. Some academic staff suggested that some successful search queries should be provided as an example to reduce this problem.
- All the participants felt that time was a major constraint, and as a result they decided a cut-off point but sometimes felt doubtful whether they had missed any useful information.
- Information overload was a significant problem, and often a significant amount of time had to be spent to choose the most appropriate and relevant information sources.

However, the participants also mentioned some positive impacts of the uncertainty related to information seeking and retrieval. All the participants, irrespective of their category, mentioned that uncertainty related to various issues often forced them to be prepared and be more specific in preparing search strategies.

It was noted that information overload was a problem and it often created some form of uncertainty. Academic staff mentioned that the huge volume and variety of information provided opportunities for discovering new information and thus getting new ideas, and this often made them more informed and confident in their area of study. Research staff mentioned that they always found something useful very easily, even if the output was not necessarily comprehensive, and this made them more empowered and gave them more choices, and often helped them learn new things in the chosen topic or related areas. Research students indicated that often they found some useful information accidentally and this sometimes helped them think from a different perspective or take a different course of action.

This chapter shows that varying degrees of uncertainty existed among academic staff, research staff, and research students based on their chosen search topics. It also shows that there was a positive impact of uncertainty. The next chapter aims to find out, through a number of pre-designed search tasks, whether there are any uncertainty shifts among different group of users and whether there is any positive impact of uncertainty.

Chapter 7

Data Analysis of Search Tasks

7.1 Introduction

One of the most difficult aspects of a qualitative analysis appears to be related to the presentation of data vis-a-vis analysis of findings. This is usually because researchers are faced with vast amounts of evidence and it seems to be a momentous task to decide what to present and how to present it. Guidelines for qualitative research suggest that, 'whatever you do, never be tempted to try and quantify your data……This is not why you chose to engage in qualitative data in the first place. We no longer have the comfort of a single, recognized graph or chart; a table is not going to be particularly useful, so what are we left with? Words! And lots of them' (Pickard, 2007, p. 245).

One of the most commonly adopted options is to use what is called a *story* (Pickard, 2007) i.e. a descriptive narration, used to tell the audience what is found. This approach has been taken in this research in presenting the findings from the qualitative study that involved a series of tasks that a selected group of study participants were asked to accomplish, and also a series of short pre- and post-search questionnaire that they were asked to complete.

Information seeking is usually motivated by the tasks that users need to perform, and therefore, it is important to understand the task context within which it takes place. Earlier research by Saracevic (1975) and more recent work by Kuhlthau (2004) show that users look for a general topic and its relevant information at the early stages of information seeking but at the later stages they look for more specific information related to the topic. Research also shows that people prefer to perform tasks and activities in which they feel confident and competent but try to avoid those in which they are not (Kear, 2000; Pajares, 2002). Tasks vary in complexity: simple tasks are 'routine information processing tasks where the elements of the tasks are predetermined, i.e. [the

user] knows them' (Vakkari, 1999, p. 826). A simple task, also known as a fact-based or closed task, has a target answer that the information seeker should find whereas complex tasks do not have target answers. Instead, they require critical thinking to extract "meaning" from the information found. Complex tasks can also be categorised as research-based or open-ended (Byström & Hansen 2005).

The main objective of this phase of the study was to find out whether and how uncertainty occurs, and changes, in relation to some specific information seeking activities and information seeking problems in the course of a series of information search tasks. In order to do this, a group of selected participants were asked to perform a set of pre-defined tasks (Appendix H) that were research-based or open-ended tasks. The participants were asked to fill in a short questionnaire to indicate their degree of uncertainty associated with certain information seeking activities and information seeking problems, as experienced by them after accomplishing the tasks.

As mentioned in Chapter 2 (Sections 2.6 and 2.7) uncertainty associated with information seeking and retrieval may be positive or negative, the positive uncertainty being manifested in several ways such as by providing new (hitherto unknown to the user) information, or by helping the user refocus the search strategy, and so on. In order to assess this, the participants were also asked to indicate whether they felt any form of positive impact of the uncertainty experienced after accomplishing the specified information search tasks.

Participants in this research were academic staff, research staff, and research students from the Department of Computer and Information Sciences at the University of Strathclyde, Glasgow, UK. Invitations were sent out through e-mails, and 15 volunteers took part in this study. Out of the 15 volunteers, four were academic staff, four were research staff and seven were postgraduate research students. Since the participants were from the academic environment they 'can be considered to be performing information intensive work tasks involving: ...inherently and/or explicitly information-related activities to a considerable degree' (Byström & Hansen, 2005, p. 1050). Furthermore, 'in

such a workplace, with layers of information-related tasks (Byström & Hansen 2005), uncertainty is associated not only with information requirements and information seeking activities, but the wider task as well (e.g., Kuhlthau 1999; Kuhlthau & Tama 2001)' (cited by Anderson, 2006).

In order to conceal their identities the participants have been represented by a code number: A1 to A4 to denote the four participants from the academic staff category, B1 to B4 to denote the four participants from the research staff category, and C1 to C7 to denote the seven participants from the research student category. A total of eight uncertainty causing factors were identified from the earlier phases of the study and the participants were asked to rate there on a five-point scale (Appendix G).

7.2 Findings from the participants in the academic staff category

Data gathered from the four participants in the academic staff category are presented below along with the appropriate analyses.

7.2.1 Profile of Participants

Academic staff A1 was very familiar with the types of tasks assigned for this experiment; he had a little familiarity with search topics one and two, but he was very familiar with topic three (Table 7.1). Academic staff A2 was very familiar with task one and familiar with tasks two and three. With regard to the search topics, he was very familiar with search topic one, familiar with search topic two and had a little familiarity with search topic three (Table 7.1). Academic staff A3 was familiar with the types of tasks assigned for this experiment. He was also very familiar with search topics one and two, but had a little familiarity with topic three (Table 7.1). Academic staff A4 had a high degree of familiarity with task one but had a little familiarity with tasks two and three. With regard to the search topics, he was not familiar with search topics one and two, but was little familiar with topic three (Table 7.1).

Table 7.1: Task and topic familiarity of academic staff (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

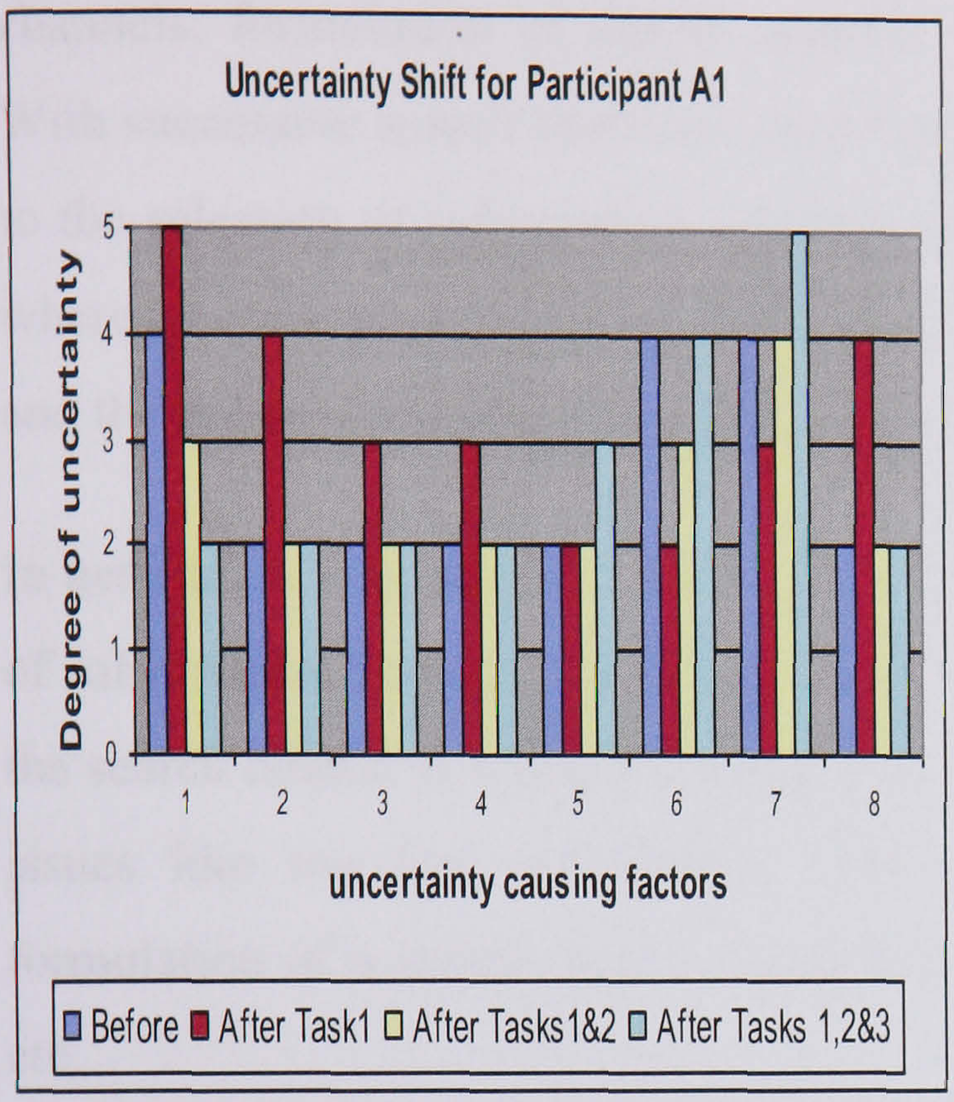
Participants	Tasks	Task familiarity	Topic familiarity
A1	1	5	2
	2	5	2
	3	5	5
A2	1	5	5
	2	4	4
	3	4	2
A3	1	4	5
	2	4	5
	3	4	2
A4	1	5	1
	2	2	1
	3	2	2

7.2.2 Uncertainty Shift

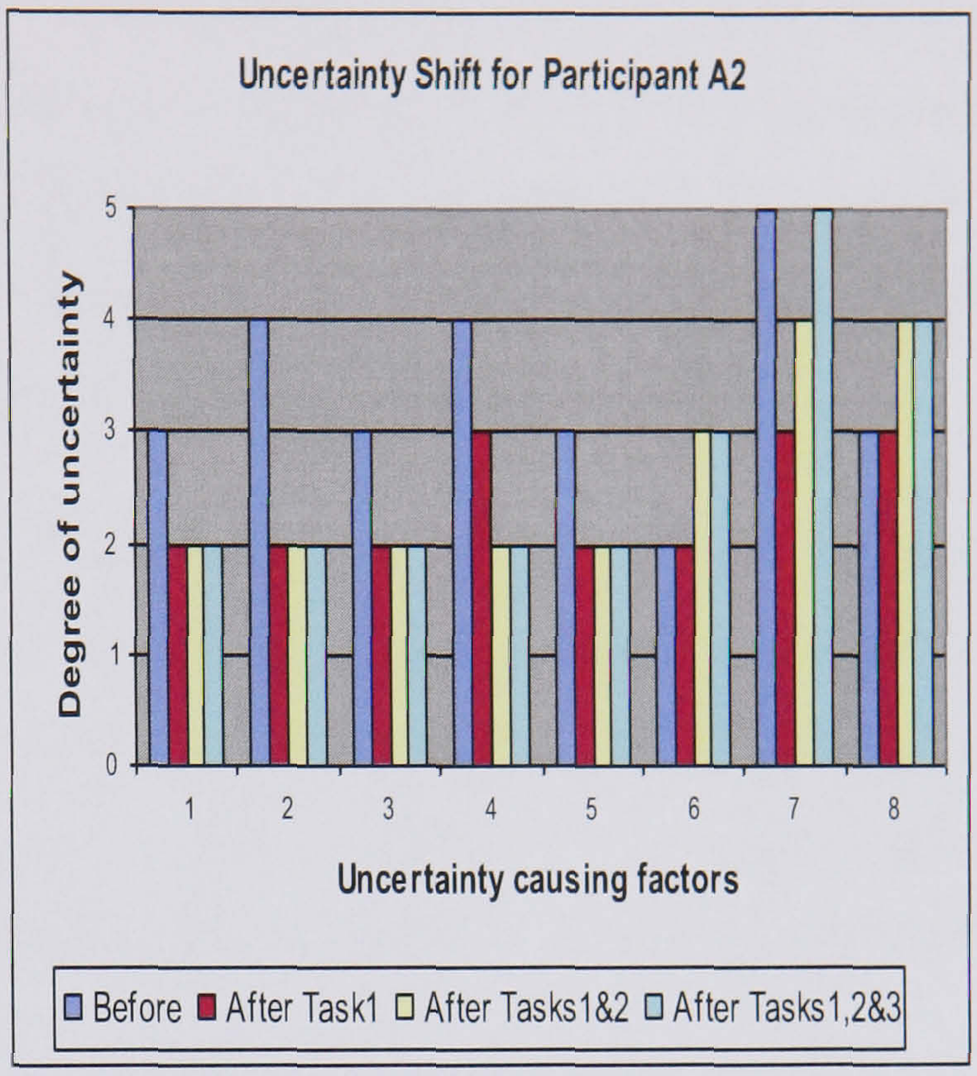
Figure 7.1 shows the uncertainty in relation to the various search tasks performed by the academic staff category. In general, A1 appeared to have a high degree of uncertainty associated with the selection of information channels, and also with information overload and comprehensiveness of the search results (Figure 7.1, Part A). Some degree of uncertainty, though to a lesser extent, was also associated with various other issues such as with the number of information channels and sources, formulation of a search query etc. In the course of the conversation after the search tasks A1 confirmed that uncertainty with the issues mentioned in the figure (Figure 7.1, Part A) remained all through the search tasks though it varied, reduced or increased in some cases through successive search tasks.

This may be noted from Figure 7.1 Part A which also shows some kind of shift in uncertainty in the course of successive search tasks performed by A1: while uncertainty associated with the selection of information channels, and adequacy of retrieved for accomplishing a given task appeared to be reduced through successive search tasks, uncertainty increased through successive search tasks in other areas such as with regard

to the question of how to deal with too much information or information overload, and the feeling that the search output is not comprehensive.



Part A



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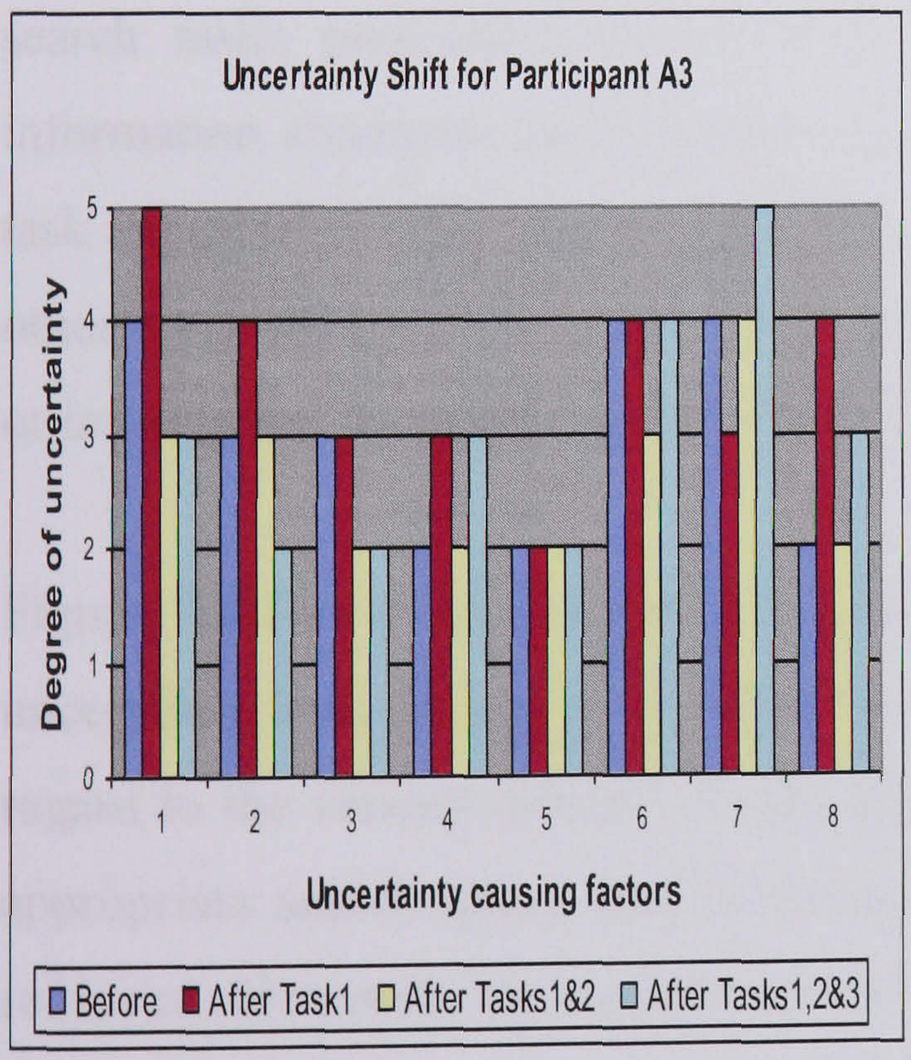
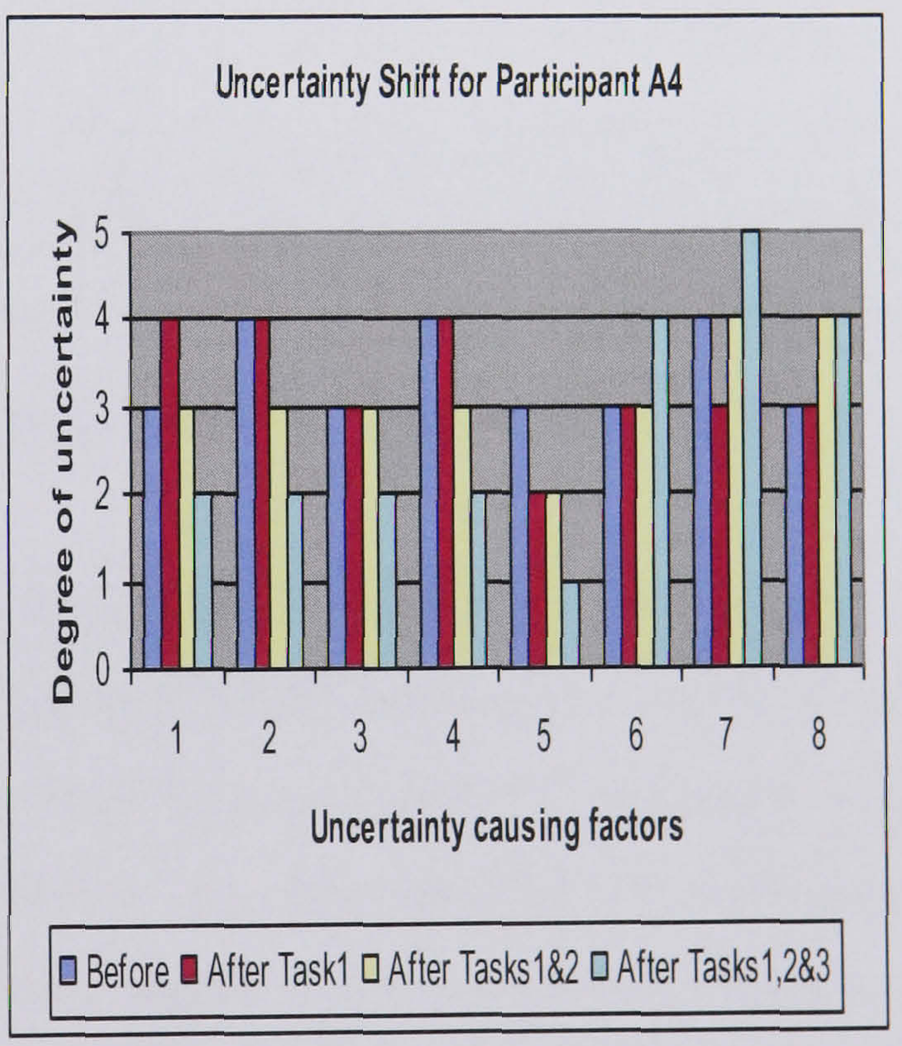


Part C



Part D

Figure 7.1: Uncertainty in relation to the search tasks indicated by academic staff

(in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

Figure 7.1 Part B shows that in general, A2 experienced uncertainty, though to a lesser extent, with almost all the points, more so with regard to selection of information channels, formulation of search queries, and comprehensiveness of the search output. With successive search tasks his uncertainty reduced in certain areas, such as with regard to the selection of information channels and formulation of an appropriate search query, whereas uncertainty increased with regard to the comprehensiveness of the search output and the information overload problem (how to deal with too much information).

In general, A3 appeared to have a high level of uncertainty associated with the selection of information channels, and also with information overload and comprehensiveness of the search output. A relatively lesser degree of uncertainty was also associated with other issues like too few information channels and sources retrieved on a given topic, formulation of a search query, not enough information retrieved to accomplish the task, etc.

Figure 7.1 Part C shows some kind of shift in uncertainty in the course of successive search tasks performed by A3: while uncertainty associated with the selection of information channels, and adequacy of retrieved information for accomplishing a given task appeared to have reduced through successive search tasks, uncertainty increased in other areas such as with regard to the question of how to deal with too much information or information overload, and the feeling that the search output is not comprehensive, etc.

Figure 7.1 Part D shows that in general, A4 experienced a moderate to high level of uncertainty with all the points. With successive search tasks his uncertainty reduced with regard to the various aspects of the selection of information channels, formulation of an appropriate search query, and decision about what to do when too little information is retrieved. However, his uncertainty increased with regard to the comprehensiveness of the search output and the information overload problem (how to deal with too much information), and also in relation to the feeling that the retrieved information is not enough to accomplish the given task.

7.2.3 Uncertainty in relation to Task and Topic Familiarity

For A1, the result shows that there were varying degrees of uncertainty even though the participant was very familiar with the tasks. For task three, the participant was also very familiar with the topic but the result shows a reasonable degree of uncertainty in certain cases especially for factors five, six, and seven (see Figure 7.1 Part A). However, although A1 had a little familiarity with topics one and two the result shows that the participant had less uncertainty with regard to factors five, six, and seven compared with task three. In some cases, the degree of uncertainty gradually decreased while in others the degree of uncertainty decreased for the first task but remained unchanged for the rest. Therefore, it is seen for academic staff A1 that the familiarity with the tasks and topics did not influence the degree of uncertainty in information seeking and retrieval.

For A2, the result shows that there were varying degrees of uncertainty even though the participant was familiar with the tasks. For tasks one and two, the participant was also very familiar with the topic but the result shows that there were differences in the degree of uncertainty. For A2 a little uncertainty remained all through the three tasks, and it remained unchanged: uncertainty reduced from high to little for factor four but uncertainty increased from little to average or average to high or very high for factors six, seven, and eight. So, there was no apparent link between the tasks and topic familiarity and the degree of uncertainty for A2.

The result shows that A3 was familiar with all three tasks and very familiar with topics one and two. A3 had a little familiarity with topic three. Although the academic staff A3 had high familiarity with the tasks one and two and had a very high familiarity with topics related to the tasks, the result shows the differences in the degree of uncertainty and in some cases the degree is high, such as for factors one, two, six, seven and eight. In most cases, A3 had an average degree of uncertainty. So, task and topic familiarity did not have any apparent link with the degree of uncertainty for A3.

The result shows that A4 was very familiar with task one but had a little familiarity with tasks two and three. A4 had a very little familiarity with topic three but no familiarity

with topics one and two. Interestingly the result shows that although A4 had a very high degree of familiarity with task one, in all cases except for factor five A4 had an average or high degree of uncertainty. The same is also true that A4 did have a little familiarity with task two but the degree of uncertainty varied between average and high. Therefore, it can be said that familiarity with the task and/or topic did not influence the degree of uncertainty.

7.2.4 Impact of Uncertainty

After completing the first search task A1 commented that uncertainty related to the selection of information channels suggested that he should be more specific next time and perhaps begin with the information channels suggested in the subject guide of the university library website. A1 also commented that uncertainty related to the comprehensiveness of the search output led to the belief that next time for this type of search he should choose search terms more carefully, perhaps through an appropriate vocabulary control tool. After completing the second task A1 mentioned that he became more aware of the information channels and sources to look for, and therefore uncertainty in that area in fact reduced quite a bit. However, some form of uncertainty remained as before with certain issues, such as the formulation of an appropriate search query, and uncertainty with certain issues increased, especially with regard to the feeling that the search output might not be comprehensive. After completion of the third task, A1 mentioned that a lot of information was obtained but still there was a feeling that the search was not comprehensive.

After completing the first task A2 commented that the uncertainties experienced in the course of the first search task suggested that he should think more about the search strategy and perhaps should base it more on the services available through the university library website. When requested to expand on the points related to the positive impact of uncertainty A2 mentioned that, although the uncertainties felt during the first search task were annoying, they helped him to become more careful in formulating a search strategy during the second task. This, in the opinion of A2, was clearly a positive outcome of

uncertainty. After completion of the second task A2 commented that after the two successive searches it was easier to zoom in on the more appropriate information channels and sources but he still needed more time to skim through the retrieved items, of which there were very many. Based on the experience of three successive searches, A2 mentioned that had there been a tool to capture his searches, he could use the strategy next time because a lot of time and effort was spent in the course of these search tasks to pinpoint the most appropriate information channels and sources vis-à-vis the appropriate search queries, and so on.

After completing the first search task A3 made a comment that choice of information channels and formulation of an appropriate query created more uncertainty but it gave an insight into the importance of preparedness with regard to the formulation of a search strategy and allocation of time and resources to accomplish the search task, which in his opinion was the problem for the first task. After completion of the second task, and based on the experience of two successive searches, A3 commented that the first task's experience helped him focus on some specific information channels and sources, but there was still some uncertainty in relation to whether the search was appropriate and whether the information obtained was adequate to accomplish the task. At the end of the third task, A3 mentioned that he was new to the given search topic and hence there was some uncertainty with regard to the choice of information channels and formulation of appropriate search query. When asked to elaborate on the search experience, and make suggestions, if any, A3 mentioned that provision of a bank of previously run successful queries would help reduce uncertainty especially in new topics.

After completing the first task A4 commented that the topic was not familiar to him, and hence despite his experience, he had a high degree of uncertainty with regard to the choice of information channels and formulation of a search query, but had some degree of uncertainty with all the other issues. However, these uncertainties helped him become more prepared in terms of search strategies. After completion of the third task, and based on the overall experience of the three search tasks, A4 commented that since there were so many possible routes (channels) to find information relevant to the given tasks, he was

always uncertain about the comprehensiveness of the search and the output, and even experience gained through successive searches was not enough to reduce such uncertainty.

7.2.5 Summary of the Findings

Although changes have been noted in the degree of uncertainty felt by the academic staff before and after the search sessions, there were no general patterns. Not surprisingly, there was a general consensus among the participants that while there was a significant degree of uncertainty at the beginning with regard to such issues as selection of information channels, formulation of a suitable search query etc., in most cases it reduced through successive searches. However, all the participants were aware of the fact that the information required for accomplishing a given task could be available from a wide variety of information channels and sources, and hence they always had some degree of uncertainty with regard to the comprehensiveness of the search output and information overload.

In general, comments from the academic staff revealed that there had always been a reasonable amount of uncertainty with regard to the feeling that the search output might not be comprehensive and how to deal with too much retrieved information, and such uncertainty either remained the same or increased through successive search tasks. Thus, overall it was revealed that uncertainty did not disappear altogether; while in certain areas it was reduced through successive searches, it also increased in some areas (Figure 7.1).

In general, the results show that in some cases, such as, factors six and seven (how to deal with too much information, and the search output is not comprehensive), the degree of uncertainty among academic staff through successive searches did not decrease. The degree of uncertainty for factor eight, that the information obtained is not enough to accomplish a specific task, also increased among all except one academic. Academic staff had an average or lesser degree of uncertainty for factor five, unsure about what to do if none or too little information is obtained. Therefore, it is seen that familiarity with

the tasks and/or topics did not have a direct bearing on the degree of uncertainty of academic staff in information seeking and retrieval processes.

All the participants from the academic staff category gave a high score with regard to the accidental discovery of information in the course of the search sessions (Figure 7.2). In the course of further post-search conversations with each participant, it was revealed that there was a general agreement that although they usually felt some form of uncertainty in information seeking and retrieval in the digital environment, they always found some useful information accidentally. There was also a general feeling that they would prefer to have a mechanism, provided by information systems, for saving such unintended discovery of useful information for future reference.

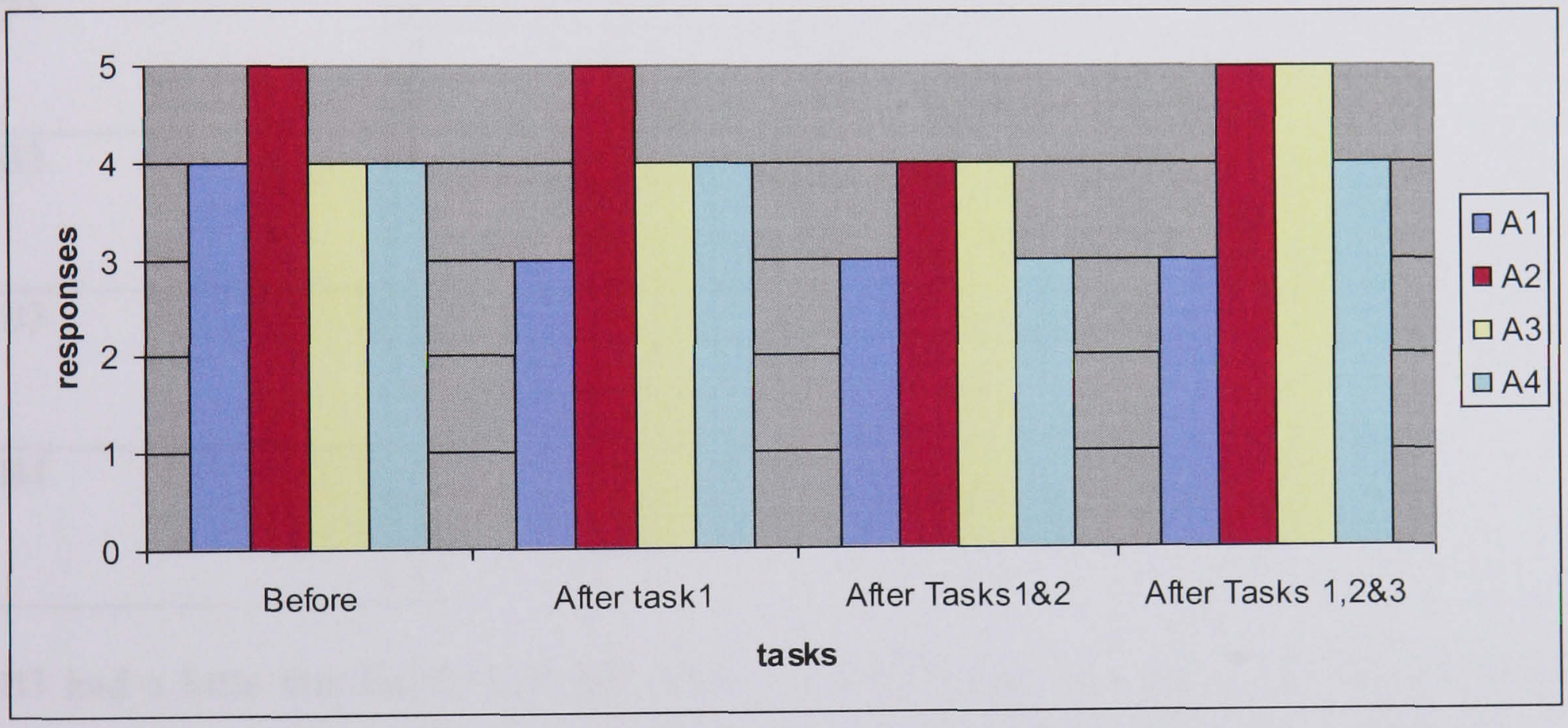


Figure 7.2: Scores of academic staff with regard to accidental discovery of information (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

7.3 Findings from the Participants in the Research Staff Category

Data gathered from the four participants in the research staff category are presented below along with analyses.

7.3.1 Profile of Participants

B1 had an average degree of familiarity with the types of tasks assigned for this experiment. He also had an average degree of familiarity with topic one, but had little familiarity with topics two and three (Table 7.2).

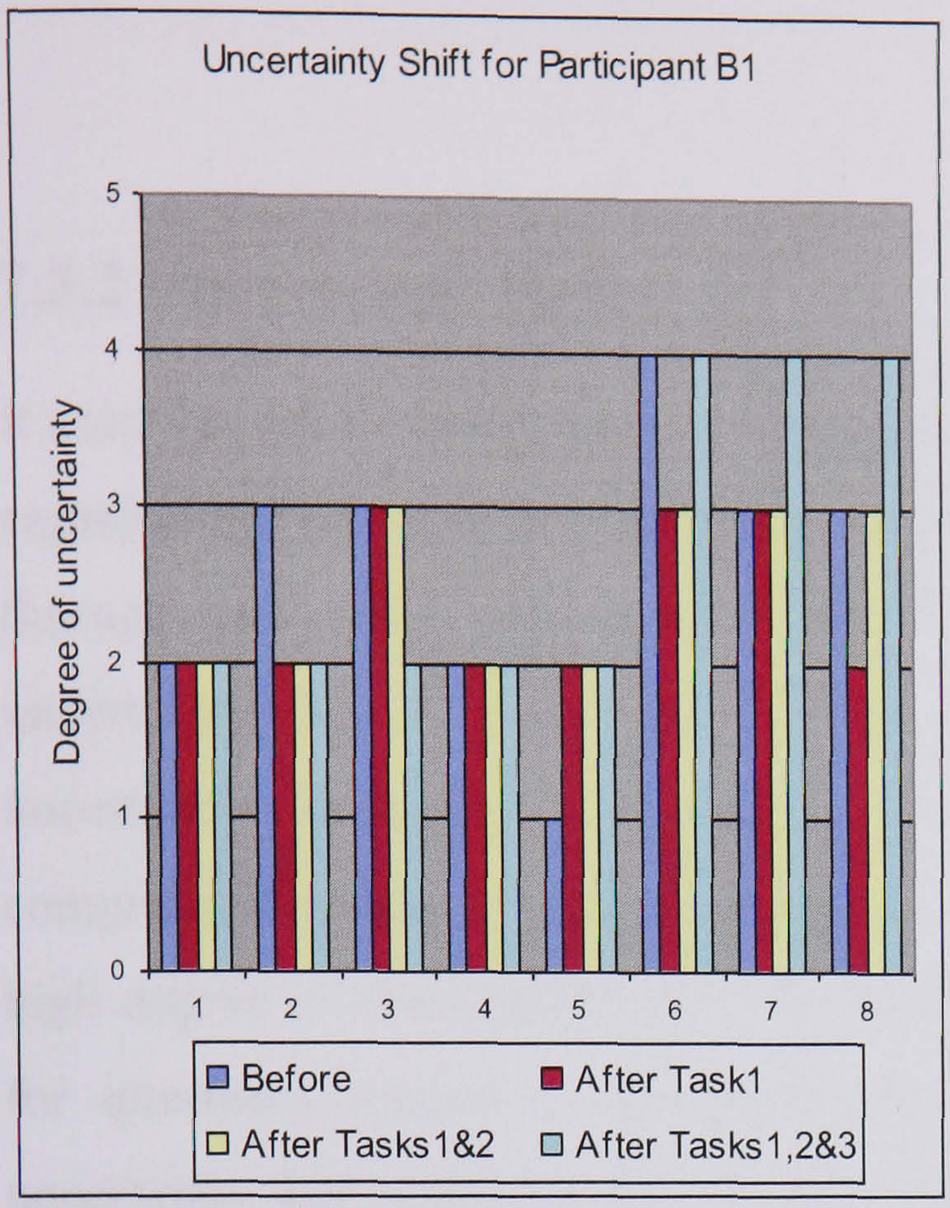
B2 had a little familiarity with the types of tasks assigned for this experiment, and had little familiarity with the search topics (Table 7.2).

Table 7.2: Task and topic familiarity of research staff (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

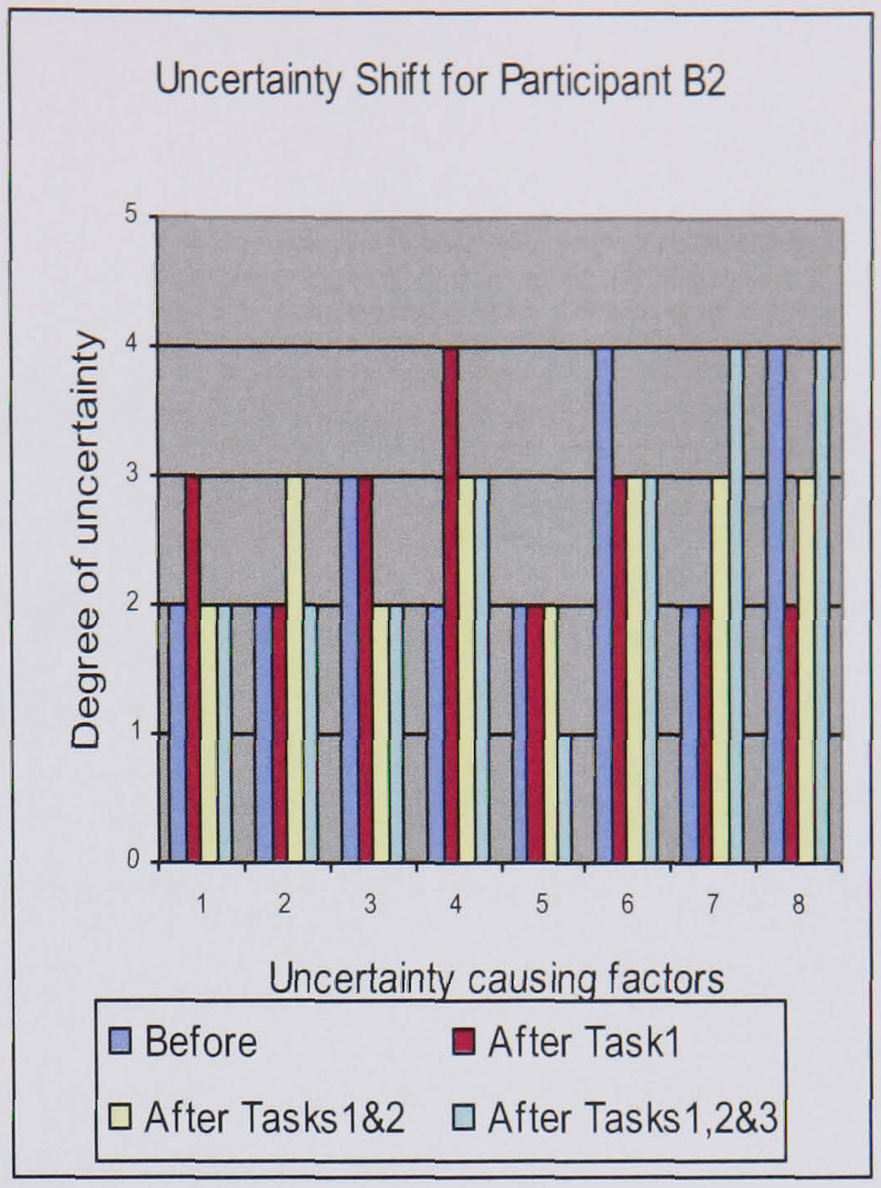
Participants	Tasks	Task familiarity	Topic familiarity
B1	1	3	3
	2	3	2
	3	3	2
B2	1	2	2
	2	2	2
	3	2	2
B3	1	2	4
	2	2	4
	3	2	2
B4	1	4	4
	2	4	4
	3	2	3

B3 had a little familiarity with the types of tasks assigned for this experiment, but was familiar with topics one and two, and had little familiarity with topic three (Table 7.2).

B4 was familiar with the first two tasks, but little familiar with the third one. He was familiar with the first two topics but had an average degree of familiarity with the third one (Table 7.2).



Part A



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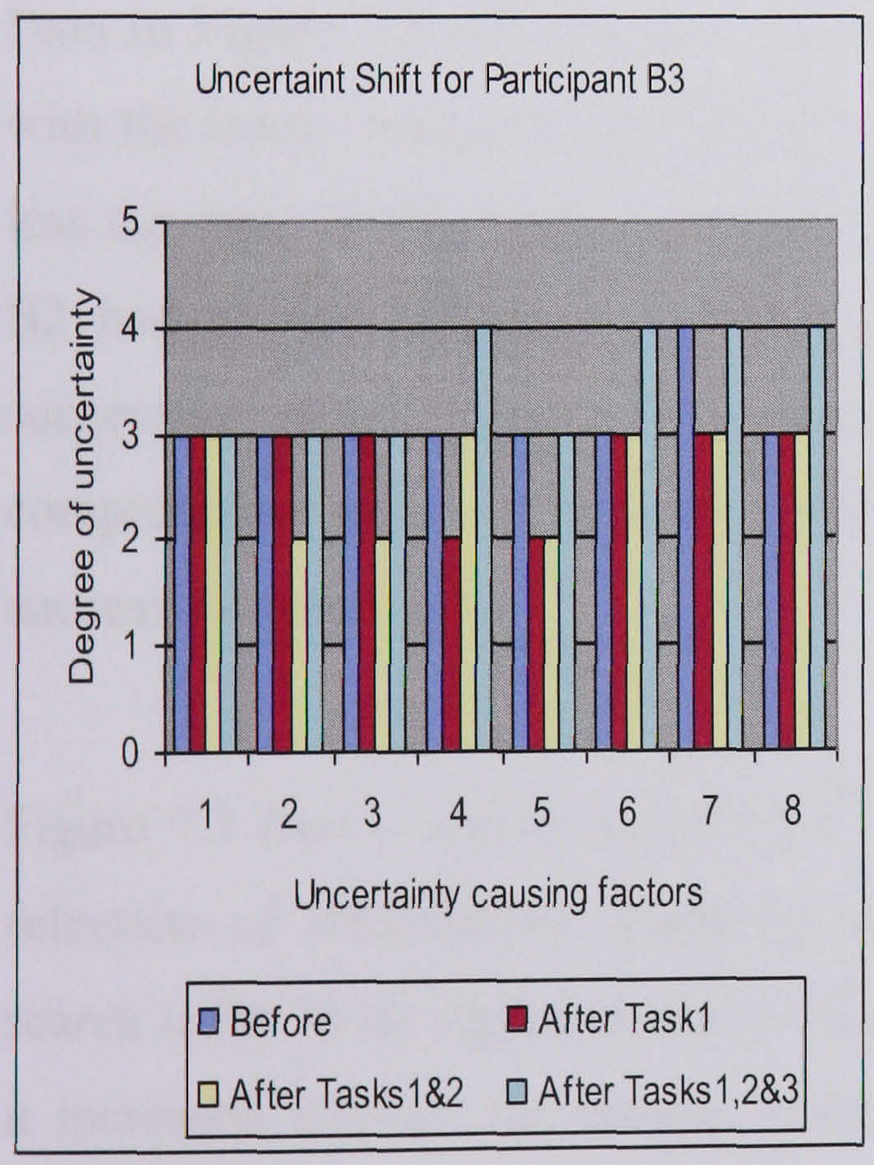
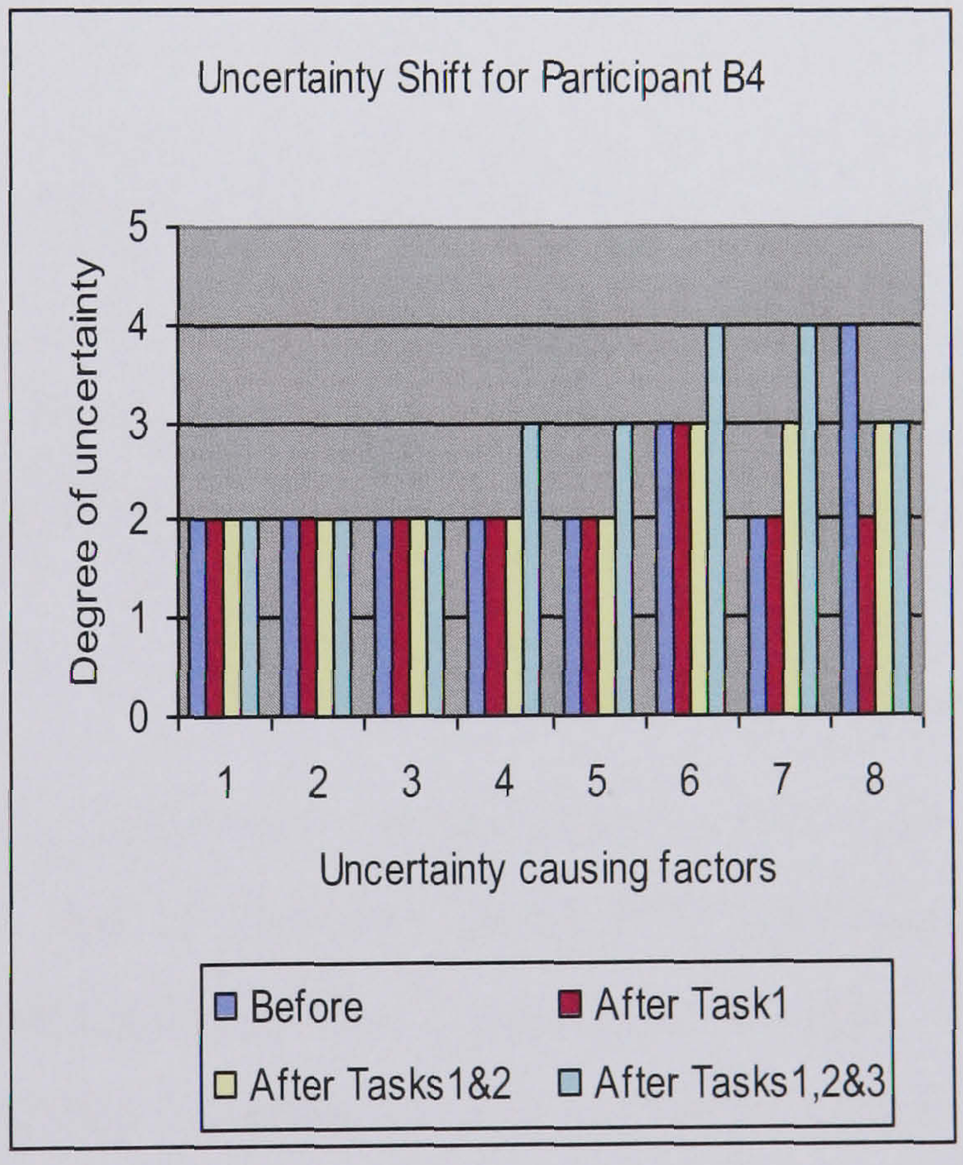


Part C



Part D

Figure 7.3: Uncertainty in relation to the search tasks indicated by research staff (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

7.3.2 Uncertainty Shift

It may be noted from Figure 7.3 Part A that B1 had average to little uncertainty with regard to the selection of information channels, etc., and it remained more or less constant through successive search tasks. With regard to query formulation B1 had little uncertainty but it remained constant through the various search tasks. However, uncertainty increased with regard to certain issues like information overload and comprehensiveness of search output. For information overload B1 faced an average to high degree of uncertainty and it increased in the course of successive search tasks, and for questions related to comprehensiveness B1 had an average to high degree of uncertainty that increased in the course of successive search tasks.

Data in Figure 7.3 Part B shows that B2 had an average to little uncertainty associated with the issues related to the selection of information channels, but it remained more or less the same in the course of successive search tasks. With regard to query formulation B2 had a high degree of uncertainty and it was reduced slightly in the course of successive search tasks. With regard to such issues as information overload and comprehensiveness of the search, B2 had little uncertainty but it increased through successive searches.

Figure 7.3 Part C shows that B3 had an average level of uncertainty with regard to the selection of information channels, etc., and it remained constant through successive search tasks. With regard to query formulation B3 had little uncertainty to begin with but it increased through the various search tasks. Uncertainty with regard to certain issues like information overload and comprehensiveness of search output also increased; in both cases uncertainty increased from an average to a high level.

Data in Figure 7.3 Part D shows that B4 had little uncertainty associated with the issues related to the selection of information channels, but it remained at the same level in the course of successive search tasks. This was also the case with regard to formulation of a search query, although it increased a bit with the third task. However, B4 had an increasing level of uncertainty with regard to such issues as information overload and comprehensiveness of the search.

7.3.3 Uncertainty in relation to Task and Topic Familiarity

For B1, the result shows that although the participant had an average degree of familiarity with the tasks and topic one and had little familiarity with topics two and three, the degree of uncertainty remained the same for factors one, two, four and five. The result also shows that the degree of uncertainty remained the same or even increased through the successive searches for factors six, seven and eight. Therefore, it can be said that there were no apparent links between task and topic familiarity and uncertainty.

For B2, the result shows that the participant had little familiarity with the tasks and topics but experienced varying degrees of uncertainty. Interestingly, the degree of uncertainty in some cases, such as, in factors seven and eight increased through successive searches. Only for factor six did the degree of uncertainty remain the same in all three tasks.

The result shows that although participant B3 had a little familiarity with the tasks and with topic three but had a familiarity with topics one and two, the degree of uncertainty remained the same for factor one in all three tasks. It is noticed that for factors six, seven and eight the degree of uncertainty increased and remained between average to high. Interestingly, the degree of uncertainty increased in the successive searches for the factor – 'unsure about how to formulate a suitable search query'. It can be said that familiarity with the topic and/or task did not have any apparent relationship with the degree of uncertainty. It is also noticed that the degree of uncertainty increased in related topics in the successive searches.

The result shows that participant B4 had familiarity with the tasks and topics one and two. The participant had average familiarity with topic three but a little familiarity with the task. Despite this, in some cases such as for factors one, two and three, the degree of uncertainty remained the same and for factors, six, seven and eight (unsure about how to deal with too much information, the search output is not comprehensive, and the information obtained is not enough to accomplish a specific task) the degree of uncertainty increased. There were no apparent links between task and/or topic familiarity and uncertainty.

7.3.4 Impact of Uncertainty

B1 made almost similar comments after completing every search task which were related to time constraints. He reiterated that in order to conduct a successful search one should be prepared to spend a lot of time, although proper planning may help to save time. Through further conversations it was revealed that in the course of his day-to-day activities he normally focused on a small selected set of information channels and sources, and that was why there was less uncertainty associated with this issue. With regard to the formulation of search queries he normally used simple queries, and hence uncertainty in that area was limited. Nevertheless, he always had a feeling that the search might not have been comprehensive and the retrieved results might not be adequate for the given task and therefore there was always a high degree of uncertainty. He suggested that for a new search topic one may first try to find a representative review paper which not only lists authoritative information sources, but also points out relevant research groups and experts in the field.

In the course of conversations B2 mentioned that she preferred to use a selected number of information channels and sources, most commonly the ACM Portal, and hence she did not have much uncertainty with regard to the selection of information channels. However, with this comfort there was a feeling that the search might not have been comprehensive (because there would be many more information channels providing information on the given topic) and that this uncertainty increased through searches on less familiar topics.

In the course of conversations B3 indicated that there was always some form of uncertainty associated with the information seeking and retrieval process, and commented that more help for inexperienced researchers should be available. She often discovered some useful information which she had not searched for, and while finding such information provided new knowledge, and sometimes a different direction, it would take a lot of her time. Thus, B3 experienced a mix of positive and negative impact of uncertainty in information seeking and retrieval.

In the course of conversations B4 mentioned that he felt less uncertain with regard to the selection of information channels and formulation of queries because over the years he has been using a small set of information channels and sources. However, he was not sure whether those channels and sources or the relatively simple queries would always produce a comprehensive and adequate set of results; this explains the increased level of uncertainty. He commented that information overload has been an increasing problem and more subject-specific help should be developed, either by the information service providers or by research groups within specific subject fields.

7.3.5 Summary of the Findings

In general, the results show there were some changes in the degree of uncertainty felt by the research staff before and after the search sessions although no uniform patterns were observed. However, the degree of uncertainty remained the same or increased through successive searches for some factors i.e., unsure about how to deal with too much information, the search output is not comprehensive, and the information obtained is not enough to accomplish a specific task. The results also show that the degree of uncertainty remained the same if the participants had different degree of familiarity with the topics and the tasks.

In general it was noted that all the participants from the research staff category had little to average levels of uncertainty with regard to the selection of information channels and formulation and reformulation of queries, the latter being the case when too few or too many items were retrieved (Figure 7.3). When asked for a possible explanation it was revealed that research staff usually focused on a very specific set of information channels and sources, for example the ACM Portal and a few selected journals and conferences therein. Consequently they had relatively less uncertainty with regard to the selection of information channels, although it remained unchanged, and never disappeared, in the course of a series of search tasks. However, it was also noted that all the participants had average to high levels of uncertainty with regard to such issues as the comprehensiveness and adequacy of the search results with regard to the specific tasks. As an explanation, they all stated that since they always had limited time, they chose to use a small number of information channels and sources, but in doing so they always had a feeling of uncertainty that they were missing out some important information and/or the retrieved information was not adequate for their task in hand. In general, it was noted that there were no obvious links between task and/or topic familiarity and uncertainty in information seeking and retrieval.

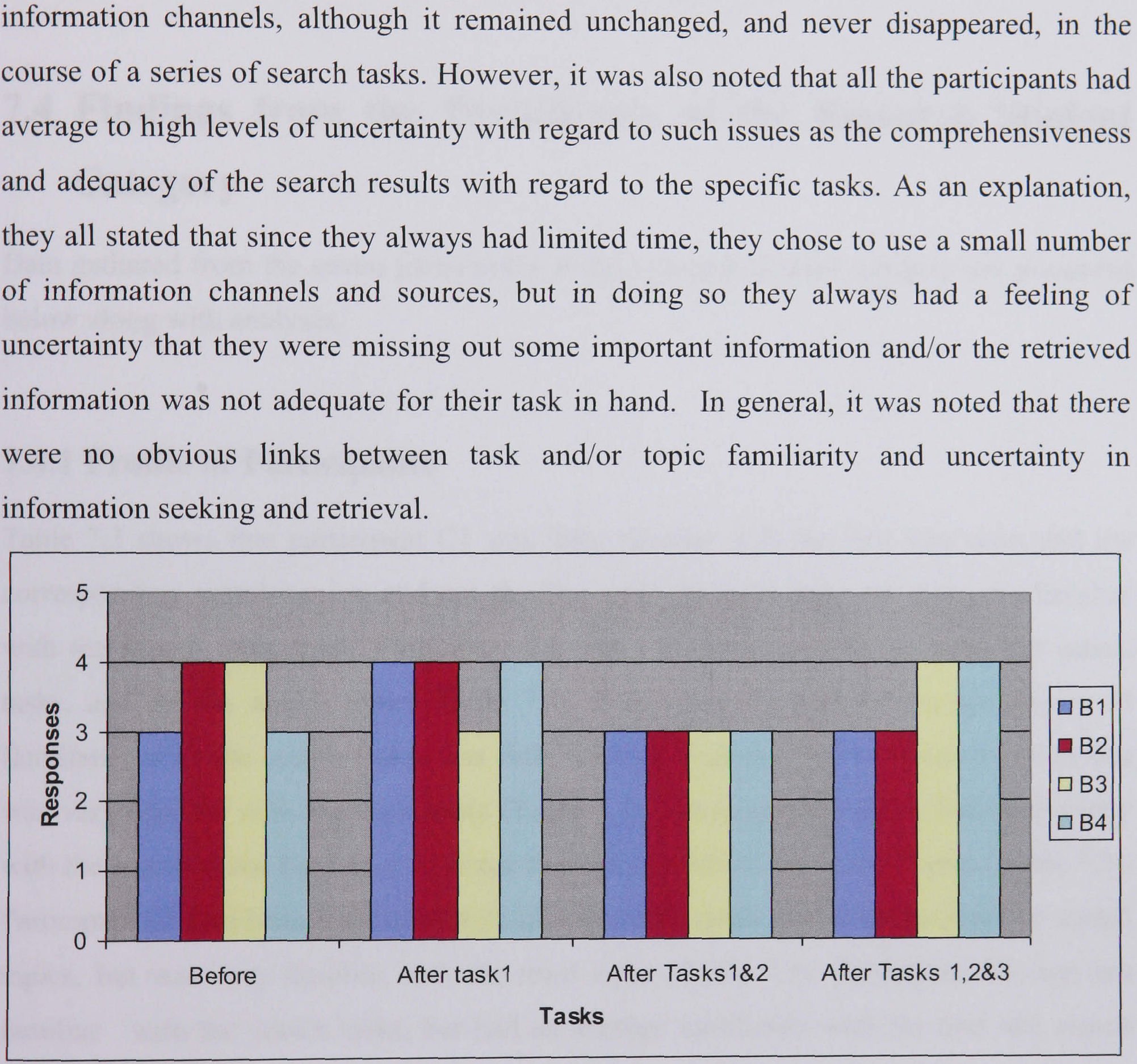


Figure 7.4: Scores of research staff with regard to accidental discovery of information (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

Figure 7.4 shows that with regard to the question of whether they felt that useful information was discovered accidentally in the course of the search tasks, all the participants from the research staff category indicated that they felt this at an average to high level. This is despite the fact that all of them had a reasonable degree of uncertainty with regard to the comprehensiveness of the search output. This indicates that despite the negative impact of uncertainty they all felt some form of reward from accidental discovery of some useful information which was not searched for intentionally.

7.4 Findings from the Participants of the Research Student Category

Data gathered from the seven participants in the research student category are presented below along with analyses.

7.4.1 Profile of Participants

Table 7.3 shows that participant C1 was little familiar with the first two tasks and the corresponding search topics, and not familiar with the third task, but was very familiar with the search topic three. Participant C2 was little familiar with all three the search tasks, and all the search topics Table 7.3). Participant C3 had an average degree of familiarity with the search tasks, was little familiar with the first two search topics, but was very familiar with the third topic (Table 7.3). Participant C4 had a little familiarity with the search tasks, but had an average familiarity with all the search topics (Table 7.3). Participant C5 had little familiarity with all the search tasks, and with the first two search topics, but was very familiar with the third topic (Table 7.3). Participant C6 was not familiar with the search tasks, but had an average familiarity with the first two search topics, and little familiar with the third topic (Table 7.3). Participant C7 was not familiar with the search tasks, but had an average familiarity with all the search topics (Table 7.3).

Table 7.3: Task and topic familiarity of research students (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

Participants	Tasks	Task familiarity	Topic familiarity
C1	1	2	2
	2	2	2
	3	1	5
C2	1	2	2
	2	2	2
	3	2	2
C3	1	3	2
	2	3	2
	3	3	5
C4	1	2	3
	2	2	3
	3	2	3
C5	1	2	2
	2	2	2
	3	2	5
C6	1	1	3
	2	1	3
	3	1	2
C7	1	1	3
	2	1	3
	3	1	3

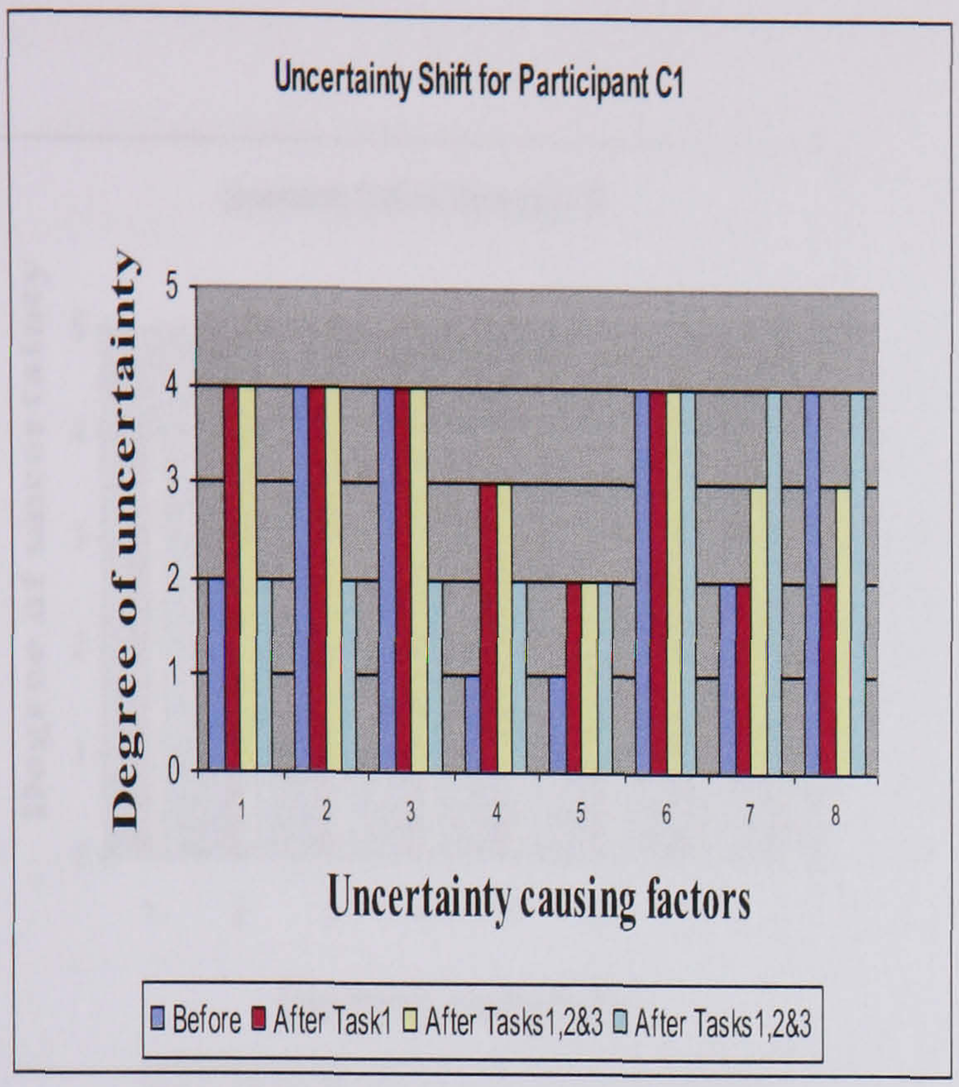
7.4.2 Uncertainty Shift

Figure 7.5 Part A shows that C1 had a high level of uncertainty with regard to the selection of information channels, and it remained constant for the first two tasks. However, it became much less after the third task, perhaps because the topic was well known to the participant, and/or may be due to the experience gained during the first two tasks. It was also noted that C1 had little uncertainty with issues like formulation of a search query, and had an average to high level of uncertainty with regard to the comprehensiveness of the search and adequacy of the results in respect of the given tasks, and this gradually increased through successive searches. When asked for a possible explanation, C1 commented that to begin with she was not aware of the vast amount of information sources available on each of the topics, and after the searches, she was not quite sure what to do with the huge volume of retrieved information. Consequently,

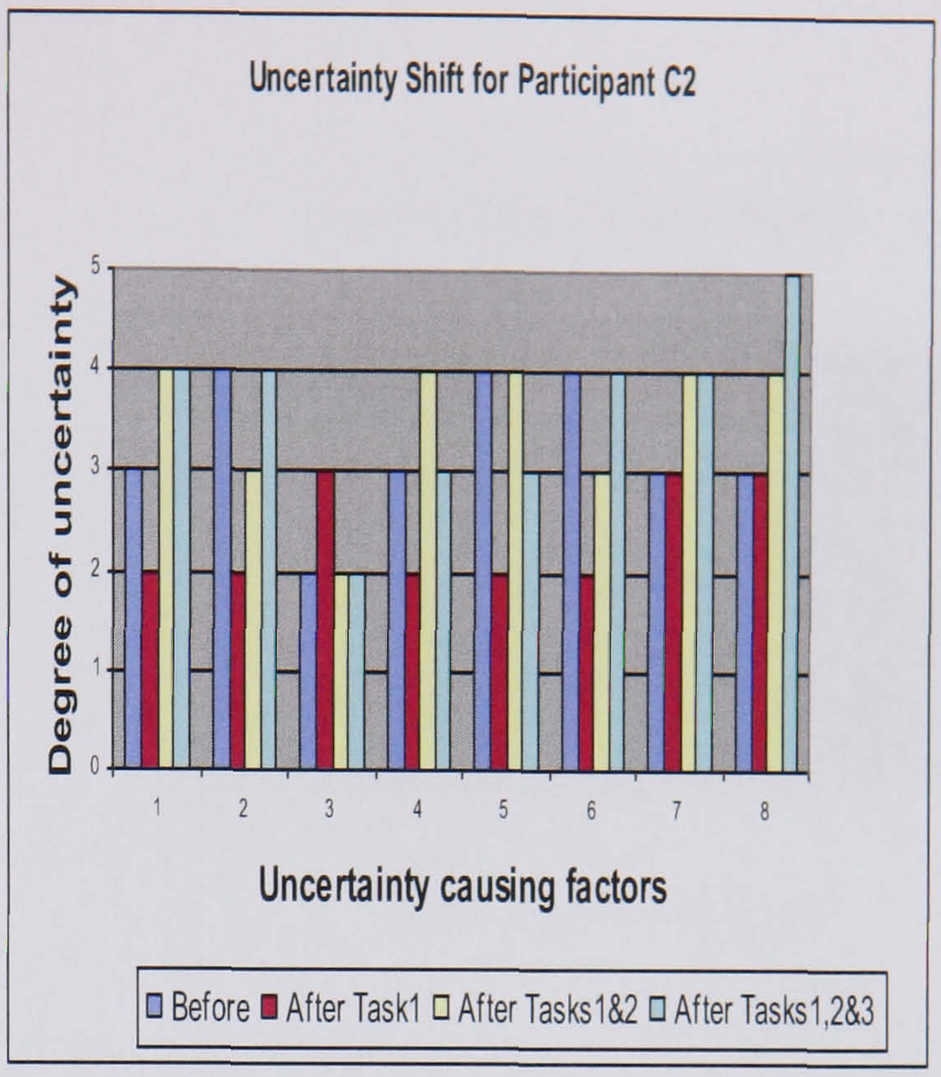
keeping in view the pressure of time, she decided to look at only a few selected information resources, but that led to uncertainty as to how comprehensive the search was, and whether the information was adequate for accomplishing the given tasks.

Figure 7.5 Part B shows that C2 had a average to high level of uncertainty in relation to all the points, and it increased through successive search tasks. When asked for an explanation, she mentioned that she was not familiar with the search topics and was not quite sure about where to start a search, which information channels to choose, and so on. Figure 7.5 Part C shows that C3 had a high level of uncertainty with regard to the choice of information channels. She had little uncertainty with query formulation and query modifications etc. (when too little information was retrieved). Similarly, she had little uncertainty with regard to the information overload problem; she explained that she was aware that there were too many information resources out there, and that was why she had adopted a general practice of using only the first few hits without worrying about the information overload problem. In other words, she had adopted a self-selected measure to avoid information overload. However, this resulted in her having worries about the comprehensiveness and adequacy of the retrieved information and this was reflected through the increase in the level of uncertainty in the course of successive searches.

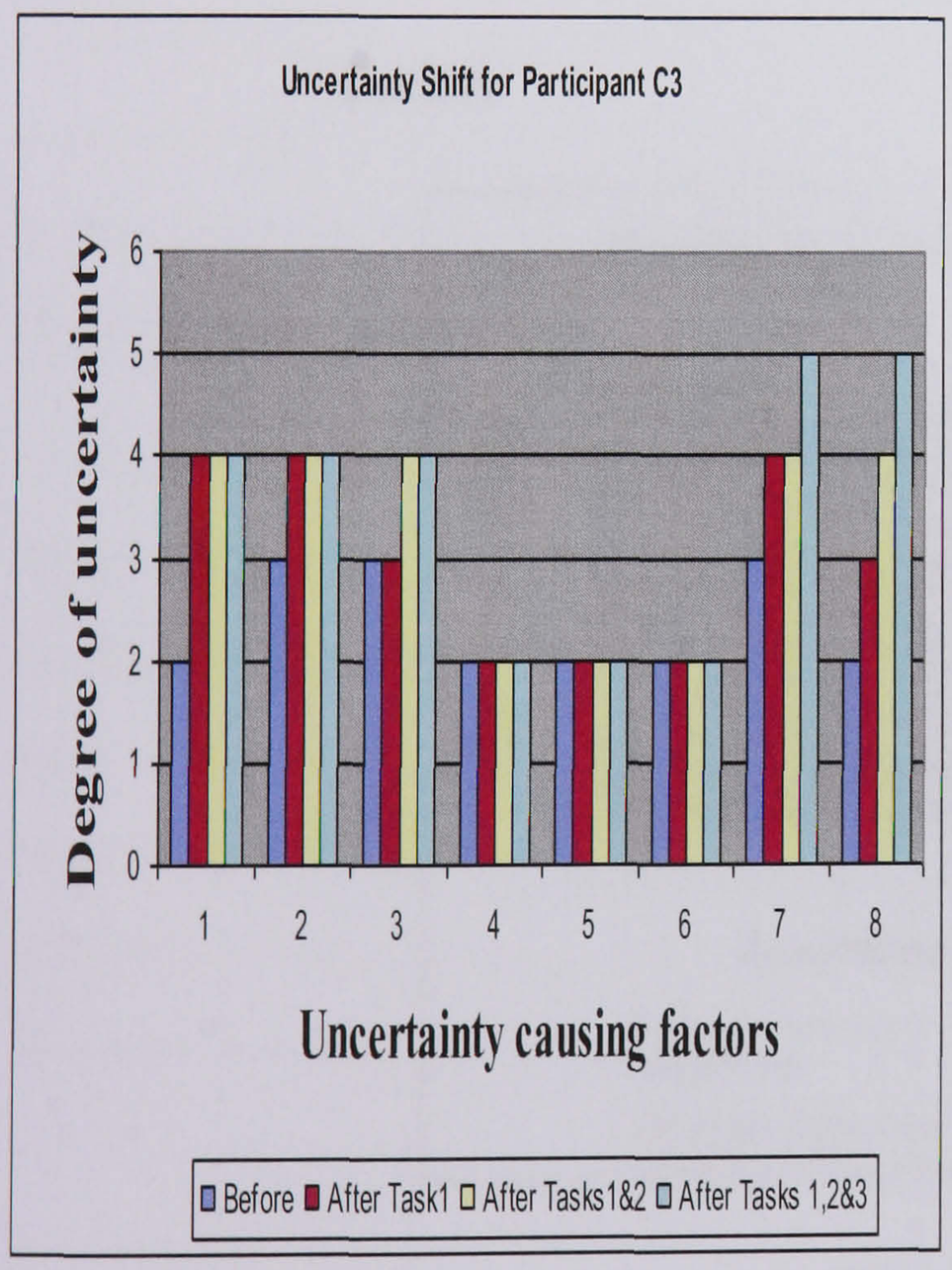
Figure 7.5 Part D shows that C4 had an average level of uncertainty with regard to the choice of information channels, and formulation of a query. However, it became slightly less in course of successive searches. When asked for a possible explanation, C4 mentioned that she was a bit unsure for the first task, but as she was experienced, and was familiar with the search topics, her level of uncertainty with regard to information channels and query formulation got reduced in the course of successive searches. However, it was also noted that she always had an average level of uncertainty with regard to the issue of information overload, though it remained unchanged in the course of successive search tasks. C4 also had an average level of uncertainty with regard to the comprehensiveness of the search and adequacy of the search results.



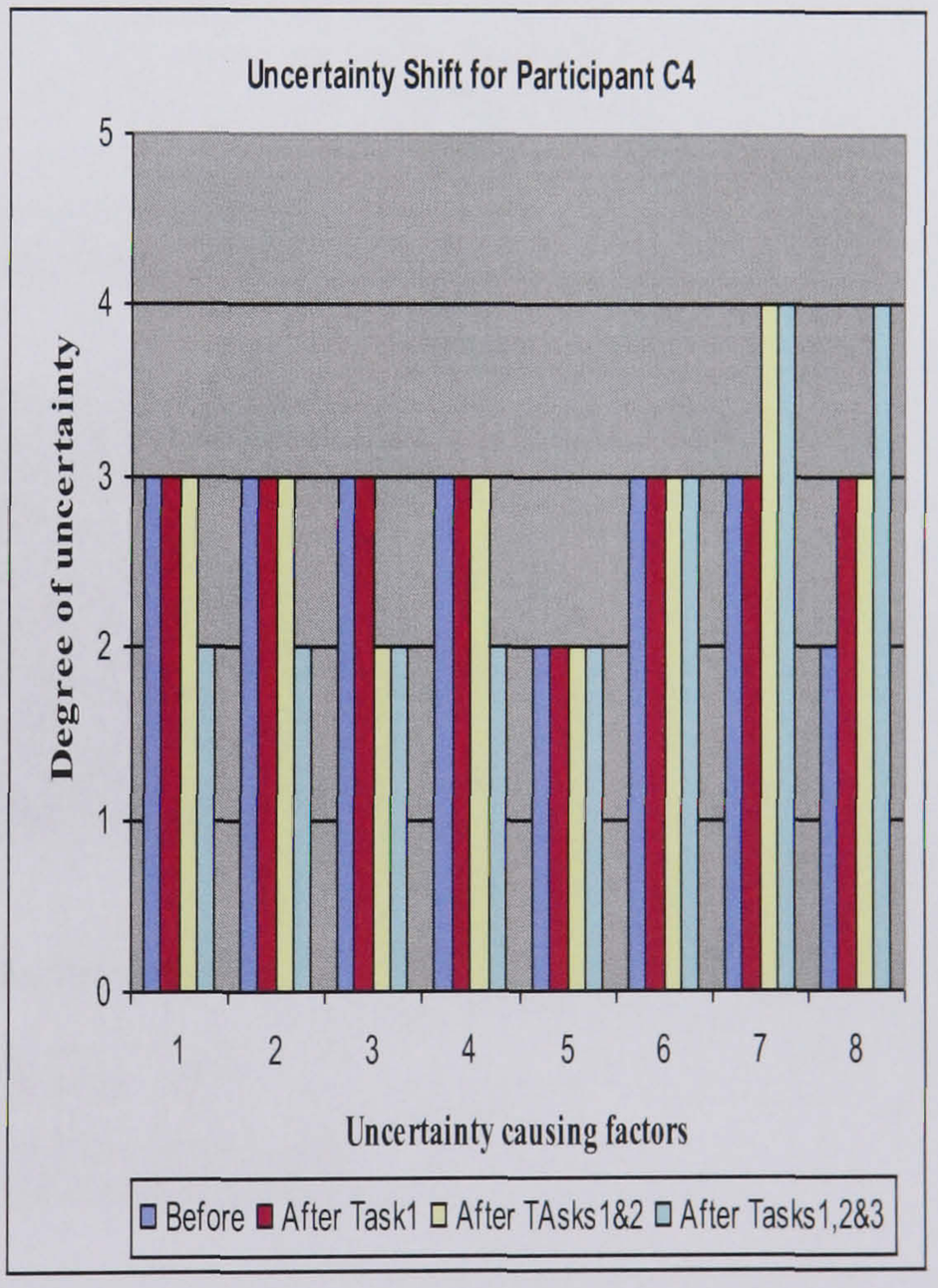
Part A



Part B

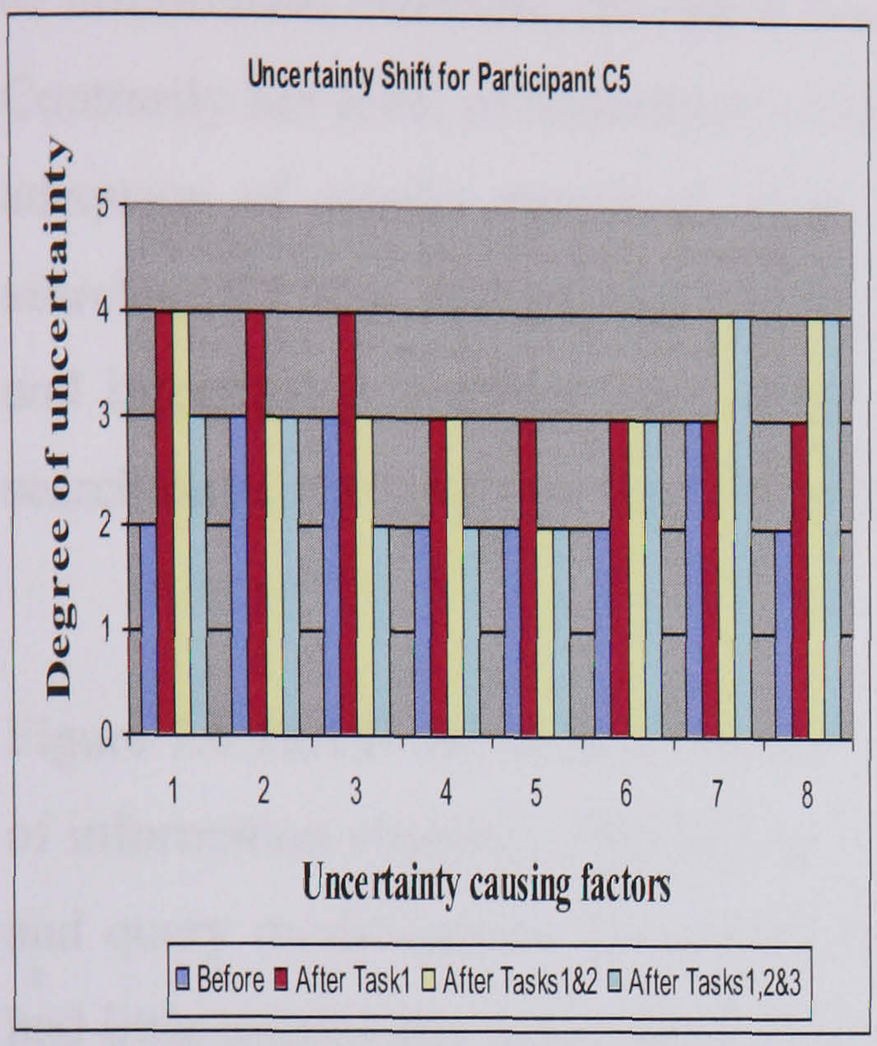


Part C

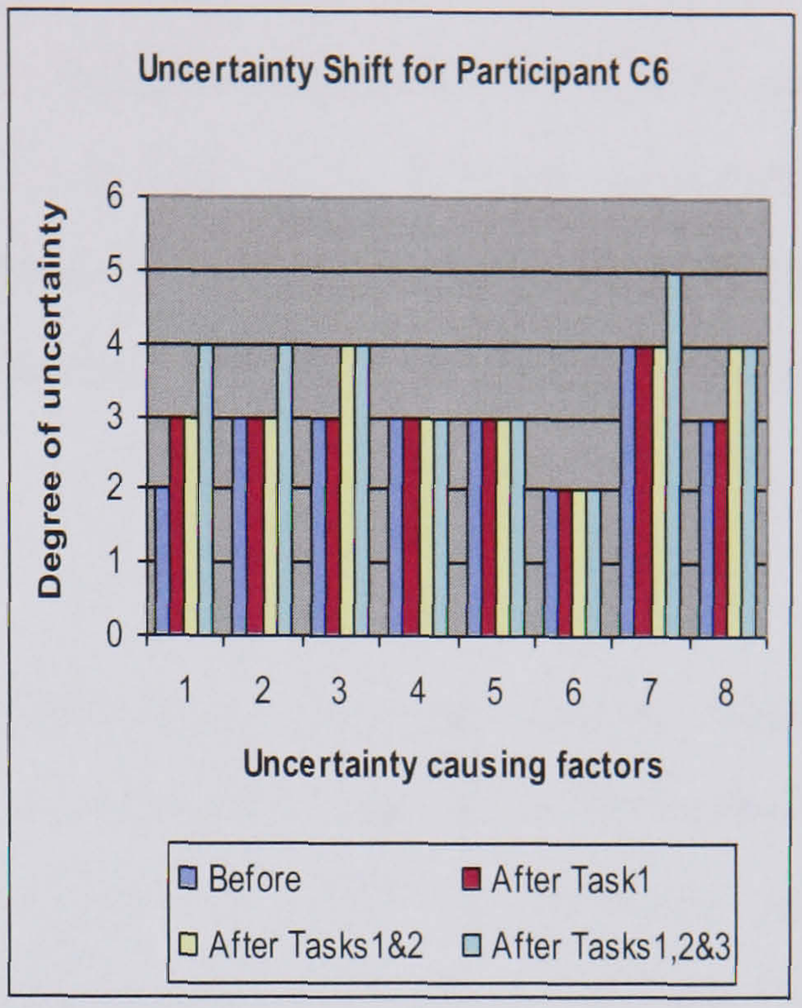


Part D

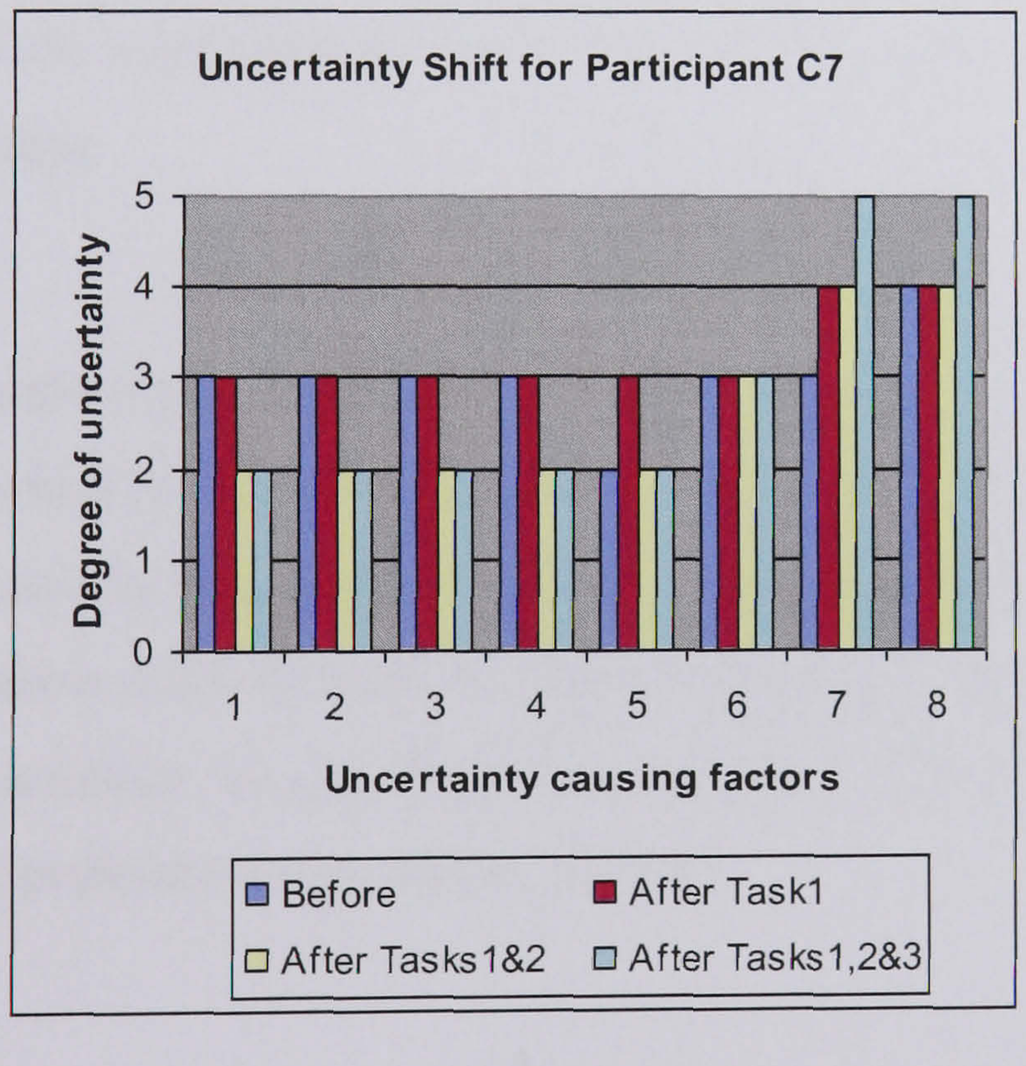
Figure 7.5: Uncertainty in relation to the search tasks indicated by research students C1 to C4 (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)



Part A



Part B



Part C

Figure 7.6: Uncertainty in relation to the search tasks indicated by research students C5 to C7 (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

Figure 7.6 Part A shows that C5 had a high level of uncertainty with regard to the choice of information channels, though it became less in the course of successive search tasks. Contrarily her level of uncertainty with regard to the comprehensiveness of research and adequacy of results increased from an average to a high level through successive searches. C5 also had an average level of uncertainty with regard to query formulation and information overload and, while the former became less after accomplishing two search tasks, the latter remained unchanged.

Figure 7.6 Part B shows that C6 had a high level of uncertainty with regard to the choice of information channels. She had an average level of uncertainty with query formulation and query modifications etc. (when too little information was retrieved). Similarly, she had little uncertainty with regard to the information overload problem; she explained that she had less uncertainty in this regard because she always chose to use only the first few search results. However, C6 had a reasonable amount of uncertainty with regard to the comprehensiveness of search, and also an average to high level of uncertainty with regard to the adequacy of the search results, and in both cases uncertainty increased in the course of successive searches.

Figure 7.6 part C shows that C7 had an average to little level of uncertainty with regard to the choice of information channels. Upon discussion it was revealed that he had been used to look for information only in a small selected set of information channels and sources, and thus there was relatively less uncertainty and it was reduced in the course of successive search sessions. He also had less uncertainty with regard to query formulation because he always preferred to use simple queries.

7.4.3 Uncertainty in relation to Task and Topic Familiarity

The result shows that the participant C1 had little familiarity with the tasks and topics one and two. The participant was very familiar with topic three but had no familiarity with task three. Although there was a varying degree of familiarity with the tasks and topics,

the degree of uncertainty remained the same for all three cases for factors five and six. For these factors the degree of uncertainty ranged between little to high. For factors seven and eight, the degree of uncertainty increased through successive searches.

The result shows that participant C2 had little familiarity with the three tasks and the topics. The degree of uncertainty increased for factors two, six and eight: the degree of uncertainty increased and then remained the same for factors one, and seven. It can be said that the degree of uncertainty varied even though the participant had the same amount of familiarity with the tasks and the topics.

The result shows that participant C3 had an average degree of familiarity with the tasks and had a very high familiarity with topic three. The participant had a little familiarity with topics one and two. Despite the fact that the participant had varying degrees of familiarity with the topics, the degree of uncertainty remained between average and high for factors one, two, three, seven and eight. In some cases, the degree of uncertainty remained little for factors four, five and six.

The result shows that participant C4 very little familiarity with the tasks and had an average familiarity with the topics. For the first four factors, the degree of uncertainty remained between little and average but it remained little for factor five. The degree of uncertainty remained between average and high for factors six, seven and eight.

The result shows that participant C5 had a little familiarity with all three tasks and with the first two topics but had a very high familiarity with topic three. The degree of uncertainty remained average for factor six. The degree of uncertainty stayed between average and high for factors one, two, six, seven and eight.

The result shows that participant C6 had no familiarity with any of the three tasks. The participant had an average degree of familiarity with topics one and two but had a little familiarity with topic three. The degree of uncertainty stayed between average and high except for factor six where the degree of uncertainty was little.

For C7, the result shows that the participant had no familiarity with the tasks but had an average degree of familiarity with the topics. The degree of uncertainty remained average for factor six and the degree of uncertainty remained between high and very high for factors seven and eight.

7.4.4 Impact of Uncertainty

In the course of conversations it was revealed that the single most common cause of uncertainty for C1 was information overload: the participant was not sure what to do with too much retrieved information. Nevertheless, C1 also mentioned that in the course of the search sessions, she discovered some useful information that was not intentionally searched for, and she had made note of that information for reference.

Participant C2 mentioned that she was always concerned with time constraints and hence was not sure how to deal with the vast amount of information retrieved, and what specific criteria to use to choose the best ones from amongst many retrieved sources. Eventually when she decided to use only the first few of the retrieved sources, she became suspicious that those may not be comprehensive and adequate for the task, and all such forms of uncertainty gradually increased in the course of successive search tasks. C2 further commented that some help should have been there to assist the searcher in choosing the best possible information channels, and also some examples of successful queries with reference to each specific information channels would be useful. C2 also mentioned the positive impact of uncertainty which was that in course of the successive searches she became more aware of the importance of an appropriate search strategy which helped her formulate queries easily and thus there was a decrease in uncertainty through successive searches.

Through discussions participant C3 revealed that retrieval of information produced by a well-known author or researcher in the field was considered by her as a measure of

relevance and success. She also suggested that it would be helpful if there was a list of the most recognised researchers in the field searching for whose works could then be the first step to retrieve the most relevant items. C3 also mentioned that a one-stop search facility allowing the user to conduct a multi-channel and multiple database search with a ranked output would be most helpful.

Participant C4 mentioned that although she could easily retrieve a lot of information, given the pressure of time, she was always forced to look at only a small subset of the retrieved results which increased her uncertainty because the search and the results might not have been comprehensive and/or adequate for accomplishing the task.

Participant C5 indicated that choosing the right information channel and formulating the right query was a challenge to begin with, thus resulting in high uncertainty, but it became easier through successive search tasks. Nevertheless, information overload was a recognised problem, and she had to choose only a certain number of search results which resulted in increasing uncertainty with regard to comprehensiveness of search and adequacy of information.

Upon discussions, C6 suggested that uncertainty with regard to information channels, comprehensiveness of search, etc., may be reduced if a list of appropriate information channels and sources, vis-à-vis names of experts in the topic was maintained within the research group, which could be viewed online while conducting a search.

C7 always had an average level of uncertainty with regard to information overload, and this was explained by the fact that he always used simple queries which resulted in a large set of hits. Figure 7.6 part C also shows that C7 had a high level of uncertainty with regard to the comprehensiveness of the search and adequacy of search results, and it increased across successive search sessions.

7.4.5 Summary of the Findings

Some changes in the degree of uncertainty felt by the research students were noted, but it varied from one participant to another, and there were no general patterns. In general, in some cases the degree of uncertainty remained the same despite the fact that the research students had varying degrees of familiarity with the topics and the tasks. It is also seen that the degrees of uncertainty were high in some factors even though familiarity with the topics and the tasks remained the same. Overall, no uniform patterns could be noticed between the research students' task and/or topic familiarity and uncertainty in information seeking retrieval.

Different pictures emerged from the data gathered through the qualitative analyses of search tasks among the selected research students. It was noted that most of the research students had a significant amount of uncertainty associated with the selection of information channels, etc., and often it increased in the course of successive searches. However, for some students such uncertainty was relatively less and did not increase in the course of successive searches, but through discussion it was found that those students were used to look for information in a small set of pre-selected information channels and sources, and that was the reason for less uncertainty. Most importantly it was noted that uncertainty associated with any particular issue did not disappear altogether, and although it became less in some cases, in most cases, especially with regard to the issues of comprehensiveness and adequacy of search, it increased in the course of successive searches. Discussions with the students also revealed that the change or shift of uncertainty from one point to another took place due to the search behaviour of the students, e.g. some students were used to choosing only a small set of information channels and sources every time irrespective of the search topics.

With regard to the positive impact of uncertainty associated with information seeking and retrieval research students mentioned that the most obvious positive outcome was that they discovered useful information in the course of the search sessions that was not searched for intentionally. As may be noted from Figure 7.7, most of the participants

rated this in the range of average to high. With regard to the other positive impacts, several points were mentioned, such as that after every search sessions they were more aware of time constraints and this forced them to be more focused on a search strategy and to use clues such as the names of experts in the field in combination with the search terms which helped them retrieve more appropriate results.

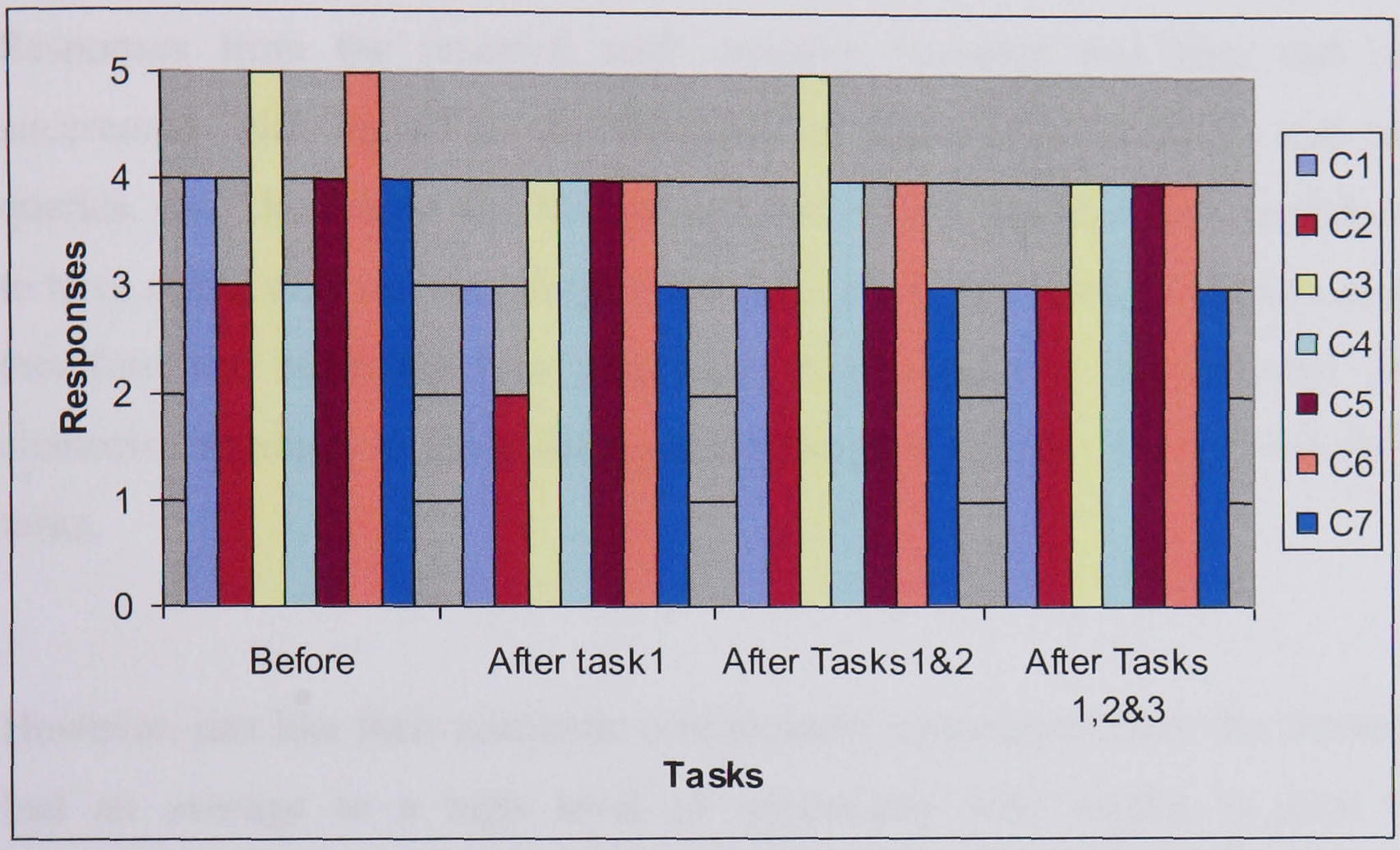


Figure 7.7: Scores of research students' with regard to accidental discovery of information (in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high)

7.5 Summary

In general, the findings of this phase of study show that some form of uncertainty in relation to certain specific issues in the context of information seeking and retrieval was always present, and that it never disappeared. However, some form of shift in uncertainty has been noted in the course of successive searches. Through the three search tasks given to the three categories of users, it was noted that uncertainty increased through successive searches in some areas, while it decreased in others; though in some cases such uncertainty remained unchanged in course of the searches. While there was a significant degree of uncertainty among the participants from the academic staff category at the

beginning with regard to such issues as selection of information channels, formulation of a suitable search query etc., it became less through successive searches. At the same time uncertainty with regard to the comprehensiveness of the search output and information overload gradually increased through successive searches.

Responses from the research staff category revealed that they had relatively less uncertainty with regard to the selection of information channels and formulation of queries, etc. The reason for this reduced uncertainty was that the research staff appeared to have relied only on a small (pre-defined) set of information channels and sources, and therefore had relatively less uncertainty with regard to the selection of information channels, although it never disappeared altogether in the course of a series of search tasks.

However, just like their academic counterparts, participants from the research staff group had an average to a high level of uncertainty with regard to such issues as the comprehensiveness and adequacy of the search results. It was further revealed that they were always pressed with limited time and they chose to use a limited number of information channels and sources, but they always had a feeling of uncertainty that they were missing out some important information and/or the retrieved information was not adequate for their task in hand.

For most of the research students an average to high level of uncertainty was associated with the selection of information channels, and often it increased in the course of successive searches. The reason for having relatively less uncertainty for some students with regard to the selection of information channels was that they were used to look for information only within a small set of pre-selected information channels and sources. Most importantly it was noted that although uncertainty associated with certain issues was reduced in some cases it did increase in most cases. With regard to the issues of comprehensiveness and adequacy of search, it increased in the course of successive

searches. The reason for such changes (or increases) in uncertainty was the search behaviour of the students, e.g. some students were used to choosing only a small set of information channels and sources every time irrespective of the search topics.

Overall, it was noted that there were no relations between the participants' task and/or topic familiarity and the degree of uncertainty with regard to the specific information seeking activities and information seeking problems.

Participants from all the three categories revealed that they felt an average to a high level of positive impact by accidentally discovering some information. Some other forms of positive impact of uncertainty were also felt by some participants, for example, some members from all the categories of participants reported that uncertainty associated with the previous search task forced them to think more carefully and they became more prepared in terms of search strategy, use of proper search terms, and so on.

Thus, the overall findings from this phase of study confirm that uncertainty in relation to some information seeking activities and information seeking problems always persists – to a greater or lesser extent among all categories of users in the academic environment. Although the extent of uncertainty felt by a given user in relation to a specific information seeking activity or information seeking problem depends on a number of factors including the user's information seeking behaviour, in general, it was noted that uncertainty did not disappear altogether in the course of successive searches, rather it decreased in some areas and increased in others, thus showing a shift in uncertainty. The next chapter summarises the findings of this research and develops a model of uncertainty in information seeking and retrieval.

Chapter 8

Conclusions

8.1 Introduction

This chapter summarises the results of this research based on the findings from different phases of study. The general objective of this research has been met through quantitative and qualitative studies and it is shown that uncertainty occurs at different stages of the information seeking and retrieval process in a digital environment in the context of higher education. This chapter highlights those information seeking activities and information seeking problems that caused uncertainty among users in higher education in information seeking and retrieval processes. Based on the findings presented in Chapter 5 it is concluded that there is a correlation among information seeking activities and information seeking problems that caused uncertainty among the participants. Based on the comments received from the respondents in the course of this study, some specific conclusions have been made about the positive impact of uncertainty. This chapter highlights other key objectives of this research, such as, persistent – positive or negative – uncertainty, and uncertainty shift in the entire information seeking and retrieval process. Based on the research, a series of recommendations have been made, indicating the possible measures for future information systems design with a view to reducing uncertainty in information seeking and retrieval. Based on the findings of this research, a new model of uncertainty in information seeking and retrieval has been developed in this chapter and it also suggests the scope of future research.

8.2 Summary

During the past few decades a significant growth in information has caused a growing requirement for the capacity to handle information and, despite a significant amount of

research and easy availability of a number of sophisticated search tools, the identification of appropriate information sources remains a very challenging task (Savolainen, 2007; Fritz & Schiefer, 2003). These challenges cause uncertainty among users, and such uncertainty forms part of the academic community's research and related activities (Anderson, 2006). The findings from this research presented here meet the key objective of this study by proving that uncertainty exists at different stages of information seeking and retrieval process in a digital information environment amongst users in the higher education.

8.2.1 Information Seeking Activities, Information Seeking Problems and Specific Information Channels or Sources that Cause Uncertainty in Information Seeking and Retrieval

Major findings of this research, as reported in Chapter 4, prove that the first hypothesis of this research (Section 1.4, P. 9), i.e. uncertainty occurs in relation to different information seeking activities and information seeking problems. More specifically it is noted that:

- In general, certain information seeking activities, such as, *choosing appropriate information channels and sources, formulating a search expression, deciding when to stop a search and to begin to use the retrieved items, making sure to remain up-to-date in a given field, judging quality of the sources, deciding how many of the retrieved items should be viewed when many items are retrieved, and ensuring that all the information required for a given task has been obtained* caused uncertainty among most of the respondents regardless of their age, gender, ICT skills, user categories and disciplines.
- In general, certain information seeking problems, such as, s*earch output is not exhaustive, unaware of source or channel, too much information or information overload,* and *unfamiliar with the source* caused uncertainty among most of the respondents irrespective of age, gender, ICT skills, user category or discipline.

- Very few respondents (≤15%) indicated any uncertainty caused by specific information channels or sources. As a result, further exploration of this aspect was not considered in the course of this research.

In terms of differences among respondents of different age groups, it has been noted that:

- A specific information seeking activity, i.e. c*hoosing appropriate information channels and source* caused uncertainty for a considerable number of respondents (29%-43%) from all age groups while certain activities like *browsing or searching the chosen information sources or channels* and *making use of the retrieved items to perform the actual task* caused uncertainty among the least number of respondents from all age groups.

- specific information seeking problems, such as, *too much information* or *information overload*, *unaware of source* or *channel* and s*earch output is not exhaustive* caused uncertainty among respondents from all age groups except for those who were 61 and over whereas one information seeking problem, viz. *too scattered information* caused uncertainty for the majority of respondents (within the range of 31-60 years of age). Technology related problems caused uncertainty among the majority of respondents in the age group 61 and over.

In terms of differences among respondents of different genders, it has been noted that:

- *formulating a search expression* and *deciding when to stop a search and to begin to use the retrieved items* were the information seeking problems that caused uncertainty amongst respondents from both genders. However, one particular information seeking activity, viz. c*hoosing appropriate information channels and sources* caused uncertainty among about half of the female respondents.

- s*earch output is not exhaustive, too much information* or *information overload, unaware of source* or *channel* and *unfamiliar with the source* are the four information seeking problems that caused uncertainty among both male and female respondents. However, information seeking problems like, *too scattered information*, *search results are not up-to-date* and *materials can be unreliable*

were the main causes of uncertainty among male respondents while *too much information or information overload, which channels and sources to look for, search output is not exhaustive* and *unaware of source* or *channel* were the main causes of uncertainty among the female respondents.

In terms of differences among respondents of different ICT skills, it has been noted that:

- two information seeking activities, viz. c*hoosing appropriate information channels and sources* and *making sure to remain up-to-date in a given field* were identified as causes of uncertainty by about one-third of the respondents irrespective of the level of their ICT skills. Information seeking activities, such as, *judging quality of the sources, formulating a search expression, deciding how many of the retrieved items should be viewed when many items are retrieved,* and *ensuring that all the information required for a given task has been obtained* were selected as the cause of uncertainty by over 25% of respondents who were extremely confident in their ICT skills.

- *too much information* or *information overload, search output is not exhaustive, unfamiliar with the source, unaware of source* or *channel*, and *too scattered information* were the most identifiable information seeking problems among respondents irrespective of their ICT skills. However, it is interesting to note that respondents who were extremely confident in their ICT skills had some problems in common with the people who were relatively less or not at all confident in their ICT skills.

In terms of differences among respondents of different user categories, it has been noted that:

- information seeking activities such as c*hoosing appropriate information channels and sources, formulating a search expression, deciding when to stop a search and to begin to use the retrieved items,* and *making sure to remain up-to-date in a given field* caused uncertainty among at least one-third of the respondents from the academic staff category. More than half of the research staff identified that the information activity c*hoosing appropriate information channels and sources* caused uncertainty whereas about half of the research students emphasised that

the information seeking activity *deciding when to stop a search and to begin to use the retrieved items* was a major cause of uncertainty.

- information seeking problems such as *too much information* or *information overload, search output is not exhaustive, unaware of source* or *channel* and *unfamiliar with the source* commonly caused uncertainty among academic staff, research staff, and research students, but to varying degrees. However, there were problems which were specific to a particular user category; for example, *too much information* or *information overload, unfamiliar with the source*, and *search results not up-to-date* caused uncertainty among most of the academic staff, research staff and research students respectively. Some problems, such as, *which channels and sources to look for, search output is not exhaustive, unaware of source* or *channel, search results are not up-to-date,* and *unfamiliar with the source* caused uncertainty for a significant number of research students.

Data collected through the qualitative study reveal that most of the respondents, irrespective of their category, said that they always felt some degree of uncertainty about *which information channel or source to choose to begin a search* and *the number of channels or sources that have been chosen are not enough.* In addition, all the academic staff, and some research staff and students indicated that they would have preferred a guide for the selection of the most appropriate information channels and sources.

Respondents from the academic staff category mentioned that they felt a high degree of uncertainty about choosing a channel, and they had a high degree of uncertainty with regard to the point that the number of channels or sources that had been chosen was not enough. This was different from the respondents belonging to the other categories. For example, respondents from the research staff and research student category indicated that they felt an average degree of uncertainty. The increased uncertainty among the respondents in the academic staff category was due to the nature of their work and some tasks that required comprehensive information. On the other hand the relatively less degree of uncertainty was justified by the fact that research staff and research students

usually focused on a small selected number of information channels and sources, and therefore, most of them were not concerned with the wider coverage of the selection.

In terms of differences among respondents from different disciplines, it was noted that:

- almost half of the respondents from business and management, and arts and humanities indicated that *formulating a search expression* was the cause of uncertainty in relation to information seeking and retrieval activities while c*hoosing appropriate information channels and sources* was identified by almost half of respondents from the social sciences, and by one-third of the respondents from science, engineering, medical sciences and technology disciplines. *Deciding which retrieved items should be viewed for their content within the available time* was the prime cause of uncertainty for more than half of the respondents from computer and information sciences. Similarly, *deciding when to stop a search and begin to use the retrieved items* caused uncertainty among business and management, computer and information sciences, and arts and humanities respondents (identified by 35%-42% respondents). C*hoosing appropriate information channels and sources* caused uncertainty among almost half of the respondents from social sciences and business and management disciplines and one-third of the respondents from arts and humanities, and science, engineering, medical sciences and technology. Almost half of the respondents from computer and information sciences emphasised that *making sure to remain up-to-date in the given field*, *judging the quality of the sources*, and *deciding how many of the retrieved items should be viewed when many items are retrieved* caused uncertainty.

- Different information seeking problems caused varying degrees of uncertainty among respondents in different disciplines. For example, more than one-third of respondents from computer and information sciences highlighted that the problems of *too much information* or *information overload* and *unaware of source* or *channel* caused uncertainty while one-third of respondents from social sciences stressed that the problem of *search output is not exhaustive* was the main cause of

uncertainty; about one-third of respondents from business and management, and arts and humanities indicated that they faced uncertainty due to *too much information* or *information overload*, and u*nfamiliar with the source* respectively. The problem of s*earch output is not exhaustive* was a cause of uncertainty among a considerable number of respondents (25%) from science, engineering, medical science and technology. However, s*earch output is not exhaustive, unaware of source* or *channel* and *unfamiliar with the source* were the problems which most commonly caused uncertainty among respondents across all disciplines. The problem of *too much information* or *information overload* caused uncertainty among all respondents except those from the arts and humanities whereas the problem *search results are not up-to-date* was a major cause of uncertainty for everyone except respondents from computer and information sciences.

8.2.2 Correlation among Information Seeking Activities and Information Seeking Problems that Cause Uncertainty in Information Seeking and Retrieval

Major findings of this research, as reported in Chapter 5, show that some of the information seeking activities and information seeking problems that caused uncertainty were correlated. These findings show that those information seeking activities and information seeking problems that cause uncertainty do not occur in isolation, instead they often co-occur.

The findings show that there was a correlation between information seeking activities and gender and disciplines as opposed to information seeking activities and age, ICT skills, and user categories, where there was a very little correlation. There was a correlation between information seeking problems and ICT skills, gender and user categories.

However, information seeking problems did not appear to be correlated with age of respondents in the higher education environment. Interestingly, information seeking activities and information seeking problems had a significant correlation with disciplines and gender. However, it was noted that for respondents in the field of computer and information sciences, uncertainty caused by information seeking activities was less compared to the other disciplines.

In this study it was also noted that information seeking activities that caused uncertainty among many respondents were also correlated to each other as follows:

- The information seeing activity *choosing information channels and sources* had a significant correlation with such other activities as *formulating a search expression*, and *ensuring that all the information required for a given task has been obtained*
- The information seeing activity *formulating a search expression* had a significant correlation with such other activities as *choosing information channels and sources, deciding when to stop a search and to begin to use the retrieved items,* and *judging the quality of the sources*
- The information seeing activity *deciding when to stop a search and to begin to use the retrieved items* had a significant correlation with such other activities as *judging the quality of the sources*, *formulating a search expression*, *making sure to remain up-to-date in the given field*, and *assuring that all the information required for a given task has been obtained*
- The information seeing activity making *sure to remain up-to-date in the given field* had a significant correlation with such other activities as *assuring that all the information required for a given task has been obtained*, *deciding when to stop a search and to begin to use the retrieved items*, and *deciding how many of the retrieved items should be viewed when many items are retrieved*

- The information seeing activity *judging the quality of the sources* had a significant correlation with such other activities as *deciding when to stop a search and to begin to use the retrieved items*, and *formulating a search expression*

- The information seeing activity *deciding how many of the retrieved items should be viewed when many items are retrieved* had a significant correlation with such other activities as *assuring that all the information required for a given task has been obtained*, and *making sure to remain up-to-date in the given field*

- The information seeing activity *assuring that all the information required for a given task has been obtained* had a significant correlation with such other activities as *deciding how many of the retrieved items should be viewed when many items are retrieved*, *choosing information channels and sources*, and *deciding when to stop a search and to begin to use the retrieved items.*

Information seeking problems that caused uncertainty among many respondents were also correlated to each other as follows:

- The information seeking problem *too much information or information overload* had a significant correlation with other problems such as *too scattered information, search output is not exhaustive, unaware of source or channel, search results are not up-to-date,* and *unfamiliar with the source*

- The information seeking problem *too scattered information* had a significant correlation with other problems such as *too much information or information overload, search output is not exhaustive, unaware of source or channel,* and *unfamiliar with the source*

- The information seeking problem *search results are not up-to-date* had a significant correlation with other problems such as *too much information or information overload, unaware of source or channel, search output is not exhaustive,* and *unfamiliar with the source*

- The information seeking problem *unaware of source or channel* had a significant correlation with other problems such as *too much information or information*

overload, too scattered information, search output is not exhaustive, search results are not up-to-date, and *unfamiliar with the source*

- The information seeking problem *search output is not exhaustive* had a significant correlation with other problems such as *too much information or information overload, too scattered information, unaware of source or channel, search results are not up-to-date* , and *unfamiliar with the source*

- The information seeking problem *unfamiliar with the source* had a significant correlation with other problems such as *too much information or information overload, too scattered information, unaware of source or channel, search output is not exhaustive,* and *search results are not up-to-date.*

8.2.3 Continued Uncertainty and Uncertainty Shift

Findings of the qualitative study, presented in chapters six and seven, prove the second hypothesis of this research (Section 1.4, p. 9) with evidence of continued uncertainty amongst respondents in relation to various information seeking activities and information seeking problems, and often the degree of uncertainty shifted from one activity or problem to another, i.e. it reduced in certain areas while it increased in others. More specifically:

- findings from the interviews revealed that the degree of uncertainty associated with some activities were rated almost equally by all categories of respondents. In general, academic staff appeared to be more concerned with uncertainty associated with certain issues. This was due to the fact that they needed the most comprehensive and relevant information compared with respondents from other categories.

- findings from the post-search questionnaire also revealed that the respondents felt some form of uncertainty, often to a significant extent, caused by some

information seeking problems associated with the information seeking and retrieval process.

- while there was a significant degree of uncertainty among the respondents from the academic staff category at the beginning with regard to such issues as selection of information channels, formulation of a suitable search query etc., it became less through successive searches. At the same time uncertainty with regard to the comprehensiveness of the search output and information overload gradually increased through successive searches.

- research staff had relatively less uncertainty with regard to the selection of information channels and formulation of queries, etc., the reason being that research staff appeared to rely only on a small (pre-defined) set of information channels and sources, and therefore had a relatively less amount of uncertainty with regard to the selection of information channels, although it never disappeared altogether in course of a series of search tasks.

- research staff had a moderate to high level of uncertainty with regard to such issues as the comprehensiveness and adequacy of the search results because they chose to use a limited number of information channels and sources because of the lack of time. However, they always had a feeling of uncertainty caused by the fear that they were missing out some important information and/or the retrieved information was not adequate for their task in hand.

- research students had a high level of uncertainty associated with the selection of information channels, and often it increased in the course of successive searches. Uncertainty with regard to the issues of comprehensiveness and adequacy of search increased in the course of successive searches because most of the respondents were not quite familiar with the search tasks and topics, and some students were used to choosing only a small set of information channels and sources every time irrespective of the search topics.

8.2.4 Positive Impact of Uncertainty on Information Seeking and Retrieval Process

'Serendipity may lead searchers to unexpected findings that may not be relevant to the task at hand, but important for a different reason ..... These documents also need to be examined, but the searcher often returns to the original task afterwards' (Komlodi, 2004, p. 181).

Results from both interviews and post-search questionnaire prove the third hypothesis of this research (Section 1.4, p.9) by showing that there is some positive impact of the uncertainty related to information seeking and retrieval. All the respondents, irrespective of their category, mentioned that uncertainty related to various issues often forced them to be prepared and more specific in preparing search strategies.

- Academic staff mentioned that the huge volume and variety of information provided opportunities for discovering new information and thus getting new ideas, and this often made them more informed and confident in their area of study
- Research staff mentioned that they always found something useful very easily, even if the output was not necessarily comprehensive, and this made them more empowered and gave them more choices, and often helped them learn new things in the chosen topic or related areas
- Research students indicated that often they found some useful information accidentally and this sometimes helped them think from a different perspective or take a different course of action.

Although one research student thought that accidental discovery of information may cause distraction, others, irrespective of the categories, emphasised that discovering information accidentally was certainly a positive aspect of uncertainty. The following are some comments of the respondents that show how they felt about the positive impact of uncertainty through accidental discovery of information:

- "It opens up a new avenue and gives some insight into a research" (Academic staff).
- "Sometimes it broadens up the area of research to fit in some new concepts. It often happens in the first year of research and is very helpful" (Research student).
- "Once I discover something accidentally, I remember it and use it whenever required" (Research staff).
- "After discovering the new information, I can prioritise the task and continue along with that" (Research student).

8.2.5 Respondents' Comments on Uncertainty in Information Seeking and Retrieval Process and Some Suggestions

> 'Some people are highly tolerant of ambiguity and uncertainty, whereas others demand specificity and completeness. Some enjoy social interactions and adopt information-seeking patterns that maximise interactions with colleagues or experts, whereas others prefer the challenge of personal discovery and immerse themselves in books or electronic systems' (Marchionini, 1995, p.72).

As mentioned in Chapter 4, a number of comments were made by the respondents that show how they take their own measures to reduce uncertainty in information seeking and retrieval.

Interestingly, in general the respondents of all categories mentioned that:

- It would have been helpful if there was a guide for the selection of the best possible information channels and sources for a search topic.
- There is always an uncertainty associated with the choice of an information channel to begin a search, especially on a new topic, and some of the respondents suggested that an integrated database with one password could help to reduce uncertainty.
- There was a consensus that formulation of an appropriate search query is a major problem. There was always an uncertainty in relation to the terminology, and

most respondents felt that if the correct terminology was not used the search would not retrieve any relevant source. As a result the respondents needed to try alternative searches with different terminology. Some academic staff suggested that some successful search queries should be provided as an example to reduce this problem which coincides with the following statement of Komlodi (2004, p.183): 'System designers should consider applying search history information to user interface tools that will allow searchers to manage complex tasks, evaluate and plan actions'.

- All the respondents felt that time was a major constraint, and as a result they established a cut-off point but sometimes felt doubtful as to whether they had missed any useful information.

8.3 Concluding Remarks

As discussed in Chapter 2, the issue of uncertainty has been studied by several researchers in the context of information seeking and retrieval, but this study, for the first time, has proved that several information seeking activities and information seeking problems cause varying degrees of uncertainty among users in the higher education environment, and that such uncertainty may persist and shift from one factor to another, in the course of successive search sessions. Thus it is believed that this research has made a positive contribution to the knowledge of human information behaviour research in general, and in understanding of the concept and implications of uncertainty in information seeking and retrieval research in particular.

Overall, it was noted that a number of information seeking problems and information seeking activities cause uncertainty among different categories of users in the higher education environment. This research also shows, as opposed to the general belief, that uncertainty does not disappear altogether even after a series of search sessions; instead, it often persists or the degree of uncertainty shifts from one factor to another.

This research shows that the extent of uncertainty felt by a given user in relation to a specific information seeking activity or information seeking problem depends on a number of factors including the nature of the user and their experience, familiarity with the search tasks, and so on. However, in general some form of uncertainty is always present in the minds of users, and this is caused by one or more specific information seeking activities and information seeking problems.

More specifically, this study reveals that uncertainty occurs and persists in relation to several information seeking activities and information seeking problems among academic staff, research staff and research students in higher education, from different disciplines, different gender and age groups, and different levels of ICT skills. Nevertheless, any specific type of information channel or source does not cause uncertainty among most users, since it was revealed that uncertainty due to specific information channels or sources was not common and occurred amongst only a small number of users.

Furthermore, it was noted that uncertainty does not disappear altogether in the course of successive searches. This corroborates Kuhlthau's recent proposition in which, refuting her earlier theory as discussed in Chapter 1, section 1.2, she says that 'the axiom that information reduces uncertainty is not necessarily the person's experience in information seeking. In certain situations information actually increases uncertainty' (Kuhlthau, 2006, p. 233). This finding also supports Rose's (2006) viewpoint who comments that uncertainty does not decrease towards the completion of the search process, uncertainty is also experienced during a post-focus stage of problem construction.

This research also shows that task and topic familiarity of users does not have any obvious link with the uncertainty in information seeking and retrieval. Furthermore it is noted that while the degree of uncertainty decreases in some areas of information seeking activities or in relation to some information seeking problems, it increases in other areas of information seeking activities and problems, resulting in what may be called a shift in uncertainty.

The fact that the modern digital information environment is closely related to uncertainty in information seeking and retrieval can be summarised by the following statement:

> 'Many communication scholars have tried to reconcile avoidance behaviours with the more typical tendency of humans to reduce uncertainty by seeking information (Affifi & Weiner, 2004, Bradac, 2001; Brashers, 2001; and Brashers, Goldsmith & Hseieh, 2002); how can we be striving both to know more and less at the same time? Yet, most of the time, information is not avoided but rather simply not used. This applies to the average person as well as the scholar' (as quoted in Case, 2007, p. 100).

Although the word uncertainty carries a negative connotation in general, recent studies show that uncertainty may not always be negative or undesirable. As Anderson (2006) comments 'negative and positive [uncertainty] are closely bound to one another in a situation'. The findings of the present research show that uncertainty may prompt users to find information from a vast collection and at the same time may be exciting in terms of discovering new information channels and sources, etc. It may also provide useful insights for future search. This coincides with Cole's (1993) assertion that 'an improbable selection might lead to things like insight or a turning point in the person's research'.

Respondents from all the three categories in the higher education sector revealed that they felt an average to high level of positive impact of uncertainty by accidentally discovering some information. Some other forms of positive impact of uncertainty were also felt by some respondents. For example, some members from all the categories of respondents reported that uncertainty associated with the previous search task forced them to think more carefully and they became more prepared in terms of search strategy, use of proper search terms, and so on.

Given the proliferation of information channels and sources, and rapid growth in information in the digital environment vis-à-vis constraints of time and other resources, users are often forced to become more selective. Case (2007, p. 327) comments that there is a justification for 'consciously ignoring or filtering relevant information in situations in which there is not enough time or energy to consider all of it. Ignoring or avoiding

information is at times a rational strategy for living and working, especially when it promotes psychological coping'.

Many of the findings of this research, and suggestions made by the participants, corroborate earlier research, while some contradict findings of earlier research.

Major findings that are unique to this research, and therefore contradict the findings of, or are different from, previous research discussed in Chapter 2, are as follows:

- Unlike the study of uncertainty in the context of electronic communication by Shannon and Weaver (1949) that suggests that uncertainty is associated with the noise in electronic communication, and that in the context of probability in information retrieval research by Rijsbergen (1996) who suggested seven different types of uncertainty though none of these covers for the 'uncertainty of the unexpected' (as commented by Wilson (1996) and discussed in Section 2.7), and the large number of studies conducted within the HIB community (as discussed in Chapter 2, specifically sections 2.7 and 2.8) this research has studied uncertainty in the context of information seeking and retrieval from a different perspective. It has studied uncertainty in information seeking and retrieval facing academic users in the digital environment with the hypothesis that uncertainty may be caused by a number of information seeking activities and information seeking problems. Therefore the main contribution of this research is that it has, for the first time, identified a number of information seeking activities and information seeking problems that cause uncertainty among users in the academic community. It has also shown the extent of uncertainty caused by the information seeking activities and information seeking problems among different categories of academic users, and how such uncertainty changes in course of a series of information search sessions.
- In contrary to the common belief in the HIB research community, as proposed by researchers like Whittemore and Yovits (1973), Belkin (1980), Bates (1986), Kuhlthau (1993,2004), and Wilson (2000) (section 2.8) that uncertainty decreases, and eventually disappears, at the end of an information seeking and retrieval

process, this research shows that uncertainty does not necessarily disappear or even decrease in course of an information seeking and retrieval process.

- This research in a way contradicts the proposition of Yoon (2007) that cognitive aspects of information seeking involve both certainty and uncertainty related to the information need of a user, in that the findings of this research show that some form of uncertainty is always associated with the information seeking and retrieval in the digital age.

However, there are a number of findings of this research that corroborate earlier research, for example:

- Some researcher, such as Yovits and Foulk (1985), and also Kuhlthau (2006) in her later studies, noted that sometimes uncertainty increases after the user obtains some information; in other words, uncertainty does not necessarily decrease at the end of an information seeking and retrieval process which is also the conclusion of the present research. However, the uniqueness of this research in this regard is that it specifies some information seeking activities and information seeking problems that cause uncertainty, and also shows how uncertainty shifts from one activity or a problem to another in course of a series of information search sessions.
- It corroborates the position of Coles (1993) and Anderson (2006) that there is a positive impact of uncertainty. However, the significance of the present study, in comparison to those of Coles and Anderson, is that it specifically indicates some information seeking activities and information seeking problems that cause positive impact of uncertainty in information seeking and retrieval, and also shows how such positive implications of uncertainty are perceived by the users in the academic community.
- The suggestions made by the participants in this research with regard to the benefits of the provision of previous search history for future information seeking and retrieval activities, supports the view of Komlodi who noted that 'information-seeking behaviour show that recording and providing search histories can be useful in search task management' (Komlodi, 2004, p. 177).

A better understanding of the issues, i.e. the information seeking activities and information seeking problems that cause uncertainty, will lead the way for improved information system design that may reduce the negative impact of uncertainty. This is in line with the position of Nahl (2006) who states that uncertainty in information seeking affect users' information seeking behaviours and thus efforts should be made to reduce the cause for uncertainty.

8.4 A New Uncertainty Model

Based on the findings of this research that uncertainty occurs due to a number of information seeking activities and information seeking problems, and that such uncertainty may continue in the course of successive search sessions, a new uncertainty model has been developed (Figure 8.1). The new model contradicts the general belief, as proposed by Kuhlthau (as discussed in Chapter 2, Section 2.4.3) and agreed by other researchers like Wilson (as discussed in Chapter 2, Section 2.7), in which an information search process begins with an uncertainty in the mind (cognitive state) of the user, and it gradually decreases, and eventually disappears, after the completion of a search session. Although the new uncertainty model supports Kuhlthau's view that, 'uncertainty is a concept that offers insight into the user's quest for meaning within the information search process.' (Kuhlthau, 2006, p.233), it is unique in the sense that (1) it shows that in the digital information environment uncertainty may be caused by a number of information seeking activities and information seeking problems, (2) such uncertainty may persist in the course of a series of search sessions, although there may be a shift in uncertainty, and (3) while there are negative implications of such uncertainty, there are some positive implications as well.

Figure 8.1 provides a conceptual representation of the new uncertainty model where it is shown that uncertainty may occur in the course of several information seeking activities and information seeking problems. The model shows that a user's information need triggers an information seeking and retrieval process that involves a number of

information seeking activities and information seeking problems that can be derived from the various stages of information seeking proposed in the Kuhlthau's and Ellis's models as discussed in Chapter 3, Section 3.2.1. However, this study has shown that out of the selected 14 information seeking activities and 21 information seeking problems, only a few caused uncertainty amongst the users and therefore only those (as opposed to the complete list of 14 information seeking activities and 21 information seeking problems) have been listed in Figure 8.1.

The model proposes that as the searcher goes through an information seeking and retrieval process, various information seeking activities and information seeking problems may cause different degrees of uncertainty, and that such uncertainty may persist even after a series of information searches. Thus the basic tenet of the model is that some form of uncertainty is always present in information seeking and retrieval in the digital environment, and while the extent of such uncertainty caused by specific information seeking activities and problems vary depending on the nature and characteristics of the users, and the degree of uncertainty may shift from one factor to another in course of a series of search sessions, it seldom disappears.

However, the model also shows that while negative uncertainty causes anxiety, lack of confidence and frustration among users, there is a positive impact of uncertainty as well. As noted in course of this research, and shown in the model in Figure 8.1, positive or desirable uncertainty also influences the user. Findings of this research, discussed earlier in this chapter, indicate that the positive impact of uncertainty is felt by information users in a number of ways, such as making accidental discovery of useful information, getting a new direction in research through discovery of new/related information, becoming more prepared for successive information seeking and retrieval processes, and so on.

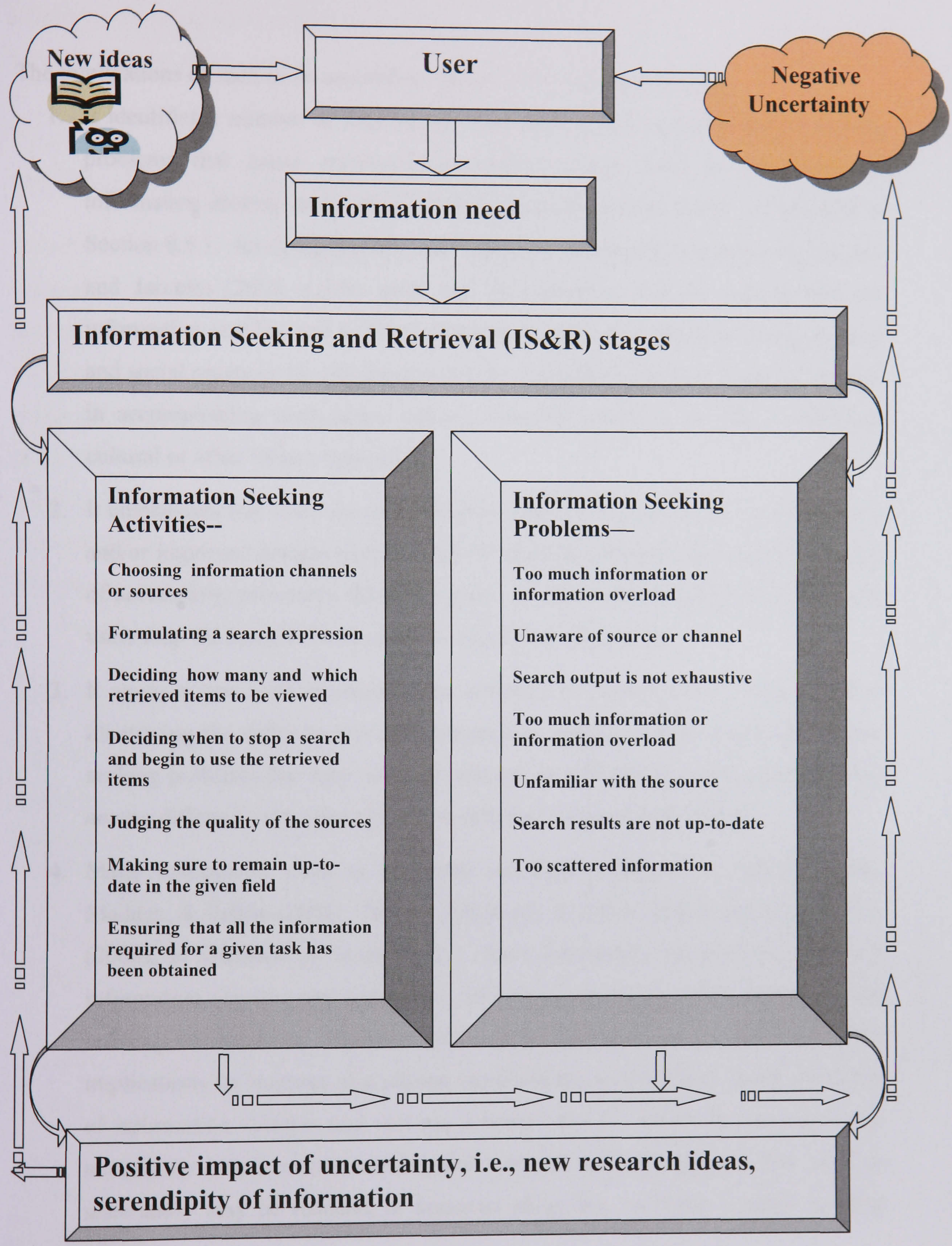


Figure 8.1: A model of uncertainty in information seeking and retrieval

The implications of such as an uncertainty model could be the following:

1. It identifies a number of information seeking activities and information seeking problems that cause continued uncertainty among users in the course of information seeking and retrieval. This knowledge will be useful, as indicated in Section 8.5.1, for designing new and improved information systems as Ingwersen and Jarvelin (2005, p.379) point out 'the practical fruit for society that the information seeking and retrieval research provides are improved tools, systems and social practices for information access, acquisition and use. These are needed in accomplishing work tasks, solving everyday problems of life, or fulfilling cultural or other leisure interests'.

2. It emphasises that there are some positive impacts of uncertainty, and while new and/or improved designs should think of measures to reduce the negative impacts of uncertainty, provisions should be made, as mentioned in Section 8.5.1, to help users reap the benefits of the positive impacts of uncertainty.

3. It opens a new vista of research, as indicated in Section 8.5.1, with regard to identifying the different types of information seeking activities and information seeking problems that may cause uncertainty in information seeking and retrieval among different categories of users in different domains and contexts.

4. Many researchers, such as Dalgleish and Hall (2000), Ford (2004), Kerins, Madden, & Fulton (2004), Tenopir, Hitchcock & Pillow (2003) and Tenopir et al (2006), as discussed in Section 2.5.2, have emphasised the need for improved information services and importance of better information skills training in the learning environment. The uncertainty model proposed in this thesis will have implications for learning in academic environments in that it will enable providers of information systems and services a better idea of which factors may cause uncertainty in information seeking and retrieval, and consequently how such an uncertainty may be reduced, or removed altogether, to create a better learning environment.

However, as mentioned in Section 8.5.2, further research needs to be conducted to validate this uncertainty model.

8.5 Recommendations and Future Work

Several researchers have made recommendations for improved design of information systems in order to support the cognitive aspects of information seeking and retrieval. For example, Kuhlthau (2004, p. 13) comments that 'people seek information to deepen and broaden their understanding about the things around them. Therefore, the user's perspective becomes an essential component in information provision and it is necessary to understand the users' perspective to design more effective services'. In the context of information overload, Blake & Pratt (2006a) comment that, 'as the quantity of information at our fingertips continues to exceed human-processing capacity, the importance of information systems that integrate findings will continue to increase'.

8.5.1 Recommendations

The following recommendations are made on the basis of the findings of this research, coupled with the comments and suggestions made by the study participants, and may be useful for new and/or improved design of information systems and services:

1. **Measures to reduce uncertainty with regard to the selection of information channels and sources**: In order to reduce uncertainty associated with the selection of information channels and sources in the course of a search session a one-stop search system could be designed providing facilities for searching across a range of information channels and sources (a number of online databases, digital libraries, e-journals, etc.); and along with this search interface, a ranked list of journals, conferences, etc., could be made available to help users choose the most appropriate sources. The ranked list could be generated automatically from the Citation index databases (ISI Web of Knowledge[11]). Another possible measure could be to provide a

[11] http://wok.mimas.ac.uk/

master index showing the ranked list of information channels with respect to a given search topic; an example of such a service is the DialIndex[12] available with Dialog database search. Another approach could be to help users with a brief description of the nature, characteristics and coverage of each information channel and source so that the user can view the details through a pop-up window. Designers of digital libraries and university information services could consider this approach to facilitate selection of appropriate information channels and sources.

2. Measures to reduce uncertainty with regard to the formulation of queries. Several measures may be taken to help users formulate better queries more easily. Scholarly information systems may use some of the commonly available features of search engines, by providing facilities for automatic spelling correction and/or suggestions as in Google[13], automatic display of concept maps and clusters, as available in Clusty[14] (formerly Vivisimo), and provision of a set of pre-defined queries and related search topics as in Ask[15]. Users should also be allowed to save successful search sets for future reference; this facility has been available in some traditional online databases or search services like Dialog, but is not common in the one-stop search system providing access to heterogeneous information channels and sources.

3. Measures to reduce uncertainty with regard to the relevance of search results. Uncertainty in this area may be reduced by making the criteria used by the given information system clear to the user, or allowing the user to select specific relevance criteria from a given list that can then be used by the concerned information service to rank the search results. Often the user does not have a clue as to how the search results are ranked, and moreover the user should be able to specify one or more criteria for ranking of search output. A combination of typical term-based approaches (presence or absence of a search term, frequency of occurrence, etc.) and other approaches like citation or usage figures (as used in Google) may be adopted. Use of a relevance feedback mechanism, providing a chance to the user to tell the system

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[12] http://library.dialog.com/bluesheets/html/bl0411.html
[13] http://www.google.co.uk
[14] http://clusty.com
[15] http://uk.ask.com

abut their own choices and preferences will be useful. Suggestions made by other researchers, such as the provision of a sliding scale to change the emphasis on the typical measures of performance (recall and precision) in the search output proposed by Blake & Pratt (2006b), may also be useful in this context.

4. Measures to reduce the time spent in information seeking and retrieval: The huge volume and variety of information, vis-à-vis availability of information through a multitude of information channels in a distributed environment, appear to be causing uncertainty and especially in terms of making greater demands on limited user time and resources. Such uncertainty may be reduced by employing good filtering mechanisms based on user tasks that would automatically filter out unwanted materials thereby requiring less user time to wade through the volume of retrieved information sources, and thus leaving more time for the users to be spent on using the retrieved information.

5. Measures to reduce uncertainty with regard to quality of assurance. Uncertainty associated with the assessment of quality of the information sources and the search output may be reduced by introducing several tools embedded within the search interface. One such tool may be a list of the most cited authors and publications in a given field generated by using systems like the Citation Index databases (ISI Web of Knowledge[16]), Google Scholar[17], etc. It may also be possible to help users by developing and using a recommender system that will recommend appropriate information sources to the user based on the user profile and requirements, etc.; a simple version of such a system is now available in systems such as Amazon[18] .

6. Measures to reduce uncertainty with regard to the feeling that the search is not comprehensive: Several measures may be taken to reduce uncertainty in this regard. It may be possible to generate and provide automatically a list of experts, research groups and most cited/used publications in a given field. This may be of great help especially for new users, or for expert users in a new field of study.

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[16] http://wok.mimas.ac.uk/
[17] http://scholar.google.co.uk/
[18] http://www.amazon.co.uk

Another approach may be to use a visual interface showing the clusters of search results and their links, as available in the Kartoo[19] search engine, say, which will help the user decide on specific cluster(s) and follow the links.

7. Measures to reduce uncertainty with regard to the feeling of inadequacy of retrieved information. Deciding how much information is enough, or whether the retrieved information is enough for accomplishing a given task has become an important area of research in the recent past (see for example, Parker & Berryman, 2008; Prabha et al, 2007). Nevertheless, there is no easy solution to this, and one possible approach may be to design a task-based information management system that would automatically search and filter information required to accomplish a specific task as proposed in Chowdhury (2004) and Meyyappan, Chowdhury & Foo (2001, 2004) in the context of a digital work environment, and more recently by Chowdhury & Chowdhury (2007) in the context of a task-based information access system for postgraduate students.

8. Measures to reduce uncertainty with regard to staying up-to-date in one's own field of study. The rapidly growing quantity of information 'makes it difficult to stay current as well as explore new connections between articles.' (Tenopir et al, 2006). Selective Dissemination of Information (SDI) services were introduced in the field of information services several decades ago to help users keep abreast of the developments in their own field of interest. Such services, in a more revised and automated mode are now available in the form of RSS feeds in the field of news services. Information system designers should introduce such a personalised service based on the user needs and context which will help users keep track of the latest developments in their own area. Another approach may be to develop a recommendation service, a simple version of which is available from Amazon in the form of recommendation for previous customers/visitors to the site, may be developed by studying the link and usage analysis of information sources vis-à-vis the individual user profile. Such a list, which shows a network of recently produced information sources, may help the users keep track of the developments in a

[19] http://www.karto.com

networked environment. Another novel approach may be to create a user space along with an information system where users can comment on specific works, recent trends etc., and this may be feasible, and useful, especially in a specific area of research (for example, research groups focusing on specific research projects) where experts and/or people with similar interest may share information and add value to it.

9. Measures to help users deal with the positive impact of uncertainty, especially with serendipity. Information systems should have provisions for helping users to make use of accidentally discovered and yet useful information. Facilities for automatic book marking and provisions for making notes with reference to the identified information for future reference will facilitate future use of accidentally discovered information in its proper context. Such a facility to support serendipity would be particularly helpful for multitasking (Spink & Cole, 2005d) which is very common for academic users.

10. Measures to help users for making use of the knowledge gained through searches. As shown in this research uncertainty often provides useful insights of the information seeking and retrieval process, and in some cases this helps the user get better prepared for the next search. It is therefore important that information systems make provisions for recording the search experience by the user for future reference. One possible approach may be to allow users to save search sets along with notes, etc. that can be accessed and used during the next search session(s).

8.5.2 Future Work

For obvious reasons of limited time and resources, the study has suffered from some limitations. One of the major limitations arises from the selection of the study population. Although the quantitative study was based on a large nationwide sample, the qualitative study was limited to one university, and in some cases, to one specific university department. Thus although this study has produced some new and valuable information, further research needs to be conducted with a larger and wider study population to validate the findings. Further research is also needed to find out the relationship between information skills and uncertainty in information seeking and retrieval.

This research has been conducted within a specific environment, i.e. the higher education, and amongst a small number of user categories, i.e. academic staff, research staff and research students. However, there is a need to replicate this study in other domains, and with other user categories that may provide useful information for validation, and/or modification of the proposed uncertainty model and the corresponding recommendations for better information system design.

Although this study has enabled creation of a new uncertainty model, showing the various information seeking activities and information seeking problems that cause both negative and positive uncertainty, further studies are required to test and validate the model by replicating this research in the context of different user categories, and with a wider range of information seeking activities, and possible information seeking problems in different environments. Such detailed studies will enable validation, and modifications, if any, of this model of uncertainty in information seeking and retrieval in the digital environment.

The proposed model of uncertainty, further tested and appropriately validated, will provide a better understanding of the issues related to information seeking and retrieval in the digital environment. However, real and explicit benefits of this research, and the new model of uncertainty in information seeking and retrieval, can be realised when new and improved information systems are designed as per the recommendations made in Section 8.5.1. Therefore, further research needs to be done to test how improved design of information systems can reduce the negative impact of uncertainty, while at the same time help the users benefit from the positive uncertainty in information seeking and retrieval.

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Appendix A: Fourteen Information Seeking Activities

No.	Activities
A1	Choosing appropriate information channels and sources (e.g. search engines, e-journals, databases, digital libraries such as the ACM digital library, personal collections, Library OPAC)
A2	Judging quality of the channels
A3	Judging quality of the sources (e.g. the content of a journal)
A4	Browsing or searching the chosen information sources or channels
A5	Formulating a search expression
A6	Taking a course of action following a search when a set of results appear on screen (Note that too many or too few items may be retrieved)
A7	Deciding when to stop a search and to begin to use the retrieved items
A8	Making use of the retrieved items to perform the actual task
A9	Deciding how many of the retrieved items should be viewed when many items are retrieved
A10	Deciding which retrieved items should be viewed for their content within the available time
A11	Deciding what to download or print
A12	Ensuring that all the information required for a given task has been obtained
A13	Making sure to remain up-to-date in a given field
A14	Making sure to remain competent in the given field in terms of information seeking and retrieval

Appendix B: Twenty-one Information Seeking Problems

No.	Information Seeking Problems
P1	Too much information or information overload
P2	Too scattered information
P3	Which channel or source to look for (i.e. you know the channel or source is there but don't know how to look for it)
P4	Fast changing technology
P5	Search output is not exhaustive
P6	Unaware of source or channel
P7	Search results are not up-to-date
P8	Time-consuming
P9	Too many technological problems
P10	Materials can be unreliable
P11	Not enough relevant materials
P12	Too many different passwords needed to access a range of sources
P13	Hard to read or to view on the screen
P14	Poor quality display of text or graphics
P15	Slow downloading of pages
P16	Lack of ICT skills
P17	Unfamiliar with the source
P18	Poor quality of information
P19	Too many irrelevant results
P20	Having to pay for access to sources
P21	Restricted access to information from elsewhere

Appendix C: Seventeen Information Channels or Sources

No.	Channels/sources
C1	Databases of full-text e-journals (e.g. Emerald, Ingenta)
C2	e-journals (e.g. information research, ACM digital library , D-Lib Magazine)
C3	e-books (e.g. from netLibrary, e-books.com, etc; through library webpage; etc.)
C4	Indexing and Abstracting Databases (e.g., LISA, Science Direct)
C5	Personal collections
C6	Government websites
C7	Business websites
C8	Websites of professional organizations (e.g. CILIP, SIGIR)
C9	Websites of online bookstores (e.g., Amazon)
C10	Website of own institution
C11	Website of other Higher Education Institutions
C12	Search engines (e.g. Google, Yahoo!)
C13	Meta-search engines (e.g. Metacrawler, Mamma, Dogpile)
C14	OPAC of own institution's library
C15	OPAC of other institutions
C16	Listservs and mailing lists
C17	Websites of own interests (like news, sports, travel, health)

Appendix D: Web Survey Questionnaire

We have easy access to a vast amount of information in today's digital world. However, due to constant proliferation of electronic information channels and sources, and tools for information access, there is a possibility of being uncertain at any stage of the information seeking and retrieval process. For example, users are not sure where to start search on a specific topic to get the best results, not sure about the quality of the sources, whether or not getting enough information due to information overload, and so on. hence, further research is required to determine how uncertainty affects information seeking so that appropriate measures may be taken to reduce uncertainty through improved information systems and services.

As a part of my research in the Dept. of Computer & Information Sciences at the University of Strathclyde, Glasgow, I am conducting a survey which aims to gather information on how people from different disciplines go through the information seeking process , start to look for a specific electronic information source/channel, how they identify the relevant ones when many items are retrieved, what problems they encounter, if any, during information seeking and retrieval process, any recommendations ,and so on. I would appreciate if you please volunteer to fill in the questionnaire. The information you provide will be kept strictly confidential, and will only be used for this research. Please note that the following tables are not dependent on each other; therefore the answers in each table will be treated independently.

Thank you very much for your kind co-operation.

Age: ≤ 30 31-40 41-50 51-60 61+

Gender: Male Female

Name of department (*Please write):*

Position: Please select

How confident are you with ICT skills? Please select

Do you think the following information seeking activities cause uncertainty ? If so, please choose as many as you think are appropriate.

Information Seeking Activities	**Uncertainty**	
	Yes	**No**
Choosing appropriate information channels and sources (e.g. search engines, e-journals, databases, digital libraries such as the ACM digital library, personal collections, Library OPAC)	☐	☐
Judging quality of the channels	☐	☐
Judging quality of the sources (e.g. the content of a journal)	☐	☐
Browsing or searching the chosen information sources or channels	☐	☐
Formulating a search expression	☐	☐
Taking a course of action following a search when a set of results appear on screen (Note that too many or too few items may be retrieved)	☐	☐
Deciding when to stop a search and to begin to use the retrieved items	☐	☐
Making use of the retrieved items to perform the actual task	☐	☐
Deciding how many of the retrieved Items should be viewed when many items are retrieved	☐	☐
Deciding which retrieved items should be viewed for their content within the available time	☐	☐
Deciding what to download or print	☐	☐
Ensuring that all the information required for a given task has been obtained	☐	☐
Making sure to remain up-to-date in a given field	☐	☐
Making sure to remain competent in the given field in terms of information seeking and retrieval	☐	☐

Do you think the following information seeking problems cause uncertainty ? If so, please choose as many as you think are appropriate.

Information Seeking Problems	**Uncertainty**	
	Yes	**No**
Too much information or information overload	☐	☐
Too scattered information	☐	☐
Which channels and sources to look for (i.e .you know the source or channel is there but don't know how to look for it)	☐	☐
Fast changing technology	☐	☐
Search output is not exhaustive	☐	☐
Unaware of source/channel	☐	☐
Search results are not up-to-date	☐	
Time-consuming	☐	☐
Too many technological problems	☐	☐
Materials can be unreliable	☐	☐
Not enough relevant materials	☐	☐
Too many different passwords to access	☐	☐
Hard to read or to view on screen	☐	☐
Poor quality display of text/graphics	☐	☐
Slow downloading of pages	☐	☐
Lack of IT skills	☐	☐
Unfamiliar with the resource	☐	☐
Poor quality information	☐	☐
Too many irrelevant results	☐	☐
Having to pay for access to resources	☐	☐
Restricted access to information from elsewhere	☐	☐
Others, if any, please specify	☐	☐

Do you have any recommendations to resolve any of the above problems?
Please write them in the following box.

Do you think use of the following specific information channels/sources causing uncertainty? If so, please select as many as you think are appropriate.

Electronic Information Channels/Sources	Uncertainty	
	Yes	No
Databases of full-text e-journals (e.g. Emerald, Ingenta)	☐	☐
e-journals (e.g. information research, ACM digital library, D-Lib Magazine)	☐	☐
e-books (e.g. from netLibrary, e-books.com, etc; through library webpage; or thorough personal collections)	☐	☐
Indexing and Abstracting Databases (e.g., LISA, Science Direct)	☐	☐
Personal collections	☐	☐
Government websites	☐	☐
Business websites	☐	☐
Websites of professional organizations (e.g. CILIP, SIGIR)	☐	☐
Websites of online bookstores (e.g., AMAZON)	☐	☐
Website of own institution	☐	☐
Website of other Higher Education Institutions	☐	☐
Search engines (e.g. Google, Yahoo!)	☐	☐
Meta-search engines (e.g. Metacrawler, Vivisimo)	☐	☐
OPAC of own institution's library	☐	☐
OPAC of other institutions	☐	☐
Listservs and mailing lists	☐	☐

Websites of your own interests (like news, sports, travel, health)	☐	☐
Other than the above, if any	☐	☐

Please write your general comments, if any, in the following box

Submit Reset

Thank you ☺

Appendix E: Interview Schedule

(The participant is told about the background and purpose of the interview as well as the timeline of the interview. The participant is assured that the content of the interview will be treated as confidential and all data collected will be anonymised and destroyed confidentially on completion of the research.)

1. ***Choice of information channel/sources***

- How do you normally decide which channel or source to choose for searching information on a given topic/question (may be more than one choice)?

    - Do you always use the same channels/sources?

    - Do you select information channels/sources:
    randomly/ based on the topic or question on hand/ your knowledge and experience/ help or guidance from the library website/ through references from some publications/ help of colleagues or contacts? Or, are there any other factors that influence your choice?

- Do you ever find it difficult as to which information channel to choose to begin a search (e.g. the web, a particular digital library or database, e-journals, etc.)?
Yes/No

    If yes, any suggestions for improvements?

    If No, why not?

- Do you ever find it difficult as to what should be the best channel to choose with regard to a specific information source (e.g. to search a particular journal, which e-journal publisher or database should be the best choice)?
Yes/No

    If yes, any suggestions for improvements?
    If No, why not?

- Do you ever feel that the number of channels/sources that you have chosen is not enough? 1 (strongly disagree) 5 (strongly agree)
1 2 3 4 5

- Do you ever feel that there should have been a guide for selection of the best possible information channels/sources for a search topic?
  1 (strongly disagree) 5 (strongly agree)
  1 2 3 4 5

- What sort of problems or difficulties you face in choosing the appropriate/possible channels of information?

- Do you ever feel that some sources/channels have been available but you are unaware of them and accidentally you got them (due to information overload/proliferation) and found it very useful. Sometimes it may change your objectives of the assigned job. Can you say that it is a sort of positive uncertainty which may lead to another avenue?
  Yes/No

  If yes, what is your opinion about it? How would you put it on a five-point scale?
  1 (very little) 5 (very much)
  1 2 3 4 5

- Finally, can we say that you face some degree of uncertainty with regard to the choice of information channels/sources? Yes/No

  If yes, what is your opinion about it? How would you put it on a five-point scale?
  1 (very little) 5 (very much)
  1 2 3 4 5

- Do you have any suggestion on how to reduce the uncertainty?

2. ***Formulation of a search expression***

- Do you think that formulation of an appropriate search expression is a major problem? Agree / Disagree
  1 (strongly disagree) 5 (strongly agree)
  1 2 3 4 5

- Any suggestions for improvements?

- Do you face any degree of uncertainty with regard to the formulation of a search expression? Please use the following five point scale.
  1 (none) 5 (very much)
  1 2 3 4 5

- Any suggestions for how to reduce the uncertainty?

3. *Quality of the sources*

- How do you judge the quality of the sources?

- Do you ever feel any degree of uncertainty with regard to the quality of the sources? Please use the following 5-point scale.

  1 (none) 5 (very much)

  1 2 3 4 5

- Any suggestions for how to reduce the uncertainty?

4. *Deciding when to stop a search and to begin to use the retrieved items*

- How do you decide when to stop?

- Do you ever feel any degree of uncertainty with regard to *deciding when to stop a search and to begin to use the retrieved items*? Please use the following 5-point scale.

  1 (none) 5 (very much)

  1 2 3 4 5

- Any suggestions for how to reduce the uncertainty?

5. *Deciding how many of the retrieved items should be viewed when many items are retrieved*

- What do you do when many items are retrieved?

- How do you decide the cut-off point?

- Do you ever feel any degree of uncertainty with regard to *deciding how many of the retrieved items should be looked when many items are retrieved?* Please use the following 5-point scale.

  1 (none) 5 (very much)

  1 2 3 4 5

- Any suggestions for how to reduce the uncertainty?

6. *Making sure to remain up-to-date in a given field*

- Do you always remain up-to-date in the given field?
  - If yes, how?
  - If not, why not?

- What are your recommendations for improvements?

- Do you ever feel any degree of uncertainty with regard to *making sure to remain up-to-date in a given field? (*Please use the following 5-point scale)

  1 (none) 5 (very much)
  1 2 3 4 5

7. Ensuring that all the information required for a given task has been obtained

- Do you always ensure *that all the information required for a given task has been obtained*?

  1 (none) 5 (very much)
  1 2 3 4 5

  - If no, why not?

  - What are your recommendations for improvements?

8. **Do you think anything else in general, apart from the above points, worth-mentioning regarding information seeking?**

- Overall, the degree of uncertainty in the information seeking process. Please use the following 5-point scale.

  1 (none) 5 (very much)
  1 2 3 4 5

Appendix F: Post-search Questionnaire

It is suggested that the proliferation of information channels and sources, and the complexities they bring with respect to information seeking and retrieval, introduce varying degrees of uncertainty, positive or negative, into the various processes and activities involved in information seeking and retrieval.

This study aims to assess the degree to which uncertainty, positive or negative, is present at various stages of the information seeking and retrieval process, and how it may eventually influence the usability of electronic information services. You may spend as much or as little time as you want to search the topic of your choice but not factual information. You may also exit the experiment at any time should you wish to do so. All data collected will be anonymised and destroyed confidentially on completion of the research. Thank you very much for your kind co-operation ☺

Total time taken:

Faculty…… Department ……

Brief Description of the topic searched:

Academic status: Academic / Research staff / Research Student

Please circle answer the following questions after completion of a search

- *Too much information or information overload*

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- *Too scattered information*

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- *Search output is not exhaustive*

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- *Unaware of source or channel*

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- *Search results are not up-to-date*

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- *Unfamiliar with the source*

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- *Search query was not appropriate*

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- Were you sure about which information channel to choose to begin a search (e.g. the web, a particular digital library or database, e-journals, etc.)? Yes/No
  - If no, any suggestions for improvements?

- Did you find it difficult to choose the best channel with regard to a specific information source (e.g. to search a particular journal, which e-journal publisher or database should be the best choice)? Yes/No

  - If yes, any suggestions for improvements?

- Do you ever feel that there should have been a guide for selection of the best possible information channels/sources for a search topic? Put it in a five-point scale :

  1 2 3 4 5

  (1 strongly disagree 5 strongly agree)

- Do you think that formulation of an appropriate search expression is a major problem? Agree / Disagree

  - Do you have any suggestions for improvements?

- How do you judge the quality of the sources (e.g. journal's reputation, author's reputation, etc.)?

- How do you decide when to stop a search and begin to use the retrieved items?

- How do you decide the cut-off point when many items are retrieved (e.g., top 10, giving a glance at the retrieved items and select)?

- Your comments about information overload (availability of enormous number of electronic information sources or channels due to information proliferation).

1. Feeling positive because
   :.....
   .....
   .....
   .....
   .....
   .....
   .....
   .

2. Feeling negative because

:.....
.....
.....
.....
.....
.....

Your kind co-operation is very much appreciated ☺

Appendix G: Uncertainty Causing Factors

Nos.	Factors
1	unsure about which information channels/sources (e.g. ACM digital library, or e-journal services, or databases available through the University library) to choose to begin a search
2	unsure which ones are the **best** channels/sources for a given task
3	that the number of channels/sources chosen for a specific task is either too many or too few
4	unsure about how to formulate a suitable search query
5	unsure about what to do if none or too little information is obtained
6	unsure about how to deal with too much information
7	that the search output is not comprehensive (i.e. not sure that every different type of information has been obtained from every possible source/channel)
8	that the information obtained is not enough to accomplish a specific task

Appendix H: Search Tasks and the Post-search Questionnaire

It is suggested that the proliferation of information channels and sources, and the complexities they bring with respect to information seeking and retrieval, introduce varying degrees of uncertainty, positive or negative, into the various processes and activities involved in information seeking and retrieval.

This study aims to assess the degree to which uncertainty, positive or negative, is present at various stages of the information seeking and retrieval process, and how it may eventually influence the usability of electronic information services. You may spend as much or as little time as you want to perform each task. You may also exit the experiment at any time should you wish to do so. All data collected will be anonymised and destroyed confidentially on completion of the research.

Thank you very much for your kind co-operation ☺

User category (Please circle): Academic staff Research staff Research student

Please fill-in the following questionnaire and then proceed to search task 1.

Put a cross (X) that best describes your answer in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high. You may skip any question if you feel is not applicable.

Usually do you feel	**1**	**2**	**3**	**4**	**5**
unsure about which information channels/sources (e.g. ACM digital library, or e-journal services, or databases available through the University library) to choose to begin a search					
unsure which ones are the **best** channels/sources for a given task					
that the number of channels/sources chosen for a specific task is either too many or too few					
unsure about how to formulate a suitable search query					
unsure about what to do if none or too little information is obtained					
unsure about how to deal with too much information					
that the search output is not comprehensive (i.e. not sure that every different type of information has been obtained from every possible source/channel)					
that the information obtained is not enough to accomplish a specific task					
that there has been an accidental discovery of information; i.e. some information has been obtained which is useful (for the given task or for any other task) but it was not searched for intentionally					

Search Task 1

Imagine that you are going to write a research proposal on the following topic:
'The architecture of distributed digital libraries'

Please indicate your familiarity with the type of task by putting a circle on a five-point scale (1- unknown; 2- little familiar; 3- average; 4- familiar; 5- very familiar):

1 2 3 4 5

Please indicate your familiarity with the topic (i.e., you have worked on this topic before and searched on the same topic, you read papers on this topic last month, within a year, etc.) by putting a circle on a five-point scale (1- unknown; 2- little familiar; 3- average; 4- familiar; 5- very familiar):

1 2 3 4 5

Please indicate the total amount of time taken to accomplish the task: ….. mins.

Please fill-in the following questionnaire based on the experience gained from the task and after completing the search task 1.
Put a cross (X) that best describes your answer in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high. You may skip any question if you feel is not applicable.

After completing the task do you feel	**1**	**2**	**3**	**4**	**5**
unsure about which information channels/sources (e.g. ACM digital library, or e-journal services, or databases available through the University library) to choose to begin a search					
unsure which ones are the **best** channels/sources for a given task					
that the number of channels/sources chosen for a specific task is either too many or too few					
unsure about how to formulate a suitable search query					
unsure about what to do if none or too little information is obtained					
unsure about how to deal with too much information					
that the search output is not comprehensive (i.e. not sure that every different type of information has been obtained from every possible source/channel)					
that the information obtained is not enough to accomplish a specific task					
that there has been an accidental discovery of information; i.e. some information has been obtained which is useful (for the given task or for any other task) but it was not searched for intentionally					

Please explain or expand on any aspect related to feelings of negative uncertainty, i.e. how some or all of the issues mentioned in the above table have affected your overall information search and retrieval process:

Please explain or expand on any aspect related to feelings of positive uncertainty, i.e. whether and how the issues mentioned in the above table have helped you in any way in your information search?

Search Task 2

Imagine that you are going to write a review paper on the following topic:

"Information access in multilingual digital libraries"

Please indicate your familiarity with the type of task by putting a circle on a five-point scale (1- unknown; 2- little familiar; 3- average; 4- familiar; 5- very familiar):

1 2 3 4 5

Please indicate your familiarity with the topic (i.e., you have worked on this topic before and searched on the same topic, you read papers on this topic last month, within a year, etc.) by putting a circle on a five-point scale (1- unknown; 2- little familiar; 3- average; 4- familiar; 5- very familiar):

1 2 3 4 5

Please indicate the total amount of time taken to accomplish the task: ….. mins.

Please fill-in the following questionnaire based on the experience gained from search tasks 1 and 2. Put a cross (X) that best describes your answer in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high. You may skip any question if you feel is not applicable.

After completing two tasks do you feel	**1**	**2**	**3**	**4**	**5**
unsure about which information channels/sources (e.g. ACM digital library, or e-journal services, or databases available through the University library) to choose to begin a search					
unsure which ones are the **best** channels/sources for a given task					
that the number of channels/sources chosen for a specific task is either too many or too few					
unsure about how to formulate a suitable search query					
unsure about what to do if none or too little information is obtained					
unsure about how to deal with too much information					
that the search output is not comprehensive (i.e. not sure that every different type of information has been obtained from every possible source/channel)					
that the information obtained is not enough to accomplish a specific task					
that there has been an accidental discovery of information; i.e. some information has been obtained which is useful (for the given task or for any other task) but it was not searched for intentionally					

Please explain or expand on any aspect related to feelings of negative uncertainty, i.e. how some or all of the issues mentioned in the above table have affected your overall information search and retrieval process:

Please explain or expand on any aspect related to feelings of positive uncertainty, i.e. whether and how the issues mentioned in the above table have helped you in any way in your information search?

Search Task 3
Imagine that you are going to present an invited talk on the following topic:
"**Usability and evaluation of multilingual digital libraries"**

Please indicate your familiarity with the type of task by putting a circle on a five-point scale (1- unknown; 2- little familiar; 3- average; 4- familiar; 5- very familiar):

1 2 3 4 5

Please indicate your familiarity with the topic (i.e., you have worked on this topic before and searched on the same topic, you read papers on this topic last month, within a year, etc.) by putting a circle on a five-point scale (1- unknown; 2-little familiar; 3- average; 4- familiar; 5- very familiar):

1 2 3 4 5

Please indicate the total amount of time taken to accomplish the task: ….. mins.

Please fill-in the following questionnaire based on the experience gained from search tasks 1, 2 and 3.
Put a cross (X) that best describes your answer in a five point scale where 1 = none; 2 = little; 3 = average; 4 = high; 5 = very high. You may skip any question if you feel and/or the given option is not applicable.

After completing the three tasks do you feel	**1**	**2**	**3**	**4**	**5**
unsure about which information channels/sources (e.g. ACM digital library, or e-journal services, or databases available through the University library) to choose to begin a search					
unsure which ones are the **best** channels/sources for a given task					
that the number of channels/sources chosen for a specific task is either too many or too few					
unsure about how to formulate a suitable search query					
unsure about what to do if none or too little information is obtained					
unsure about how to deal with too much information					
that the search output is not comprehensive (i.e. not sure that every different type of information has been obtained from every possible source/channel)					
that the information obtained is not enough to accomplish a specific task					
that there has been an accidental discovery of information; i.e. some information has been obtained which is useful (for the given task or for any other task) but it was not searched for intentionally					

Please explain or expand on any aspect related to feelings of negative uncertainty, i.e. how some or all of the issues mentioned in the above table have affected your overall information search and retrieval process:

Please explain or expand on any aspect related to feelings of positive uncertainty, i.e. whether and how the issues mentioned in the above table have helped you in any way in your information search?

Based on your experience above, please add your comments, if any, which you think can help to reduce uncertainty in information seeking and retrieval in the electronic environment