AN INVESTIGATION INTO THE WEB SEARCHING STRATEGIES USED BY POSTGRADUATE STUDENTS AT THE UNIVERSITY OF KWAZULU-NATAL, PIETERMARITZBURG CAMPUS

By

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Abstract

The purpose of this mixed methods study was to investigate the Web search strategies used to retrieve information from the Web by postgraduate students at the University of KwaZulu-Natal, Pietermaritzburg campus in order to address the weaknesses of undergraduate students with regard to their Web searching strategies. The study attempted to determine the Web search tactics used by postgraduate students, the Web search strategies (i.e. combinations of tactics) they used, how they determined whether their searches were successful and the search tool they preferred. In addition, the study attempted to contribute toward building a set of best practices when searching the Web. The sample population consisted of 331 postgraduate students, yielding a response rate of 95%. The study involved a two-phased approach adopting a survey in Phase 1 and interviews in the Phase 2. Proportionate stratified random sampling was used and the population was divided into five mutually exclusive groups (i.e., postgraduate diploma, postgraduate certificate, Honours, Master's and PhD). A pre-test was conducted with ten postgraduate students from the Pietermaritzburg campus. The study revealed that the majority of postgraduate students have been searching the Web for six years or longer and that most postgraduate students searched the Web for information from five to less than ten hours a week. Most respondents gained their knowledge on Web searching through experience and only a quarter of the respondents have been given formal training on Web searching. The Web searching strategies explored contribute to the best practices with regard to Web search strategies, as interviewees were selected based on the highest number of search tactics used and they have several years of searching experience. The study was also able to identify the most preferred Web search tool. It is envisaged that undergraduate students can potentially follow these search strategies to improve their information retrieval. This finding could also be beneficial to librarians in developing training modules that assist undergraduate students to use these Web search tools more efficiently. The final outcome of the study was an adaptation Bates' (1979) model of Information Search Tactics to suit information searching on the Web.

List of abbreviations and acronyms

OPAC	Online Public Access Catalogue
Pmb	Pietermaritzburg
UKZN	University of KwaZulu -Natal
URL	Uniform Resource Locator

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Chapter 1

Introduction to the study

1.1 Introduction

The World Wide Web (hereafter "the Web") is considered a powerful tool for information retrieval (Nazim, 2008). However, there are challenges associated with information retrieval on the Web (Kriewel & Fuhr, 2010). The vast quantities of Web-accessible information, as well as the independence of information suppliers' cause the information on the Web to be susceptible to obsolete, misguiding, or imprecise information (Bizer & Cyganiak, 2009). Most students rely on the Web when searching for information, irrespective of the nature of the content being searched for, either academic or non-academic (Griffiths & Brophy, 2005; Shanahan, 2008; Timmers & Glas, 2010). In doing so, it is imperative that these students question the authenticity of the information retrieved, especially if the information is used for academic purposes (Nazim, 2008; Asemi, 2005). Other problems associated with information retrieval on the Web is that students are faced with the difficulty of retrieving information from some resources that are not entirely effective due to a poor understanding of search engines and the inability to use search engines effectively, in addition to the difficulty of evaluating search results and sources (Yates, 2003; Timmers & Glas, 2010).

Google, in its efforts to enhance the search process, has proposed new search features which include easy keyword refinement, flexible search options, results filtering by word or keyword match type, removal of duplicate keywords and the inclusion of negative keywords (Judic, 2010). However, Teevan *et al.* (2004) suggests that even the "perfect" search engine would still be insufficient if one did not know how to use it properly. Even though search providers like Google are spending millions of dollars in order to perfect information retrieval, this will not make a major impact on information retrieval if Web users are ignorant on effectively using Web searching tools (Teevan *et al*., 2004). According to Nachmias & Gilad (2002), a blend of skills is essential for Web searching tools to be used efficiently, such as the skill necessary to use Boolean logic rules (for example OR, AND, NOT), knowledge of Internet notation, knowledge on the categorisation of information and analytical thinking enabling effective information retrieval.

Nachmias & Gilad (2002) further suggest that the searcher needs to possess general knowledge on the topic at which the search is directed. It is also essential for Web searchers to take an

active role in Web search tasks if valuable information is to be obtained and if the information is to be used effectively (Hoeber, 2008). If a searcher is not information literate, then the search may be inaccurate and the results of the search irrelevant, causing the searcher a great deal of frustration and result in much time being wasted (Shanahan, 2008).

According to Kraft *et al*. (2006), search engines cannot easily sustain high precision due to ambiguity and poorly formed queries. Markland (2005) suggests that one of the reasons students may not be able to effectively retrieve information could be that they are hesitant to use search engines requiring complicated decisions with the aim of obtaining relevant information on the first page of the search results, despite the quality of the information retrieved. In order to overcome this problem, Markland (2005) advises that students' should be educated on how to use complex Web searching tools if these tools are to be utilised effectively.

This mixed methods study investigates the Web search strategies currently used to retrieve information via the Web by postgraduate students at the University of KwaZulu-Natal (UKZN), Pietermaritzburg (Pmb) campus in order to address the weaknesses of undergraduate students with regard to their Web searching strategies. One of the goals of UKZN is to "promote excellence in teaching and learning through creative and innovative curriculum design and development, pedagogical strategies and assessment practices in accordance with sound quality assurance principles" (UKZN, 2010a). However, the only training with regard to information retrieval that undergraduate students undergo is voluntary library orientation, which teaches them to access the Online Public Access Catalogue (OPAC) systems to search for print media and books available in the UKZN libraries. Since novice students do not receive training with regard to Web search strategies, most students naturally find it difficult to retrieve information that meets their information needs (Mansourian & Ford, 2007; Nazim, 2008).

The desired outcome of this study is to generate best practices on Web search strategies. This chapter includes a background to the study, the research problem, the objectives of the study, key research questions, definitions of significant terms, the conceptual framework that was used as the basis for the study, potential limitations in research design, an overview of the study and a summary of this chapter. The background to UKZN provides an insight into the campus and college structure, as well as the number of registered postgraduate students on the Pmb campus, who made up the target population of this study.

1.2 Background to the University of KwaZulu-Natal

The vision of UKZN is "to be the premier university of African scholarship" (UKZN, 2010a). UKZN is a South African university that consists of five campuses across KwaZulu-Natal, namely Howard College, Westville, Medical School, Edgewood and Pmb. The former University of Natal was established in Pmb and its predecessor, the Natal University College, was inaugurated in 1910 with a student count of only 57. As of 2011, the Pmb campus has a total of 11,386 registered students, of which 2,344 are postgraduate students (UKZN, 2011). There are four colleges at UKZN. At the time of the study, each college consisted of two faculties and each faculty consists of numerous schools (shown in Table 1.1).

Table 1.1 - College Structure (UKZN, 2010b)

College	**Faculty**
College of Agriculture, Engineering and Science	Faculty of Science and Agriculture Faculty of Engineering
College of Humanities	Faculty of Education Faculty of Humanities, Development and Social Sciences
College of Law and Management Studies	Faculty of Law Faculty of Management Studies
College of Health Sciences	Faculty of Health Sciences Nelson R. Mandela School of Medicine

The Pmb campus offers academic programmes in the fields of Science and Agriculture, Education, Human and Management Sciences and Law. The Pmb campus was selected for this study because it contains the majority of the colleges, except for the College of Health Sciences. Postgraduate students were chosen as the research population because they are all required to search for information as part of their core curriculum (UKZN, 2010c: Introduction). Owing to the research requirements at postgraduate level and that students have most likely spent a number of years searching the Web for information, postgraduates should arguably already be experienced Web searchers. Studying the Web search strategies of postgraduate students could help in addressing the weaknesses of undergraduate students' ineffective retrieval of information on the Web.

1.3 Problem statement

Students are faced with the difficulty of effectively retrieving information, even though the vast amount of information available on the Web is continuously increasing and the design of search engines is constantly evolving to enhance the search experience (Liaw & Huang, 2006; Mansourian & Ford, 2007). Griffiths & Brophy (2005) conducted a study to determine student searching behaviour and found that the use of commercial search engines was the predominant approach. Nowicki (2003) found that most students do not utilise a search engine's advanced search features, and even when they do so, they use them incorrectly. Nowicki (2003) suggests that most Web users utilise search engines to find information and, as a result, she emphasises that it is imperative for the interaction between end-users and search tools to be understood and improved in order to promote successful information retrieval.

It is more convenient for Web users to search the Web due to its easy access to information than to physically go to a library, searching through aisles and sifting through print media to find information that meets their information needs (Nowicki, 2003). Whilst Web searching is convenient, it is a complex task that requires training and experience. Nachmias & Gilad (2002) emphasise users do not naturally posses the complex Web searching skills necessary to retrieving information effectively. Searching the Web for information is not a straightforward task. Sharma (2008) emphasises that some search engines have certain limitations, such as poor Web coverage and low query relevance of the results. Users typically start with keyword searching via a search engine but end up with many of the irrelevant results being retrieved due to the search engine's partial ability to figure out the user's information requirements (Kerschberg *et al*., 2002).

Kuhlthau *et al.* (2008: The Information Search Process in a digital environment) suggests that "the Internet's readily available information has changed students' conceptions of the research process in that they expect to find information quickly and without effort and where choice of topic is guided by an estimate of easy availability of information". Web searchers typically click on links that appear near the top of the search results without considering that more relevant information may be found in links found further down or on subsequent Web pages. Chapelle & Zhang (2009) argue that the main difficulty with regard to Web search ranking comes from position bias, whereby links appearing in lower positions are less likely to be clicked even if they are relevant. Lewandowski (2005) suggests that a perfect search engine will display an extensive account of the Web. However, in reality, a search engine like this is non-existent (Teevan *et al*, 2004).

Based on the sources reviewed, it is evident that Web users face various challenges when retrieving information. Nowicki (2003) claims that addressing these concerns will contribute to the development of the Web as a useful information tool that will include search services that retrieve information effectively. Therefore, it is important to find Web search strategies which will assist students to work around these limitations. Ramírez (2006: Motivation) argues that even though interest in the field of information retrieval is increasing, there is still a gap "between the advances in information seeking research regarding user tasks and behaviour and the work done to apply these studies in information retrieval systems". This study is important in trying to help bridge this gap.

The problems discussed above can prohibit the effective retrieval of information on the Web. These issues may lead to a student retrieving large volumes of information, most of which may be irrelevant (Walraven *et al*., 2009). As a result, much time and effort in the information retrieval process is wasted. The purpose of the study is to gather and analyse the Web search strategies currently employed by postgraduate students at UKZN in order to assist undergraduate students so that they may retrieve information via the Web more effectively. These Web search strategies will arise from postgraduate students' perceptions of which Web search strategies work best for them. The researcher will also adapt Bates' (1979a) model of Information Search Tactics to incorporate Web searches.

1.4 Objectives of the study

The objectives of the study are as follows:

a) To determine what Web search tactics postgraduate students use.
b) To determine what Web search strategies (i.e. combinations of tactics) postgraduate students use.
c) To establish how postgraduate students determine whether Web searches have been successful or not.
d) To contribute towards developing best practices that can be used by undergraduate students when searching the Web.
e) To determine which search tool postgraduate students prefer.

1.5 Key research questions

The following questions are under investigation:

a) What Web search tactics do postgraduate students use?
b) What Web search strategies (i.e. combinations of tactics) do postgraduate students use?
c) How do postgraduate students determine whether Web searches have been successful or not?
d) What are the best practices with regard to Web search strategies that undergraduate students can follow?
e) Which search tool do postgraduate students prefer?

1.6 Definitions of significant terms pertinent to the study

The definitions below are explained in context of information retrieval for the purpose of this study.

1.6.1 Information retrieval

According to Manning *et al.* (2009: 1), Information retrieval is defined as "finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need from within large collections (usually stored on computers)".

1.6.2 Information search strategy

Marchionini (1995) in Thatcher (2006: 1055), defines strategies as "generalised approaches to particular information seeking problems".

1.6.3 Meta-search engine

According to Jansen *et al*. (2007: 744), "a meta- search engine sends queries simultaneously to multiple other Web search engines, retrieves the results from each, and then combines the results from all into a single results listing, at the same time avoiding redundancy.

1.6.4 Online Public Access Catalogue (OPAC)

OPAC is a library system that is used for accessing the library catalogue when searching for resources in campus libraries (Hadebe, 2010).

1.6.5 Web portal

A Web portal is a specialised Web site that has been created to provide convenient access to other sites by acting as a gateway (Tatnall, 2005).

1.6.6 Postgraduate students

Postgraduate students are students at a tertiary level that have obtained an undergraduate degree. A postgraduate student may be registered for an Honours Degree, Master's Degree, PhD Degree or a Postgraduate Diploma.

1.6.7 Search engine

A search engine is a computer program used to crawl the Internet to build a index of Web document (Jansen *et al*., 2007).

1.6.8 Success

Success is when a result or outcome wished or hoped for is achieved (Cambridge Dictionaries Online, 2011: Success). A search is considered successful if the information retrieved meets the searcher's information needs. In essence, the "relevance of web pages to queries is correlated with user search success" (Hassan *et al.*, 2010).

1.7 Conceptual framework

The conceptual framework adopted for the basis of this study is Bates' (1979a) model of Information Search Tactics, which is applicable to manual and online systems, as well as every type of question and field of study. Her model has been used by Carstens *et al.* (2009) to determine how users searched the German education index, as well as the tactics and strategies

they used. For this reason, the model is arguably still appropriate for this study, even though it was created three decades ago. Bates (1979a) defines 29 tactics, which are intended to assist in complicated searches. There are at least four different types of searching strategy models that can be characterised, "models for idealising searching, representing searching, teaching searching and facilitating searching" (Bates, 1979a: 206). This study focuses primarily on facilitating searching and secondarily on facilitating searching, and therefore requires a model that can be used whilst searching for information, which will help students search effectively and efficiently. She advises that her model is "intended primarily as a facilitation model and secondarily as a teaching model" (Bates, 1979a: 206).

Even though it is suggested that the terms "strategy" and "tactic" are well recognised for military usage, Bates (1979a: 207) describes:

> a tactic as "a move made to further a search",
> a search strategy (in searching) as "a plan for the whole search" and
> a search strategy (as an area of study) as "the study of the theory, principles and practice of making and using search strategies and tactics".

She further claims that every move an individual makes towards the goal of finding information to meets his/her information need is seen as a tactic. Bates (1979a: 207) articulates that a "strategy deals with overall planning", whereas a tactic "deals with short-term goals and manoeuvres".

Her model provides tactics likely to enhance the success rate of the search results (Bates, 1979a). She emphasises that the tactics are heuristic as they may assist in some cases, but not necessarily all, and may be good in one situation, but not in another (Bates, 1979a: 207). She further suggests that the "model may make it possible to state the circumstances under which certain tactics are most likely to be useful" (Bates, 1979a: 207). She distinguishes four types of tactics, "namely monitoring, file structure, search formulation and term tactics" (Bates, 1979a: 207). She also suggests that "a few steps may be taken in progressing from a facilitation model of tactics to a facilitation model of strategy" that provides "helpful search strategies or techniques for developing strategies" (Bates, 1979a: 212). The definitions of Bates (1979a) information search tactics are explored in the next chapter.

1.8 Limitations of the study

As with many research projects, this research endeavour is subject to certain limitations. The major limitation is that respondents are restricted to postgraduate students at UKZN, Pmb

campus. Most undergraduate students are considered inexperienced in Web searching (Hsieh-Yee, 2001). However, there are some undergraduate students that are experienced Web searchers (Hsieh-Yee, 2001). Restricting the research population to postgraduate students will mean that those experienced undergraduate students will not contribute their Web search strategies to this study. Owing to personal circumstances, other universities could not be part of this study. If other universities were included in this study, the Web search strategies used by those postgraduates could have been compared to that of the UKZN (Pmb) students. Finally, all postgraduate students could not be surveyed due to the large number of students, which means that the results will have to be generalised to a larger population.

1.9 Overview of the study

This study consists of the following chapters:

- Chapter 2 contains the literature review.
- Chapter 3 discusses the research design adopted for this study.
- Chapter 4 discusses the analysis and findings of the study.
- Chapter 5 concludes the study and provides recommendations for further research.

1.10 Summary of the chapter

This chapter has introduced the issues faced by students when searching for information on the Web. UKZN (Pmb) undergraduate students arguably have insufficient training in Web searching and therefore lack the knowledge to effectively search for information. This poses a challenge for them, taking into consideration that all tertiary education requires information searching to some extent. The background information, problem statement, objectives of the study, key research questions, definitions of significant terms pertinent to the study, conceptual framework, limitations of the study and an overview of the study were presented.

Chapter 2

Literature Review

2.1 Introduction

Research on Web searching is an interdisciplinary topic that incorporates computer science, cognitive science, library and information science and sociology (Hsieh-Yee, 2001; Mansourian, 2005). This chapter examines various disciplines that have studied Web searching strategies for effective information retrieval, the research methods used in the studies reviewed and intentions of the user while searching the Web, as well as the strategies used by the searcher. The objective of this chapter is to look at empirical and theoretical studies on the challenges of information retrieval on the Web, Web searching strategies, search engines and the "invisible Web". Information retrieval tactics and strategies have been of longstanding interest to various disciplines, such as education, information studies, psychology and information technology since the 1950s.

"Information retrieval is central to functioning as an informed society" and the effective retrieval of information is therefore a critical skill (Bhavnani *et al*., 2001: 2). It has been argued that for school and university students, Web sources are now dominating over the use of reference books, academic journals and articles, and it is beneficial to be familiar with how students use Web searching tools to retrieve information (Nowicki, 2003; Shanahan, 2008; Code System, 2009). Academics frequently allege that the Web, to a certain degree, is more powerful than texts due to its ability to be frequently updated (Shelburne, 2009; Code System, 2009). The Web is said to be a valuable avenue for students to improve their technological skills and develop their research skills by learning how to research more effectively using search engines (Shelburne, 2009; Code System, 2009).

Information-seeking is a complex task, which requires numerous search strategies. The digital environment compels people to employ several information-seeking strategies, forcing them to shift from one search strategy to the next (Xie, 2007). The digital age induces change in information retrieval systems and information, which creates difficulties for searchers to retrieve information effectively so that they may accomplish their information goals (Xie, 2007). Searchers are required to use their knowledge and skills, namely their cognitive skills, domain knowledge and general knowledge, in addition to understanding and expertise of a system, and proficiency and ability in information seeking (Xie, 2007; Marchionini, 1995). Cummins (2001)

articulates that developing a clear Web searching strategy as well as critically assessing the results of the search are the most fundamental factors of Web searching.

Users should play an active part when searching the Web, in order for valuable information to be extracted and the information used effectively (Hoeber, 2008). "These tasks include crafting and refining queries, browsing, filtering, investigating and exploring search result sets" (Hoeber, 2008: 29). Additional tasks may require analysing, understanding, organising and saving retrieved documents (Hoeber, 2008). Various aspects are considered crucial factors in Web searching, such as the nature of the search task, system capabilities, user behaviour and search outcomes (Hsieh-Yee, 2001). The manner in which a user searches for information may be affected by their experience with information retrieval tools and computers (Hsieh-Yee, 2001). Hung *et al*. (2008) points out that a great deal of literature in information studies focuses on information seeking at a general level. However, other important aspects, such as information requirements, cognitive abilities, domain knowledge and affective states, similarly affects information seeking (Hsieh-Yee, 2001).

Therefore, in order to recognise effective search strategies, it is important to know strategies used by experts, the type of information searched for and the way in which strategies are linked to particular searches (Bhavnani *et al*., 2001). Nachmias & Gilad (2002) claim that trial and error cannot improve the skills needed to search the Web, and therefore appropriate training is necessary. They argue that the learning objectives of an education system should involve students' possession of Web search skills. They suggest that suitable training resources concentrating on search strategies must be considered and applied (Nachmias & Gilad, 2002). Asemi (2005) explains that students require skills for Web searching and that methodical training is required in order to gain excellence in information searching.

Hwang *et al*. (2008) point out that researchers have stressed the importance of analysing Web search strategies of students for improving the learning capacity associated with online activity. According to Thatcher (2006: 1058), there are various definitions of the term "strategy" in relation to Web searching and studies have frequently "confused a search task with a search strategy". Section 2.2 below describes the terms move, tactic and strategy in the context of a Web search.

2.2 Definitions of moves, tactics and strategies

As Thatcher (2006: 1058) found that previous studies have often "confused a search task with a search strategy", it is imperative to first define each of the terms in order to differentiate them.

2.2.1 Moves

A move is a single step in executing a search tactic (Bates, 1979a; Marchionini, 1995; Xie, 2007; Wildemuth *et al*., 2010). Below is a list of moves and their definitions by Wildemuth (2004: 249), which has been adapted from Shute & Smith (1993).

Table 2.1 - Definitions of moves (adapted from Shute and Smith, 1993 in Wildemuth, 2004: 249)

Beginning moves	
New concept	Enter term(s) for a concept that was not included in previous cycle.
Moves to reduce the size of the set	
Add concept	Add a concept that is not represented in the previous search cycle, using AND.
Combine with AND	Combine two pre-existing concepts, using AND.
Narrow term	Replace a term with a narrower term for the same concept.
Narrow operator	Replace an operator with a narrower operator.
Exclude	Exclude a concept or term, using NOT.
Moves to increase the size of the set	
Delete concept	Delete a concept (that was ANDed) from the previous search cycle.
Combine with OR	Add a term to a concept that is already represented in the previous search cycle, using OR.
Broaden term	Replace a term with a broader term for the same concept.
Broaden operator	Replace an operator with a broader operator.
Move to increase both precision and recall	
Replace term	Replace a term with a sibling/cousin term (i.e., a synonym or closely related term) for the same concept.
Other moves	
Error	Typographical, syntactic, and other types of errors.
Repeat	Repeat the same search terms in two consecutive moves.

An example of a move is selecting a particular device, such as a smart phone, a notebook or a personal computer, to browse the Web. Fidel (1985: 62) recommends moves to "alter sets that

are too large, too small, off target, or to increase precision and recall" (Bhavnani *et al*., 2001). In the next section, the concept of search tactics is discussed and are said to assist the searcher whilst searching for information (Bates, 1979a).

2.2.2 Tactics

Bates (1979a: 207) explains that "a search tactic is a move made to further a search". Marchionini (1995) defines tactics as groups of behaviours, such as capturing a query using general terms and then later narrowing the search by using more specific search terms. Hung *et al*. (2008) defines a tactic as a localised manoeuvre made to further a strategy, where tactics are typically utilised to reduce the number of results retrieved and/or improve the precision or recall of a search. Below is a list of search tactics and their definitions by Savolainen & Kari (2006: 528).

Table 2.2 - Search tactics (Savolainen & Kari, 2006: 528)

Search tactic	**Short definition**
Following links	Activating hyperlinks available on the screen
Going back	Activating Back button
Activating Back button	Inputting a search term into a search engine
Finding search terms	Finding search terms for a query
Remembering a URL	Recalling and typing a URL
Moving to known resource	Drawing on an information resource known from earlier use
Narrowing search	Specifying search by trying narrower search terms
Finding a directory	Finding a useful directory or a list of links
Finding links	Finding individual hyperlinks
Browsing	Browsing hyperlinks in a random way
Finding advice	Finding advice provided by the search system
Switching language	Switching language in formulating search terms, e.g., from Finnish to English
Finding by chance	Finding useful information resources by chance

Wildemuth (2004: 246) adds to the discussion of tactics by suggesting that "a set of moves that are temporally and semantically related, can be a search tactic". In essence, a tactic can be viewed as a combination of moves. Xie (2007) explains that tactics for information retrieval are signified by entities including attributes and methods. The various types of methods include scanning, tracking, specifying, manipulating, surveying, selecting, consulting, comparing,

extracting, acquiring and trial-and-error (Xie, 2007). It is further suggested that strategies for seeking information comprise retrieval tactics and interactive intentions (Xie, 2007). For example, an information seeking strategy: "learning domain knowledge by selecting descriptors of retrieved results" (Xie, 2007: Major components of planned-situational model).

2.2.3 Strategies

Strategies for searching may be perceived as preparation for implementing search tasks that involve numerous search stratagems and tactics (Bates, 1990; Kriewel & Fuhr, 2010). Bates (1979a) defines a search strategy as an overall plan for the entire search. Basically, the stage at which the query is analysed is the point at which the strategy is developed (Bates, 1979a). Below is a list of information seeking at various levels, (i.e., moves, tactics and information seeking strategies) (Xie, 2007).

Table 2.3 - Information strategies at different levels (Xie, 2007: Major components of planned-situational model)

Moves	
Fidel's (1991)	Operational and conceptual moves
Shiri & Revie's (2003)	Cognitive and physical moves
Tactics	
Bates' (1979a, 1979b)	Information tactics
Shute & Smith's (1993)	Knowledge-based search tactics
Wildemuth's (2004)	Domain-knowledge-related search tactics
Information-Seeking Strategies	
Marchionini (1995)	Concept-oriented strategies
Soloman (1997)	The plan strategies versus reactive strategies
Drabenstott's (2003)	Non-domain exerts' strategies

Marchionini (1995) describes strategies as generalised approaches to specific information seeking problems, such as the use of a search engine. However, Kuhlthau (2004) suggests that a strategy is a tactic employed to search for information or to assist during the searching procedure. Hung *et al*. (2008) explains that one or more search goals make up a strategy, which symbolises theoretically well-defined components of the searching strategy, or immediate sub-goals. In essence, a strategy is a combination of one or more tactics each comprising several distinct moves (Wildemuth *et al*., 2010). Therefore, the strategy may consist of various combinations of tactics. Four levels of description have been defined by Marchionini (1995) in

information seeking, i.e., tactics, moves, strategies and patterns, but for the purpose of this study only the first three levels have been discussed. The following section describes the classification of strategies by other researchers.

2.3 Classification of strategies by other researchers

Bates (1979a: 206) discusses the four strategy models, "namely idealising searching, representing searching, teaching searching and facilitating searching". She states, "a model for facilitating searching is one that searchers can use while in the process of searching, one that helps them search more efficiently and effectively" (Bates, 1979a: 206). She also identifies 29 tactics, which are discussed in detail in the conceptual framework section. Xie (2007) points out that information searching strategies has been studied from various angles but concludes that the research is still centred on queries and the modification of queries. Xie (2007) also emphasises that it is essential for more information searching strategies to be identified.

Thatcher (2006) used 80 participants to investigate their cognitive strategies by engaging them in participant-defined tasks as well as researcher-defined tasks to search the Web for information. Based on the results of his study, he maintains that prior Web experience, in addition to knowledge on the subject-matter, perform a vital part in establishing the searching strategies one would use. Search engines were selected by participants based on the search algorithm, the way search results were ranked, possible phrases or keywords, the manner in which a search engine gathered Web page listings (Thatcher, 2006). He explains that there are many limitations to studies on search strategies, such as small sample sizes, researcher-defined tasks and limited sets of users. His study describes the search behaviours and fundamental cognitive strategies when searching the Web for information (Thatcher, 2006). Table 2.4 below is a list of studies with regard to Web searching strategies, the methods used by the researchers, the sample size for each study and the strategies identified by each researcher.

Table 2.4 - Studies investigating Web searching strategies

Author & (Perspective)	**Study Methods**	**Sample size Technique (Participants)**	**Strategy**
Tseng *et al*. (2009)	Transaction log data of a meta-search engine (i.e. Dogpile)	N = 116,466 Unspecified (Total population in log file)	Query reformulation (generalized, specified, dynamic, constant)
Tseng & Wu (2008)	Questionnaire, experimental observation, and interviews	N = 34 Purposive sampling (Patent Engineers)	Keywords, related terms, broader terms and then narrower terms
Hung *et al*. (2008) (Cognitive Scientific)	Observational data, client-side log-files and information science literature	Unspecified Unspecified (Health science librarians)	Grand strategy, Strategy, Tactics, Operations, Assessment
Chu & Law (2007)	Search statements, interviews, questionnaires and think-aloud sessions	N = 12 Purposive sampling (PhD students)	Seventeen search skills (pg. 306)
Bhavnani *et al*. (2006)	Experimental and questionnaires	N = 59 Convenience sampling (Undergraduate students)	Domain portal called the Strategy Hub based on search procedures by experts in their field
Thatcher (2006) (Cognitive)	Structured interview, Client-side log-files and observational data	N = 80 Snowball sampling (University students, academic staff, school children, professionals)	Cognitive search, safe player, Parallel player, link-dependant, To-the-point, known address, Sequential player, deductive reasoning and secondary search strategies
Nachmias and Gilad (2002)	Client-side log-files and questionnaire	N = 54 Unspecified (Master's Students)	Keyword search, wide search definition, complex search, use of general knowledge, computer convention, Boolean search, using a directory, accessing a specific portal and direct typing
Bates (1979a)	Bates experience, literature, comments from her friends	N = Unspecified	Tactics - monitoring, file structure, search formulation and term

The process of seeking information is considered iterative and consists of interrelated sub-processes, which are: identify and acknowledge the need for information, classify and comprehend the information requirement, select a search tool, create a query, implement the search, inspect the search results, source out information then deliberate/iterate/end (Bates,

1979a; Fidel, 1985; Marchionini, 1995). Although many studies on search strategies have been rather more comprehensive and descriptive in nature than most studies, Thatcher (2006) highlights the fact that those strategies have been obtained from high school pupils. Lazonder (2005) points out that most teenagers are incapable of selecting appropriate search strategies, monitoring their progress and assessing how relevant the results of the search are. Considering that information seeking is a complex process and research shows that training on Web searching is essential, it is likely that postgraduate students may offer more effective search strategies than high school pupils.

Markey (2007a) reviews findings from research that has been carried out over a period of 25 years regarding online information retrieval by end-users. Since her focus was on end-users, the review was limited to studies were the users initiated the searches. She identified six studies that supported the claim that less than 15 percent of queries contain the Boolean AND operator, 12 studies that supported the claim that less than three percent of queries contain the Boolean OR operator and six studies that supported the claim that less than two percent of queries include the Boolean NOT operator. She further identified three studies that supported the claim that less than 20 percent of queries include Boolean operators and two studies reported using Boolean searches on different systems.

In addition, Markey (2007a) found two studies that supported the claim that under 15 percent of queries were enclosed with quotation marks, four studies that supported the claim that when advanced search features were used, they were used incorrectly approximately a third of the time. She thus concludes that when the online information retrieval systems were utilised, not many search terms or phrases were used and queries included between two to four words. The next section involves the challenges associated with information retrieval on the Web.

2.4 Challenges of information retrieval on the Web

The study by Bhavnani *et al*. (2001: 2) addresses three areas: “the development of an explicit user-based approach to model information retrieval, an approach to train users to be effective retrievers of information and a systematic method to guide designers to identify and implement functionalities that enable users to execute effective information retrieval strategies”. Their findings suggest that strategies for seeking appropriate information effectively are not obtained by users regardless of the awareness of simple searching methods. Searchers may not take advantage of the self-training online tutorials due to their formats, which may be a significant

deterrent owing to the likelihood that these programmes may be too in-depth for a novice Web searcher (Debowski, 2001).

Another crucial problem is that search engine crawlers fail to index millions of articles, even though they are allowed access to the digital archives, some of which are the leading academic publishers and repositories (Pedley, 2001; Jacso, 2005). This gap portrays an incorrect reflection of the academic coverage which leads to the exclusion of some significant articles (Jacso, 2005). Many information seeking tools seldom help searchers to acquire the correct search technique even though advanced search functionalities are provide (Brajnik *et al*., 2002; Kriewel & Fuhr, 2010). According to Wilson *et al*. (2009), the default standard of information retrieval on the Web is keyword searching, however Web searchers are not supported by this approach when their goals have been inadequately defined, questions that are complicated, inadequate knowledge on searching, the use of a poorly defined system or unpredictable indexing.

Teevan *et al.* (2004) points out that directed searching has been supported by researchers in that they are trying to create a "perfect" search engine (i.e., which will return precisely what is searched for). However, it is argued that the "perfect" search engine may be insufficient, even if a user identifies precisely what information they require (Teevan *et al.,* 2004). Teevan *et al.* (2004) conducted an observational study of users executing searches that were personally motivated and established that keyword searches featured in only 39 percent of searches, in spite of being aware of their information requirements. The users performed directed situated navigation as an alternative of going straight to the relevant information by means of keyword searches (Teevan *et al.,* 2004).

They conducted 151 semi-structured interviews by interviewing every user twice a day for five successive days, for approximately five minutes for each. To comprehend how directed searches were performed as well as the reasons for avoiding a keyword search, the data was qualitatively examined and two opposing strategies (i.e., teleporting and orienteering) were discovered (Teevan *et al.,* 2004). "Orienteering denotes a search behaviour in which people reach a particular information need through a series of small steps" (Teevan *et al.,* 2004: 417). Teleporting, in contrast, is described as involving several local, situated steps (Teevan *et al.,* 2004).

Jansen & Spink (2006) examines the changes and characteristics with regard to searching the Web from nine different studies involving US and European-based search engines. They also compared the interactions between search engines and users from "the perspectives of session length, query length, query complexity and content viewed among the search engines". Jansen

& Spink (2006) explain that although users appeared reluctant, they devoted extra effort to retrieving relevant information. However, most users viewed only the results page (Jansen & Spink, 2006). It was found that fewer results pages were being viewed and more query operators were used on search engines that were US-based than European-based (Jansen & Spink, 2006). They concluded that research findings on one search engine cannot be applied to another (Jansen & Spink, 2006). It was suggested that the extensive use of search engines, the decline in viewing of results pages and the use of simple queries is probably due to algorithmic enhancements made by information service providers (Jansen & Spink, 2006).

When queries are specific, search engines display highly relevant results, most of which are in the first few pages (Hoeber, 2008). However, search engines become ineffective when a user is unable to create queries that specify exactly what information is required or if the queries are ambiguous (Hoeber, 2008). Studies reveal that a user frequently provides only one or two terms when formulating their queries and rarely views more than three pages of the Web searching results (Jansen & Spink, 2006; Hoeber, 2008). There are many challenges regarding information searching on the Web, such as position bias, formulation of queries and search engine crawlers. Position bias is a problem regarding ranking as links that appear in lower positions may not be viewed even if they are relevant (Chapelle & Zhang, 2009). Keywords are used by search engines as a key factor to seek information and some Web searchers struggle when formulating queries that are descriptive enough to meet their information needs (Chu & Law, 2007; Tseng *et al*., 2009).

The difficulty that novices face is obtaining search terms that summarise their information needs and will produce result sets to meet these needs (Fields *et al*., 2004; Kriewel & Fuhr, 2010). It is argued that novices seldom employ sophisticated search strategies and frequently use counter-productive methods (Carstens *et al*., 2009; Kriewel & Fuhr, 2010). Novices rarely recognise when and how to use the advanced search features (Markey, 2007a; Kriewel & Fuhr, 2010). Aitken (2007: Undergraduate research on the Web) explains that at the University of Tasmania, first year undergraduate students were discouraged from using online sources for research. She explains that the reluctance stemmed from students' inexperience in judging academically reliable sources available on the Web.

Codina (2007: Introduction) claims that "there is a difficulty in finding academic or scientific results when terms with the same name (but a different meaning) are also used in commercial or popular culture". Hung *et al*. (2008) suggests that although physicians are proficient in patient care, they lack the expertise crucial to translating their information needs into searching strategies to facilitate the retrieval of relevant results. They believe that health science librarians

are proficient at searching information sources that will almost certainly deliver relevant information as they possess practical experience and have undergone formal training. Savolainen & Kari (2006) analyse the methods to enable users to deal with and bridge the gaps when searching the Web.

Seven participants conducted Web searches that were videotaped and 11 gaps including 13 search tactics were documented (Savolainen & Kari, 2006). The gaps stemmed from three critical aspects, namely problematic information, problems created by the search environment and insufficient search competence (Savolainen & Kari, 2006). They found that the most frequent gaps were irrelevant material, content that was inaccessible, and uncertainty. They further explain that if the process was terminated due to inadequate search abilities, then users returned to familiar information from prior use in order to get back on track with the search process and followed by trying to specify the terms searched (Savolainen & Kari, 2006). Table 2.5 below reveals the gaps faced in Web searching.

Table 2.5 - The gaps faced in Web searching (Savolainen & Kari, 2006: 527)

Type of gap	**Short Definition**
No relevant material	Lack of relevant material found in the Web pages
Confusion	Unable to see how to continue moving in the Web in general
Inaccessible content	Unable to understand the content of information available on a Web page
Overload	Information overload: ‘‘too many hits’’
No access	No access to Web pages, e.g., due to ‘‘broken links’’
Crossroads	Unable to decide between alternative links
No links	Unable to identify relevant hyperlinks, e.g., by using search engines
Wrong way	Getting lost in cyberspace
Badly organized material	Material found in the Web poorly organized
No search terms	Unable to define relevant search term(s)
Technical problems	Technical problems such as frozen engine

Gap-bridging is a move to find alternative methods of searching when a problem arises. Savolainen & Kari (2006) found that of the tactics used to bridge the gap, the most frequently used were activating the Back button and following links. Where participants found that the content of information was problematic, the search was redirected to locate more relevant information (Savolainen & Kari, 2006).

2.5 Search Engines

There are various types of search engines, such as news search engines (for example, NewsIndex and InforGrid) and speciality search engines (for example, AskJeeves and Web Help), to name a few (Chowdhury & Chowdhury, 2001). Kim *et al*. (2007) studied three search engines (i.e., Google, Yahoo and MSN) by analysed their Web coverage and found that the leading search engine was Google, covering 85 percent of all search terms that were unique. They believe that Web coverage is not drastically enhanced by meta-search engines, since the main issue is the rate of information updates and not the extent of the Web coverage.

Nowicki (2003) concluded that the popular search engines were not effective in retrieving relevant results. It is believed that the reason for this may be that students did not use search engines to their greatest potential, which is probably due to insufficient user search experience (Nowicki, 2003). Downey *et al*. (2008: 457) claim that "several measures of user interaction (i.e., results clicks, query reformulations and session length) indicate that search engines are doing a better job at satisfying common information goals".

Jansen & Molina (2006: 1075) examined "the effectiveness of five types of search engines in response to e-Commerce queries by comparing the engines quality of e-Commerce links using topical relevancy ratings". Their research employed 100 queries relating to e-Commerce, over 3,540 Web links and five main search engines. They found that e-Commerce search engines produce considerably superior links than links provided by other engines types. Table 2.6 below is a list of the top five United States search providers reported by The Nielsen Company and the searches performed in one month for each year between 2008 and 2010.

Table 2.6 - Search engine ranking (Johnson, 2009; The Nielsen Company, 2009; The Nielsen Company, 2010)

Rank	Provider	Searches (000) December 2008	Searches (000) November 2009	Searches (000) February 2010
	All searches	8,623,705	10,002,458	9,174,408
1	Google search	5,421,943	6,546,172	5,980,116
2	Yahoo! search	1,448,140	1,525,964	1,294,261
3	MSN/Windows Live/Bing Search	841,457	1,073,416	1,142,344
4	AOL Search	357,025	280,311	206,969
5	Ask.com Search	169,116	177,589	175,074

Bertolucci (2007) concludes that Google is the best search engine as its index proved to be the most accurate, comprehensive and timely. However, Cohen (2006) suggests that Google has been so successful that intense, scholarly research has become the victim of Google. Instead of analysing material for an essay or assignment, students rely on Google and believe that they have found enough information (Cohen, 2006). There is no sense of Boolean logic, no double-checking of the resources in the top 10 results, and probably no thinking involved at all (Cohen, 2006).

Griffiths & Brophy (2005) studied student searching behaviour in addition to the Web and found that students' search strategies where dominated by commercial search engines. Since the usage of search engines is hard to quantify due to their uncontrolled environments, it was difficult for them to use the recall and precision model in assessing Web search engines to information retrieval systems (Griffiths & Brophy, 2005). The findings from previous research have been summarised by Griffiths & Brophy (2005:541) as follows, "(1) students use the Web for everything; (2) they may spend hours searching or just a few minutes; (3) searching skills vary and students will often assess themselves as being more skilled than they actually are; and (4) they will give discussion list comments the same academic weight as peer-reviewed journal articles". They found that 23 students searched Google, four searched Google as well as Yahoo, three searched Yahoo, and five searched a range of search engines.

They concluded that students preferred to use a search engine when seeking information, the preferred search engine was Google, academic resources were hardly used, it is challenging for students to find relevant information, the quality of information may be traded for time used up seeking information and students' expectations of all electronic resources are influenced by their usage of Web search engines (Griffiths & Brophy, 2005). They also claim that students seemed to have either insufficient knowledge of alternate methods of information retrieval or have attempted other ways but nonetheless favour the use of Google). Most users also showed satisfaction with the initial 10 search results that was sufficient to satisfy their information needs and a comprehensive search was seldom of interest to them (Griffiths & Brophy, 2005).

An experiment involving eye tracking showed that students have significant faith in Google's "ability to rank results by their true relevance to the query" (Pan *et al*., 2007: 801). Pan *et al*. (2007) claim that information retrieval algorithm used by Google arranges the results by estimating the probability to have the searcher's information need fulfilled. They found that effort and time costs cannot be reduced by faith to retrieve largely relevant information. According to Popova (2011), Google personally tailors each individual's search queries by means of the filter bubble, which returns results containing links that one is most compelled to

click. This means that Google is aware of everything that every user has searched for. Popova (2011) further explains that your filter bubble is the personal universe of information that you live in online (i.e. unique and constructed just for you by the array of personalized filters that now power the Web).

Nazim (2008) evaluates the information seeking behaviour of Web users to learn their information needs, their satisfaction level with Web resources in addition to issues that hinder their Web use. The favourite tool for Web searching was the search engine (Nazim, 2008). He found that the most prevalent search engines were Google and then Yahoo and over 50 percent of users requested programs on Internet literacy to help search for quality information.

> Google's Library Linking program allows you to setup your OpenURL link resolver (e.g., Serial Solutions 360 Link) so your users searching in Google Scholar can access the full-text of their results whenever the content is licensed by your library (Metz, 2008: 2).

Drewry (2007) suggest that blended databases, such as Windows Live Academic Search (WLAS) and Google Scholar, provides quick access to academic information at no cost over and above links to library reserves and other services. Questionnaires were sent to 540 librarians to find out how they used WLAS and Google Scholar (Drewry, 2007). Librarians are forced to acknowledge the advent of a relatively new paradigm within research due to their recognition and effectiveness particularly Google Scholar. (Drewry, 2007).

While search engines are said to be important tools for retrieving information via the Web, the ability to use search engines effectively is a major obstacle for many novice Web users (Liaw & Huang, 2006). They investigated individual behaviours during the information seeking process by utilising information processing theory and found that users' outlook on search engines is affected by their experience with this search tool (Liaw & Huang, 2006). In addition, they found that the precision of information retrieved does not entirely satisfy users, and the motivation of users is a crucial factor used to assess their intent to seek information using search engines (Liaw & Huang, 2006).

A mixed methods study conducted by Kules & Shneiderman (2008) reveals how combining quantitative and qualitative methods was used to addresses their research questions. Their study reveals cognitive and tactical advantages of categorised overviews. Kules & Shneiderman (2008: 481) concluded that "searchers explored results more deeply; (2) they agreed that the categorized overviews helped them organize, explore and assess their results without being

appreciably more complex than typical Google-like interfaces". When categorised overviews were available, more categorised pages were viewed and eagerness for categorised overviews was frequently expressed, e.g. "I loved it. . . I wish Google had that" (Kules & Shneiderman, 2008: 481). A categorised overview is a search interface that combines a meta-data based overview plus the search results to facilitate effective interaction between the user and the search tool (Kules & Shneiderman, 2008).

Hwang *et al*. (2008) propose a Web-based environment for learning, called Meta-Analyser, which can support educators in analysing the learning behaviours of students utilising search engines when solving problems. The results revealed that this innovative method is proficient in increasing one's knowledge in relation to the learning methods used by students' and search techniques used in environments driven by technology (Hwang *et al*., 2008). Meta-search engines provide a foundation for Meta-Analyser, providing integrated access to more than one search engine (Hwang *et al*., 2008). Two hundred and twenty students attending school were required to answer a few questions using Meta-Analyser, in order to assess the feasibility as well as the prospective implementation of Meta-Analyser (Hwang *et al*., 2008). It was established that a variety of learning objectives together with research challenges can be efficiently and effectively explored and achieved with this innovative method (Hwang *et al*., 2008).

Lewandowski (2005) suggests that a comprehensive account of the Web would be provided by a perfect search engine, but a perfect search engine is non-existent. It would be extremely costly to crawl the entire Web. Furthermore, locating every single relevant document from an enormous environment would be a major challenge (Lewandowski, 2005). It is, therefore complicated to determine the Web coverage of a particular search engines. Search engines are said to be one of the most preferred and valuable facilities available on the Web (Beg & Ahmad, 2007). O'Reilly (2007) explains that one should search in phrases or questions and those phrases are then highlighted in the results to make browsing easier. Nolan (2008) advises that new opportunities are opened by research on exploratory searching in order for information architects to expand the domain. The following section deals with the "invisible Web" in relation to Web searching.

2.6 The "invisible Web"

The "invisible Web" can be described as the portion of the Web that is not indexed by search engines (Sherman & Price, 2001; Lewandowski, 2005). The "invisible Web" contains every

single information resource present on the Web, which is disregarded by traditional search engines, such as Google (Devine & Egger-Sider, 2004). The majority of this disregarded material resides in subject databases that require individualised searching or comprise information that is dynamically generated for a specific inquiry (Devine & Egger-Sider, 2004). They claim that only indexed content can be found by search engines using software programs, called spiders or crawlers. Search engine indexing is most likely limited in the quantity of information it obtains from a single site, with the intention that some Web site content will be indexed and some will not (Devine & Egger-Sider, 2004). Through raising awareness of the "invisible Web" and assisting people to use it, librarians are building on their knowledge and the services that they offer at their reference desks (Devine & Egger-Sider, 2004).

> The "invisible Web" consists of "text pages, files, or other often high-quality authoritative information available via the Web that general purpose search engines cannot, due to technical limitations, or will not, due to deliberate choice, add to their indices of Web pages (Sherman & Price, 2001: 139).

Numerous resources that constitute the "invisible Web" are said to be superior in quality than the resources found on the open or visible Web (Pedley, 2001; Yang *et al.*, 2009). It is suggested that the quality of the resources available on the "invisible Web" is much higher than that of the visible Web (Pedley, 2001; Yang *et al.*, 2009). Pedley (2001) presents a report which contains a list of tools that may be used to surf the "invisible Web", a list of valuable "invisible Web" sites and a few worked examples on how to use the "invisible Web".

Ford & Mansourian (2006) studied the concept of the "invisible Web" by undertaking an empirical investigation. A distinction was drawn between "technical objective conceptions of the "invisible Web" that commonly appear in the literature and a cognitive subjective conception based on searchers' perceptions of search failure" (Ford & Mansourian, 2006: 584). They suggest that resources on the "invisible Web" include content, which "general-purpose search engines either cannot, or are not intended to index" (Ford & Mansourian, 2006: 584). The following section deals with information literacy in relation to Web searching strategies.

2.7 Information literacy as a factor

We are living in an era that is driven by global information systems, which is can be accessed by the Web, but basic skills and abilities are required to utilise these advanced technologies, therefore a crucial prerequisite appears to be information literacy (Zins, 1999). He claims that

"Information searching is a sequence of interrelated actions, each of which determines the course of the searching and thus affects its final result" (Zins, 1999: Systematic searching). He also emphasises that crucial to successful information retrieval is a searcher's rationale. A search engine is better used when the required information is associated with several topics at the same time, for a vague subject matter or when a precise item is being searched (Zins, 1999). He defines information literacy as internalising search strategies that are well thought-out, in addition to advanced proficiency with technology. The success strategy was based on structured interviews with scholars, information specialists and expert librarians, and field observations (Zins, 1999).

Eagleton *et al*. (2003: 34) established that the Web searching procedure is a tricky literacy task for students, which involves "choosing topics, setting goals, asking questions, applying search strategies, selecting keywords, analyzing search results, evaluating Web site relevancy, documenting sources, note taking, synthesizing, transforming, and presenting findings". Their project extended over a period of six-weeks and involved stating each participant's goal, short evaluations, and questions from students, thereafter students were taught how to review for 15 minutes, they practiced independently for 25 minutes and the last five minutes was used to think about their improvement (Eagleton *et al*., 2003). The majority of the students enjoyed the activities, as they concentrated on improving competence for online research (Eagleton *et al*., 2003). Eagleton *et al*. (2003) suggest that educators are able to meet a number of teaching goals as well as literacy standards through inquiry-based learning at the same time incorporating technology into the curriculum.

Nowicki (2003) claims that her results clearly illustrate the need for information literacy and computer literacy training for students and indicates that faculty members need to consider that students require training in searching skills, critical thinking skills, technological skills and Web site evaluation to be successful in information retrieval on the Web. Eisenberg *et al.* (2004) concurs that all students ought to acquire skills in information literacy, particularly the ability to evaluate if the information source is appropriate. Candy (2004) explains that a Presidential Commission on Information Literacy was created by the American Library Association, which states:

> To be information literate, a person must be able to recognise when information is needed and have the ability to locate, evaluate and use effectively the needed information … whether the information they select comes from a computer, a book, a government agency, a film, or any number of other possible resources (American Library Association, 1989: 1).

Henry (2005) highlights the importance of the skill to dexterously seek and find information on the Web and suggests that new literacy skills and Web searching strategies are vital for education in the 21st century. She explains that there were two reasons for her exploratory research. It aimed at identifying original literacy skills as well as strategies necessary to effectively retrieve information via the Web and to also establish the methods used by participants to learn how to seek information via the Web (Henry, 2005). Apart from the most important literacy skill (i.e., reading), she found several more specific types of reading, namely the "ability to scan, skim and sift through material quickly, in-depth reading of information and texts and critical reading ability" (Henry, 2005: Literacy skills).

Henry (2005) suggests that training students to find, examine, evaluate as well as understand Web searching results should be a key focus of reading as students are challenged with a future that is immersed in technology. Information retrieval on the Web requires literacy skills, as well as problem solving skills (Henry, 2005; Hung *et al*., 2008). In addition, Mansourian (2008) explains that any information literacy course would benefit students by enabling them to search more efficiently if the contextual aspects were considered in the educational program.

Lwehabura & Stilwell (2008) identified several challenges that need to be dealt with in order to promote information literacy, namely ample library staff, the lack of available resources, encouragment of enthusiasm in students to be trained, partnerships between librarians and teachers to mainstream information literacy and the formulation of and information literacy policy. According to Hadebe (2010), these challenges are also being experienced at the University of KwaZulu-Natal. Kim (2008) suggests that well-designed information literacy course is sure to increase users confidence when seeking information and expand their search skills. The next section deals with Web searching strategies that have been identified by other researchers.

2.8 Web searching strategies

White & Iivonen (2001) focus on a searcher's choice of the initial search strategy, where the searcher needs to decide whether to use a subject directory, a direct address or a search engine. They surveyed 54 experienced searchers, who showed some understanding of the three search strategies discussed in the study. White & Iivonen (2001) indicate that within the search process, choosing the initial search strategy is just the first step, which ultimately comprises numerous steps. They explain that "the selection among direct address, subject directory and search engine often translates into a decision influenced by considerations about the amount of

information or the number of sites to be searched, the degree of pre-screening, the probability of relevance and the effort involved in creating a viable search statement (White & Iivonen, 2001: 723). They found that 43 percent of overall participants relied on search engines, 30 percent relied on direct access and 27 percent on directories.

Downey *et al*. (2008) found URLs to be an effective strategy for fulfilling unusual information requirements by first finding general information and thereafter moving to more precise information. According to Berkeley Library (2010), skilfully evaluating Web pages requires two things simultaneously. Firstly, trained fingers and eyes to apply a series of procedures in order to assist in quickly locating information about the Web page (Berkeley Library, 2010). Secondly, critical thinking, which involves posing several questions designed to assist in determining to what extent a one can trust a Web page (Berkeley Library, 2010).

Hung *et al*. (2008) provide a list of example tactics and sub-tactics that support Boolean searches, such as limit tactics, query tactics, facet tactics and term tactics. They emphasise that a crucial aspect to acknowledge is that the choice of strategy and the strategy problem space is restricted to the resource being searched (Hung *et al*., 2008). Hung *et al*. (2008: 8) suggest that "the number of appropriate strategies to search a given resource is substantially smaller than the universe of all strategies". They claim that the overall search goal influences the strategy choice, for example, a search with high precision will probably call for another strategy than that of a search with a high relevancy (Hung *et al*., 2008).

Jeonghyun (2009) studied the search task as a crucial factor of information seeking in order to characterise tasks and to examine how various kinds of task produce different kinds of information-seeking behaviour. Data was collected via an experiment intended to observe searchers' behaviour, whereby three tasks were allocated to thirty graduate students and the data were collected using interviews, questionnaires and search logs (Jeonghyun, 2009). Fourteen information-seeking strategies were identified through a quantitative and qualitative analysis (Jeonghyun, 2009).

Wildemuth *et al*. (2010) focus on the search tactics used when searching an online collection of digital videos. Transaction logs were used to capture the 36 participants' interactions with the system, in addition to their search strategies. The sequence of moves in each search was analysed in order to determine the search tactics employed. Wildemuth *et al*. (2010) found that searches varied extensively in terms of the search tactics used and that a large number of search tactics were used (i.e., 13 individual tactics in 141 searches). They claim that even though the search tactics primarily incorporate only four different moves (New Search, Add Concept,

Delete Concept, and Display), those moves can be and are sequenced in a variety of ways by searchers. Wildemuth *et al*. (2010) concludes that the displaying/viewing of results plays an essential role in search tactics. It was further established that searchers occasionally made changes in the search terms representing a concept (i.e., either by selecting broader or narrower terms) and seldom manipulated the search operators (Wildemuth *et al*., 2010).

Kriewel & Fuhr (2010) describe an adaptive search suggestion system that is based on case-based reasoning techniques and evaluates its effectiveness in assisting searchers to utilise advanced search strategies. An experiment was conducted with 24 users (i.e., volunteer students from the University of Duisburg-Essen) and the results indicated a relationship between the success of a search and the use of suggestions (Kriewel & Fuhr, 2010). They found that the advanced search tools were employed considerably more by users who obtained search suggestions (Kriewel & Fuhr, 2010). They wanted to determine if successful searches were due to the suggestions and if it helped users to utilise more sophisticated search techniques (Kriewel & Fuhr, 2010). For the first research question, the number of relevant documents saved by a user was taken into account and search logs were examined for the remaining two questions (Kriewel & Fuhr, 2010).

Weare (2010) claims that when students begin searching the Web, they do not actually think through the information search process. He claims that they should first answer four key questions before embarking on the search, namely as "Is the open Web the right tool?", "What type of sources is likely to contain the information I need?", "Where am I likely to find this information?" and "What terms are likely to appear on the page I am looking for?" (Weare, 2010: 56). He describes a Web searching strategy that, in his view, would help students improve their search results and the overall effectiveness of the search. In some instances, the approach taken may be inappropriate, whilst in other instances the problem may be the tool chosen (Weare, 2010). He thus maintains that a more efficient approach may prove to be the use a subject-specific search tool.

Research suggests that users can better express their information requirements in natural language, yet the majority of the research on improving document retrieval has concentrated on keywords, phrases or Boolean queries (Turtle 1994, Belkin *et al*. 2001, Kelly *et al*. 2005, Murdock *et al*. 2007). Murdock *et al*. (2007) investigate ways to improve document retrieval for natural language questions that involve how things are done. The approach is based on taking advantage of the document structure and reveals a major improvement with precision at the first rank for questions involving how things are done (Murdock *et al*., 2007). Wolfram (2008) found

that those users who do engage in different search behaviours, do not view Web searching facilities in the same light.

When students understand the search process, they will be competent to perform more calculated searches, thereby locating better quality resources (Weare, 2010). Mansourian & Madden (2007) found that participants showed more confident when performing searches that were work-related and their searching strategies were more effective in this type of search. Most of the search tactics/strategies have been discussed in this section. The following sub-sections deal with various tactics, such as searching in collaboration, the use of multiple browsers, the use of multiple search engines, query formulation and cognitive search strategies.

2.8.1 Searching in collaboration

Lazonder (2005) examines the effect of collaboration on undergraduate student behaviour when searching the Web and the outcome of the search and found that students who collaborated produced better search results more efficiently than students that searched on their own. Students also showed evidence of an advanced range of search strategies (Lazonder, 2005). Based on the results of his study, it was suggested that undergraduate students should work jointly when searching the Web for information due to the advantages of collaborative Web searching (Lazonder, 2005).

2.8.2 The use of multiple browsers

Aula *et al.* (2005) used questionnaires to study 236 experienced (i.e. individuals that manipulate information as their main profession) Web users and found that respondents commonly used key strategies, such as the use of multiple browser windows simultaneously, which they believed to be essential. It was also noted that some strategies recommended in previous studies were not found to be as important, such as the use of URLs on a Web page (Aula *et al.,* 2005). When searching with several Web browser windows, considerable cognitive resources were required, more attention had to paid when searching than when using one Web browser at a time and users had to constantly remind themselves of each search and its progress (Thatcher, 2008).

2.8.3 The use of multiple search engines

Asemi (2005) studied the search behaviour of Web users at the Medical University of Isfahan by collecting data from 188 postgraduate students through the use of questionnaires and performing follow-up interviews using a random sampling method. Her analysis revealed that 54 percent of respondents always found useful information on the Internet, whereas 25 percent disagreed. Twenty-four percent did not always find research-oriented information on the Internet, and 72 percent indicated that the Internet did provide research-oriented information. White *et al*. (2008) found that when users switched search engines, roughly 50 percent of all searches returned information which met their information needs. Asemi (2005) suggests that a Web searcher should utilise multiple search engines, as one search engine may present better quality results for certain queries than others do, so that users can search the Web more effectively.

2.8.4 Query formulation

A searcher's information requirements are expressed as search queries and searchers use a range of navigation and search strategies in order to satisfy their information needs (Downey *et al*., 2008). Jansen *et al*. (2008: 1251) "define and present a comprehensive classification of user intent for Web searching" and is said to "consist of three hierarchical levels of information, navigational and transactional intent". After obtaining the attributes for each, they "developed a software application that automatically classified queries using a search engine log of over a million and a half queries submitted by several hundred thousand users" (Jansen *et al*., 2008: 1251). The findings reveal that over 80 percent of Web queries were information and approximately 10 percent were transactional and 10 percent navigational. Jansen & Spink (2006), claim that users would rather reformulate the query than navigate through the results pages.

Nachmias & Gilad (2002) examined information retrieval process on the Web by evaluating the success of 54 university graduate students when searching for researcher-defined information on the Web, the search strategies used, as well as assessing the effectiveness of the search strategies. The search processes were recorded and logged by tracking software (i.e., Surf Spy). Nachmias & Gilad (2002) defined success as locating a Web page that included the exact information outlined in the search task. If a respondent located partial information, the search was considered unsuccessful. They found that only 15 percent of respondents succeeded in accomplishing all three tasks, 39 percent completed two out of three tasks, 40 percent completed

only one task and six percent failed in their attempts. Although the participants' most widely used strategy was a single keyword search, this strategy was found to be inefficient (Nachmias & Gilad, 2002).

Nowicki (2003) found that almost 50 percent of students used single-word queries to search, most of which were unclear. Searches on proper names returned an extensive range of information because they lacked more specific search terms (Nowicki, 2003). A few (exact number not specified in the article) students used specific search queries, but these searches also returned an extensive range of information and those who used ambiguous queries may have assumed that search engines would return relevant information (Nowicki, 2003). She also established that advanced search features were not utilised by the majority of students (such as Boolean operators) and when they did, they used them incorrectly.

Chu & Law (2007) categorise two keyword search types, i.e., a simple keyword search, where a single search term is used and complex keyword search, whereby two or more search terms connected by one or more search operators are used. Chu & Law (2007) found that 40 percent of respondents used single keywords and 60 percent used complex keywords. Interactive query expansion may be a valuable technique to assist users in formulating improved queries and consequently achieve better search results (White & Marchionini, 2007). As a user captures the query into a textbox, a list of additional query terms is provided, thereby offering query expansion preferences whilst the query is prepared (White & Marchionini, 2007). White & Marchionini (2007) explains that the effectiveness of real-time query expansion depends on various factors.

Hammond & Brown (2008: 61) suggests that citation searching is a good means of building a complete body of knowledge, because "the databases allow you to follow a trail of cited references that weaves a Web of information across the boundaries of time and subject limitations". The need to be familiar with subject-specific jargon or appropriate synonyms to facilitate effective searches is eliminated by citation searching (Hammond & Brown, 2008). It saves time, whilst improving the relevancy of the search results to meet a user's information needs and one may benefit immensely from the citation searching databases if a user requires a comprehensive literature review (Hammond & Brown, 2008).

Mansourian (2008) shows how search performance is affected by a particular context for a Web search and acknowledges the key components that manipulates the Web searching process. Tseng & Wu (2008) investigated the search tactics of patent professionals and the factors of choice of tactics at various stages of the search. It was found that the most frequent approach

was the use of keywords at the initial stage of the search process, followed by the use of related words, then by the use of broader terms and finally the use of narrower terms (Tseng & Wu, 2008).

Manning *et al.* (2009) categorises common Web searching queries into three broad categories: informational, navigational and transactional, and suggests that some queries may fall outside these categories whilst others fall into more than one. An informational query seeks non-specific information relating to a broad topic (Manning *et al.,* 2009). Here, Web searchers attempt to incorporate information from several Web pages since no Web page exclusively contains all the required information (Manning *et al.,* 2009). A navigational query looks for the home page of a particular entity required by the searcher, such as South African Airways. A transactional query is a preamble to the searcher performing an online transaction, such as making a hotel reservation or purchasing a product. Manning *et al.* (2009: 433) suggests that "in such cases, the search engine should return results listing services that provide form interfaces for such transactions".

Tseng *et al*. (2009) suggest that the general query formulation behaviour denotes a searcher's strategy. Tseng *et al*. (2009) discuss four query modification strategies, that is, generalised reformulation, specified reformulation, dynamic reformulation and constant reformulation. Generalised reformulation is when a user begins the search with multiple terms and then excludes a few terms to improve the accuracy of the results (Tseng *et al*., 2009). Specified reformulation is when a searcher continuously alters a query by increasing the number of terms or by adjusting the query to include more precise terms (Tseng *et al*., 2009). Dynamic reformulation is when a searcher randomly swaps between specified and generalised reformulation (Tseng *et al*., 2009). However, they advise that searchers who use this strategy usually have terrible search problems and end up spend more time trying to locate the necessary information.

It is further explained that "constant search occurs when a user modifies terms of the same concept level which share some common characteristics, for example, when substituting with related objects or synonyms" (Tseng *et al*., 2009: 5). This strategy involves keeping the number of query terms constant across the whole adjustment process, despite the existence of alternate adjustments (Tseng *et al*., 2009). It is suggested that when novices recreate a query, they often employ similar behaviour or increase the query length by adding more terms to the original query (Rieh & Xie, 2001; Kriewel & Fuhr, 2010).

2.8.5 Cognitive search strategies

Thatcher (2008) investigates the variations in cognitive search strategies of 80 participants through Web experience. Participants carried out two information seeking tasks defined by the researcher and two tasks defined by the participant. The tasks incorporated a general-purpose and a directed search task (Thatcher, 2008). He found considerable differences when cognitive search strategies were used and "participants with higher levels of Web experience were more likely to use parallel player, parallel hub-and-spoke, known address search domain and known address strategies" (Thatcher, 2008: 1308). On the other hand, "participants with lower levels of Web experience were more likely to use virtual tourist, link-dependent, to-the-point, sequential player, search engine narrowing and broad first strategies" (Thatcher, 2008: 1308).

Several models and theories have suggested that knowledge, or experience, with systems play a crucial role in establishing the search strategy employed, in addition to the effectiveness of the search (Thatcher, 2008). It is argued that information seeking expertise and domain expertise is more important than experience with a specific search system (Marchionini, 1995; Thatcher, 2008). Thatcher (2008:1324) claims that "experience levels are also associated with the search engine player, to-the-point, sequential player, search engine narrowing and broad first strategies, which involve search engines and the use of queries". He explains that the least amount of cognitive effort is required from participants for the link-dependent strategy, as they only have to determine which hyperlinks provided on the Web page presents the best alternative. Finally, he explains that "the search engine narrowing down strategy allows participants to rely on the search engine to do the narrowing of the search domain rather than having to exert cognitive effort to think of appropriate query terms to narrow the search domain" Thatcher, 2008: 1325).

Bilal & Kirby (2002) examine the physical and affective, in addition to the success and cognitive behaviours of graduate students and children when utilising the Yahooligans! search engine with the aim of locating answers to a fact-finding task. The findings were based on nine graduate students' Web sessions and 14 children's sessions, whose "Web activities were captured online using Lotus ScreenCam, a software package that records and replays online activities in Web browsers" (Bilal & Kirby, 2002: 649). The findings showed that 50 percent of the children found the right answer to the fact-finding task as opposed to 89 percent of the graduate students (Bilal & Kirby, 2002). Both sets of participants failed when they used keywords in their search but were successful when they searched through subject hierarchies (Bilal & Kirby, 2002). Kao *et al*. (2008: 1330) suggest that "Web searches entail complex cognitive processes influenced by individual differences, and users with similar cognitive or skill factors tend to develop multiple search strategies".

2.9 Experienced vs novice searchers

According to Candy (2004) searchers with more searching experience will be able to better assess the information quality than a novice searcher. Experienced Web searchers find the information retrieval process rapid and typically retrieve satisfactory search results, whereas novice searchers ineffectively specify their information needs resulting in low precision and recall of the search results (Debowski, 2001). She revealed three key aspects with regard to supporting inexperienced Web searchers. Firstly, novice Web searchers who have no training or support are likely to obtain poor quality search results that may not meet their information needs. Secondly, searchers with limited experience may explore other avenues and become distracted. Thirdly, user training should be provided by information providers.

Marchionini (1995) states that specialized mediators that frequently perform searches are familiar with several information search systems and possess the abilities to use numerous information-seeking strategies. Marchionini (1995: 33) further suggests that the "information seeker's personal information infrastructure affects overall performance while solving information problems and executing tasks and continues to develop as information seekers accrue experience and knowledge". Bhavnani (2001) in Bhavnani *et al*. (2006) found that domain experts can obtain complete information efficiently and effectively by using search procedures when searching for information within their field of expertise, in comparison to searching for information outside their field of expertise.

Novice searchers are steered toward unsuccessfully meeting their information needs due to insufficient search knowledge (Bhavnani *et al*., 2006). They argue that incomplete information could lead to life threatening consequences in domains such as healthcare. It is suggested that even though experts possess search procedures that are said to improve the accuracy of the search results, such knowledge cannot be obtained from the information offered by traditional search tools (Bhavnani *et al*., 2006). Chu & Law (2007) found that initially, students were inexperienced in searching for information effectively, as they often conducted erroneous searches and searched the Web frequently through browsing. Chu & Law (2007) claim that this may be due to the fact that the majority were novices in their subject areas, as well as in information retrieval and searching. On realising the effectiveness of keyword searching, participants depended largely on this method, regardless of the subject searched (Chu & Law, 2007).

Markey (2007b) states that high precision is the main objective of the domain expert strategies. Experts rely on the accuracy of their search strategies, and therefore they recognize activities,

look for clues that best describe their information needs (Markey, 2007b). Experts possess effective information searching strategies that enable them to acquire result sets to meet their information needs (Fields *et al*., 2004; Kriewel & Fuhr, 2010).

Savolainen & Kari (2006) based their study on data gathered from 18 respondents, which comprised novices (i.e. basic Web searching skills) and experts (i.e. advanced Web searching skills). Initially, they conducted semi-structured interviews in order to investigate the methods used by participants when searching the Web for information (Savolainen & Kari, 2006). They were then asked to perform a Web search on self-chosen subject matter that related to personal development. It is further suggested that of the tactics listed, only narrowing search, using search engines and attaining search terms are evidently linked to analytical search strategies (Savolainen & Kari, 2006). The remaining tactics dealt with browsing, which Savolainen & Kari (2006) suggest indicates the prevalence of browsing when users navigate the Web.

Savolainen & Kari (2006), claim that participant-defined searches topics have advantages, as well as disadvantages, in comparison to search tasks that are researcher specific. They further claim that participant-defined search tasks enhance spontaneity and naturalism, which might not necessarily be accomplished in experimental settings that are standardised. The drawback, they explain, is that a participant-defined topic may result in substantial discrepancies in the topic searched, consequently making the results and search methods difficult to directly correlate (Savolainen & Kari, 2006). Their analysis was qualitative, revealing evident features that were common to the majority of gap-bridging processes when searching the Web (Savolainen & Kari, 2006). In most cases, the user encountered irrelevant information or was unable to comprehend the information and was therefore forced to stop the search. To bridge this type of gap, new links were identified which provided access to content that met the users information need in order to complete the task.

Chu & Law (2007) embarked on a study to gain a comprehensive understanding of the progression by which PhD students progress from being novice searchers to expert searchers in information searching and retrieval. The respondents consisted of twelve research students from The University of Hong Kong, who represented those students who perform the most literature searching both in terms of depth and quantity. Simple keyword searches were most prominent during the initial stages as compared to complex keyword searches, as students were not yet accustomed to the different search methods and they lacked skills in this regard (Chu & Law, 2007). Chu & Law (2007) found that students studying Education, tended to use additional complex keyword searches as their knowledge and understanding grew, whereas engineering students continued with the use of simple keyword searches.

However, the engineering students possessed more specific information needs than education students and were successful in obtaining significant results with the use of simple keyword searching (Chu & Law, 2007). In order for the education students to obtain significant results, they had to use complex keyword searches due to their more general research topics (Chu & Law, 2007). However, Chu & Law (2007) suggest that novice researchers usually find keyword searches useful, since keywords will search most of the records in most databases. The following section involves precision and recall of Web searches.

2.10 Precision and recall

Mansourian (2005) suggests that the problem with precision and recall is that measuring precision does not necessarily relate to the effectiveness of the search. He advises that there are a range of meta-search engines that offer a wider range of retrieval than a single search engine like Google. He further suggests that many Web sites do not wish to be crawled and depending on the search engine crawling policy some search engines just ignore some Web sites as it is not regarded as significant.

Huuskonen & Vakkari (2008) investigate the extent to which medical students retrieved useful information when searching for essay writing purposes. Precision and relative recall (as observed by these participants) was calculated when a medical system (i.e. Medline) was used. Forty-two third year medical students were required to search Medline as part of an essay writing assignment. It was found that users looked for an adequate number of documents that contain sufficient information in order to progress with their task. Huuskonen & Vakkari (2008) suggests that the students' ability to ascertain the quality of information depends on their level of knowledge on the topic.

Furthermore, the results revealed that high recall and precision are partly caused by the participants' limited ability to choose information that will add value to their work (Huuskonen & Vakkari, 2008). In addition, they found that high precision indicated the inability to differentiate between useless and useful information but high precision indicated the students' ability to distinguish between the two (Huuskonen & Vakkari, 2008). According to Huuskonen & Vakkari (2008: 302) "perceived precision and relative recall are not associated to the way information in the retrieved items is used for performing the task".

Bar-Ilan (2005) compares the ranking of results obtained from a number of search engines using the same queries and found that the ranking algorithms employed by large commercial search

engines varied significantly. Web search engines, typically have little overlapping coverage (Bar-Ilan, 2005). Bhavnani *et al*. (2006: 7) suggest that "while the ranking algorithm attempts to give higher ranks to pages that are most pointed to, there is no explicit guarantee for the reliability of such highly ranked sites, nor any indication of the critical sub goals in a domain to guide which pages to visit in which order".

Nowicki (2003) argues that since user relevance is subjective, the searcher is ultimately the best judge of her own needs and expectations. Her study aimed to determine the effectiveness of information gathering through six popular Web search engines by comparing users' relevance judgments (relevance according to searchers) and system-determined relevance rankings (Nowicki, 2003). She gives a detailed description and definition of Web search engines. She also suggests that the definition of relevance includes numerous ideas, such as topicality, usefulness and satisfaction and information scientists have defined relevance from numerous points of view (that is, philosophy, logic, system and utility). A blend of variables influences relevance judgments (that is, state of mind, experience, context and circumstances) and each individual evaluates relevance in a different way, making relevance a subjective measure (Nowicki, 2003).

Nowicki (2003) also argues that searchers assign relevance to items according to determinations they make with regard to several criteria, popularly termed "relevance judgments." She further states that these judgments differ in relation to the kind of relevance judged, the kind of judge (i.e. expert or novice), the information obtained (i.e. abstracts, or full text), the items to judge against (i.e. queries or information needs) and time (Nowicki, 2003). She also found that the criteria users employ to judge relevance are internally created and belong to a user's mental and psychological state. This creates a difficulty in measuring user relevance judgments, since no two judgments are the same (Nowicki, 2003). She found that users defined relevance according to their background and experience, beliefs, preferences and situation. The sample population for her project included 75 undergraduate students who received a pre-experiment questionnaire, a sheet detailing directions for ranking search engine results and search forms (one per search engine).

Lorigo *et al*. (2006) observed that in order to improve the effectiveness of search engines, interest grew in collecting further responses concerning the information needs of users', which extend query formulation. By using eye tracking software, they were able to analyse the patterns and sequences that searchers employ to assess the results of the information retrieved when using Google (Lorigo *et al*., 2006). They found that in approximately 20 percent of the cases,

the abstracts of the search results were examined in their ranking order and no more than three abstracts per results page was viewed on average (Lorigo *et al*., 2006).

Jung *et al*. (2007: 805) explore the "reliability of click data as a source of implicit relevance feedback data and described a prototype system that uses this relevance feedback data to generate recommendations alongside traditional search results". They found that "using click data from the entire search session may be valuable, either because it increases the coverage of relevant documents (the recall), or because it increases the precision" (Jung *et al*., 2007: 805). They concluded that integrating collaborative filtering ideas yields search engines that are considerably more effective. Downey *et al*. (2008), claims that the success of a search takes place when an alignment between the expressions of goals exists and the frequency of those goals.

2.11 User satisfaction

User satisfaction with a search engine can be determined by viewing the click logs, which also offers a significant source of information with regard to relevance (Chapelle & Zhang, 2009). Liu (2007) believes that the only way to measure user satisfaction is to use queries from a searcher's daily information requirements and based on their subjective and/or personal assessment of the usefulness of results returned by the queries. After testing Microsoft Network (MSN), Liu (2007) found that the navigational queries of MSN were 'quite far behind Google'. For example, after searching for the Web site of a particular author, MSN and Yahoo failed to retrieve the Web site, whereas Google ranked the site in the first 10 results displayed (Liu, 2007).

The participants constituted 25 graduate students, which were split into three groups. The participants were required to perform daily searches based on their normal information needs. The task was to use one search engine for the week and they were only allowed to use another search engine if the initial search engine used did not produce good results. Before the evaluation, participants were asked which search engines were used on a daily basis and everyone answered Google. Only four out of the 25 participants tried Yahoo, none used MSN and all responded that Google was their primary search engine, but no participant was willing to use MSN (Liu, 2007). It was noted that participants indicated that Yahoo and MSN were slower than Google and all agreed that speed affected their choice of search engine (Liu, 2007).

In a study conducted by Mansourian & Ford (2007), all searchers were able to recall "successful" and "unsuccessful" searches. Mansourian (2008: 212) claims that "some elements of the search context like time allocation or search importance are more significant in users' judgment about success/failure of the search". He further claims that context is exceptionally dynamic, constantly changing within the same search session or for the same user (Mansourian, 2008). Zhang (2008) explored the mental models of 44 undergraduate students and their behaviour whilst searching the Web. Zhang (2008) concluded that participants' satisfaction was directly related to the time it took them to complete a task.

2.12 Domain knowledge

The objectives of the study by Mu *et al*. (2010) were to assess the quality of a new health information retrieval system (that is, MeshMed), to examine the search strategies of users and to ascertain the relationship between previous knowledge on the topic as well as the search strategies that they use. Mu *et al*. (2010) found that MeshMed provided the users with further choices to form effective search strategies and three search styles were identified, namely the novel, traditional and balanced. Mu *et al*. (2010) claims that a user's domain knowledge (that is, knowledge on a search topic) is an additional crucial factor that is said to influence their search strategies.

Wildemuth (2004) consolidated the tactics of 77 medical students that were required to search a factual database in microbiology over a nine month period in order to identify the modification in students' tactics seeing that their domain knowledge changed over time. She found that the most frequently used search tactic was concept specification, followed by adding one or more concepts, thereafter gradually decreasing the amount of results retrieved prior to being displayed. She further found that different levels of domain knowledge affected the tactics used by students. Wildemuth (2004) found that a searcher enters one or more terms, displays the search results and then iteratively adapts the terms until the results meet the his/her information need. She further states that every iteration in the formulation and reformulation process may be regarded as a search move.

Wildemuth (2004) claims that the domain knowledge of a searcher could influence the formulation and reformulation process of a search strategy, in addition to the success of the search results retrieved and the overall outcome of the search. The random sampling method was used to invite students to participate (Wildemuth, 2004; Hsieh-Yee, 2001). The results revealed that based on the discrepancies in domain knowledge, search tactics and search

behaviours varied (Wildemuth, 2004). More moves per search were found when domain knowledge was extremely low, there were and the greater number of moves was probably due to the amount of alterations required to make in the search strategies with the aim of retrieving appropriate records (Wildemuth, 2004).

Holscher & Strube (2000) investigate the knowledge types relevant for information retrieval on the Web, the strategies and the knowledge structures involved. Twelve Web experts were interviewed on the search strategies they use and they had to perform a series of practical search tasks on the Web (Holscher & Strube, 2000). They found combined and differential effects of domain knowledge and Web experience. "Users' domain knowledge, system knowledge, information retrieval knowledge, and cognitive styles assist users in determining their actions and plans under different circumstances" (Xie, 2007: Shifts in information-seeking strategies determined by planned and situational aspects). The next section explains the conceptual framework in detail.

2.13 Conceptual framework unfolded

The conceptual framework adopted for the basis of this study is Bates (1979a) model of Information Search Tactics. Her model has been commonly used as a framework in similar studies. Marcia J. Bates is a professor at the University of California, Graduate School of Education and Information Studies. She has published many papers in the areas of information system search strategy, organisation of knowledge, user-centred design of information retrieval systems and information seeking behaviour (Bates, 2010: Biography). She is currently the editor-chief-in of the Encyclopaedia of Library and Information Sciences, 3rd edition (Bates, 2010: Biography).

Bates (1979a) defines 29 tactics that are intended to assist in complex searching for both manual and online systems. She distinguishes four types of tactics, namely "monitoring, file structure, search formulation and term tactics" (Bates, 1979a: 205). All the tactics from Bates' (1979a) model of Information Search Tactics have been presented verbatim in order to illustrate the changes made to the model in the Chapter 5. Summary tables of the search tactics by Bates (1979a) in each search category have also been present verbatim.

2.13.1 Monitoring tactics

Bates (1979a: 207) describes monitoring tactics as “tactics to keep the search on track and efficient”. She lists and describes five monitoring tactics, namely “check, weigh, pattern, correct and record”.

MI. CHECK. To review the original request and compare it to the current search topic to see that it is the same.

M2. WEIGH. To make a cost-benefit assessment, at one or more points of the search, of current or anticipated actions. Among other things, the searcher might consider whether any other approach would be more productive for the effort.

M3. PATTERN. Frequent experience with a type of question may lead to an habitual pattern of search. If, for example, a common request in an academic library is for addresses of researchers, then the librarian may soon develop a sequence of sources to search, arranged by their likely productivity. To PATTERN is to make oneself aware of a search pattern, examine it, and redesign it if not maximally efficient or if out of date.

M4. CORRECT. To watch for and correct spelling and factual errors in one's search topic. These may exist in the topic as presented originally by the user (cf. Josel's first “reference commandment”, or may slip into the searcher's thinking in translating a verbal request, or in remembering (without having in hand) a written request. In observing bibliographic searching done by several librarians, Carlson noted that the searchers would allow inaccuracies, particularly spelling errors, to slip into their search formulation. One librarian, for example, had a request on “neuroglia,” and searched instead on “neuralgia,” a very different concept. He noted several cases where a difficult technical term was not written down and the librarians “would search for the *remembered* spelling, usually not find it, and then stop the search for that term”. A clue to errors in the request as stated may be provided by suspicious coincidences. Josel's fourth “reference commandment” is “Coincidence is no coincidence.” As he says: “When a patron wants to have a biography of Saint Edmund Hall, born 1226, and you find the same name listed as a college of Oxford University, and 1226 as its date of construction, do not doubt the patron needs further talking to”.

M5. RECORD. To keep track of trails one has followed and of desirable trails not followed up or not completed. In complex searches it is sometimes necessary to return to the source of information or citations recorded earlier in the search. For example, after recording a number of

citations from a periodical index, the searcher may then attempt to retrieve the articles cited and find a blind lead. The citation needs to be checked again in the original source. But unless the source, volume date, and subject term searched under were recorded, the searcher may have to go through the entries under a dozen terms or in several volumes to locate the desired citation. Similarly, if productive on-line and manual bibliographic search formulations are retained, later repeat effort may be saved.

Table 2.7 - Monitoring tactics (Bates, 1979a: Summary)

Monitoring tactics	Tactics to keep the search on track and efficient.
M1. CHECK	To review the original request and compare it to the current search topic to see that it is the same.
M2. WEIGH	To make a cost-benefit assessment, at one or more points of the search, of current or anticipated actions.
M3. PATTERN	To make oneself aware of a search pattern, examine it, and redesign it if not maximally efficient or if out of date.
M4. CORRECT	To watch for and correct spelling and factual errors in one's search topic.
M5. RECORD	To keep track of trails one has followed and of desirable trails not followed up or not completed.

2.13.2 File structure tactics

Bates (1979a: 210) describes file structure tactics as" techniques for threading one's way through the file structure of the information facility to the desired file, source or information within source". She lists and discusses seven file structure tactics, namely "bibble, select, survey, cut, stretch, scaffold and cleave".

Fl. BIBBLE. One way to cope with the file structure is to find a way to do without it altogether. The only neologism among the set of tactic names, BIBBLE is based on the abbreviation "bibl." for "bibliography." To BIBBLE is to look for a bibliography already prepared, before launching oneself into the effort of preparing one. More generally, to BIBBLE is to check to see if the search work one plans has already been done in a usable form by someone else.

F2. SELECT. To break complex search queries down into subproblems and work on one problem at a time. This tactic is a well-established and productive technique in general problem solving. As each subproblem is solved, the parts can then be knit into a solution to the whole, larger problem.

F3. SURVEY. To review at each decision point of the search the available options before selecting. In Carlson's description of human searching behavior, he noted the following problem: “There is almost no look-ahead in the human search procedures. All of the librarians studied exhibited to some extent this lack of look-ahead. They would often scan each entry as they came to it and then encounter a heading which would alter the search procedure.” He concludes: “Here the lesson is very clear: humans should scan over a reference document before making any detailed searches through it”. Psychologically, this is a problem of “going for closure” too soon, that is, settling on a source or approach prematurely. In employing SURVEY, one resists that temptation and presumably achieves a more effective search.

For example, in a bibliographic search, instead of selecting the first index that comes to mind, one thinks of all the major indexes in the subject and then selects the one best suited to the particular query. Then, instead of moving immediately to a subject entry term within the index, one first scans through the thesaurus to find the best term or terms for the subject.

F4. CUT. When selecting among several ways to search a given query, to CUT is to choose the option that cuts out, eliminates, the largest part of the search domain at once. In my opinion, this tactic is of fundamental significance in our field, and is relatively little known or discussed. Here are some examples: When looking up a book written by Smith and Brzustowicz, the search will be much briefer if one looks under Brzustowicz (assuming the file has entries under co-authors). In most files, there will be far fewer entries to scan under the latter name. Thus, in choosing to search under the latter name, with its few entries, one has cut out a larger part of the search domain than would be the case when searching under Smith, and has shortened the search accordingly.

Similarly, in a subject search, other things being equal, one should look up the most specific elements of the topic first. For example, in using a KWIC (rotated title term) index, the searcher will find desired material on the topic “Research in Retinopathy” much faster by looking under the more specific term “retinopathy,” because there will be fewer entries.

The concept of CUT has received the most explicit use in information science in manual coordinate indexing searching. If one pulls three subject-term cards for an ANDed search on terms A, B, and C, then makes comparisons among term cards to find the documents indexed under all three terms, the smart tactic is to start with the card with the fewest document numbers posted on it. Since all acceptable documents must have all three terms assigned to them, the card with the fewest documents posted exercises the most control and eliminates the largest part of the search domain.

F5. STRETCH. Naturally enough, one tends to think about information resources in terms of the uses for which they are intended. However, almost all reference sources can be used productively for some other purpose than intended. The internal organization of a file or reference book is designed around certain uses. Thus, access via certain record elements is provided, and access via other elements is not. But even though formal access is not provided, that other information is there in the source nonetheless. Introductions, which are outside the formal internal file organization of an information source, may also be informative in unexpected ways.

In general, it may be assumed that the most efficient searching involves using sources for their intended purposes. But when such approaches fail, answers may still be found by putting in the harder work to ferret out information incidentally provided. Thus, to STRETCH is to use a source for other than its intended purposes. However, it should be kept in mind that to STRETCH effectively the searcher must first *think* differently, he/she must think about all the information that is in a source, not just about the ordinary uses of it.

For example, after searching unsuccessfully through many directories for the address of an engineer, the searcher may recall that patents contain the name of the inventor and also the business affiliation, since the patent is usually owned by the company she/he works for. If the engineer has patented anything, then the address should be available in the nearest patent file.

F6. SCAFFOLD. Hodnett discusses the use of what he calls “auxiliaries” which are aids in problem solving which may or may not themselves be a part of the solution, but which make the solution possible. The technique of using auxiliaries is often employed in mathematics, where a seemingly irrelevant theorem is introduced, a theorem with little intrinsic interest, but one that enables the main theorem to be proved.

The use of scaffolding in construction is another such example. When the building is finished, the scaffolding is torn down, but the building could not have been built without it. In information searching, it is sometimes the case that the shortest route through the file structure is a dead end. In that case one may build a roundabout path to the answer by going through files or sources that themselves may seem to have nothing to do with the question. One may acquire an additional piece of information that in no way contributes directly to the answer but which makes it possible to search for the answer in some other source. Thus, to SCAFFOLD is to design an auxiliary, indirect route through the information files and resources to reach the desired information. For example, after unsuccessfully seeking information on an obscure poet,

the searcher may find out who the poet's contemporaries were and research them in hopes of finding mention of the poet.

F7. CLEAVE. To employ binary searching in locating an item in an ordered file. (For those unfamiliar with this principle: In binary searching one first looks at a record in the middle of an ordered, e.g., alphabetized, file. One then determines the half of the file in which the desired record must lie. Then the middle record in that half of the file is looked at, and the quarter of the file in which the record must lie is determined. Then one looks at the middle record in the quarter section of the file, and so on until the desired record is discovered. In each case, the file is split in two, hence the term "binary".)

Table 2.8 is a summary of the file structure tactics and definitions.

Table 2.8 - File structure tactics (Bates, 1979a: Summary)

File structure tactics	Techniques for threading one's way through the file structure of the information facility to desired file, source, or information within source.
F1. BIBBLE	To look for a bibliography already prepared, before preparing one; i.e. to check if the search work one plans has already been done by someone else.
F2. SELECT	To break complex search queries down into sub-problems and work on one problem at a time.
F3. SURVEY	To review, at each decision point of the search, the available options before selecting.
F4. CUT	When selecting among several ways to search a given query, to choose the option that cuts out, eliminates, the largest part of the search domain at once.
F5. STRETCH	To use a source for other than its intended purposes.
F6. SCAFFOLD	To design an auxiliary, indirect route through the information files and resources to reach the desired information.
F7. CLEAVE	To employ binary searching in locating an item in an ordered file.

2.13.3 Search formulation tactics

Bates (1979a: 210) describes search formulation tactics as "tactics to aid in the process of designing or redesigning the search formulation". She lists and discusses six search formulation tactics, namely specify, exhaust, reduce, parallel, pinpoint and block.

SI. SPECIFY. To search on terms that are as specific as the information desired. Specificity is one of the crucial concepts in systems of information access. Almost all systems of classification and indexing require that descriptions assigned to materials be as specific as the content of the materials and as the indexing system itself allows. Sears and Library of Congress subject headings use the "rule of specific entry" which requires entry of materials under the most specific terms that still encompass the content of the item; coordinate indexing, with its focus on "concept" indexing, brings about highly specific description, and so on.

Thus, specificity at the time of indexing requires specificity at the time of retrieval. An indexing system may or may not allow entry under broader terms as well, but it will almost always require specific entry. Thus, it is probably the case that starting with specific terms in all kinds of searches (including both bibliographic and reference) will be the most productive approach.

S2. EXHAUST. To include most or all elements of the query in the initial search formulation, or to add one or more of the query elements to an already-prepared search formulation. Both this and the next tactic, REDUCE, are related to Lancaster's use of "exhaustivity". In searching, the more exhaustive a search is, the more of the elements of a complex request have been included in the search formulation. For example, the searcher interested in the "training of teachers of mathematics for the elementary grades" has a four-element problem. An exhaustive search would include all four elements in its formulation. Both EXHAUST and REDUCE deal implicitly with the number of elements in the query that are to be ANDed together in the search formulation. The more exhaustive the search statement, the more stringent the requirements, and thus the fewer the documents likely to be returned on a search.

While this tactic is probably most useful for Boolean searching, it is also meaningful for other kinds of searches. For example, in a catalog using Library of Congress subject headings, one can decide between searching under the main heading only or more exhaustively under the main heading plus geographical, bibliographical form, or other nontopical subdivisions.

S3. REDUCE. To minimize the number of elements of the query in the initial search formulation, or to subtract one or more of the query elements from an already-prepared search formulation. REDUCE is the opposite of EXHAUST. This tactic reduces the number of ANDed elements in the search formulation, making the search specification less stringent, and thus increases the number of documents likely to be returned on a search.

S4. PARALLEL. To make the search formulation broad (or broader) by including synonyms or otherwise conceptually parallel terms. PARALLEL and PINPOINT deal implicitly with

elements in a query that are to be ORed together. Though these tactics are most readily applied in on-line Boolean searching, they may also be used in manual searching. For example, in the process of manually compiling a bibliography, one may look over catalog subject headings and terms in periodical indexes and expand the number of similar terms searched under (PARALLEL), either at the beginning of the search or after getting some experience with the type and quantity of materials under each term.

S5. PINPOINT. To make the search formulation precise by minimizing (or reducing) the number of parallel terms, retaining the more perfectly descriptive terms. PINPOINT is the opposite of PARALLEL.

S6. BLOCK. To reject, in the search formulation, items containing or indexed by certain term(s), even if it means losing some document sections of relevance. This tactic deals implicitly with the Boolean AND NOT. The term NOT was not used, however, because the concept extends beyond the usual applications of Boolean searching. For example, in doing a manual literature search, one may choose to reject all items containing a certain word in the title. BLOCK was selected as the name of this tactic to draw attention to the tricky side of NOT—to the fact that in eliminating a document that contains an undesired term, one may also block out desirable material that happens to be found in the same document.

Below is a summary of the search formulation tactics and definitions.

Table 2.9 - Search formulation tactics (Bates, 1979a: Summary)

Search formulation tactics	Tactics to aid in the process of designing or redesigning the search formulation.
S1. SPECIFY	To search on terms that are as specific as the information desired.
S2. EXHAUST	To include most or all elements of the query in the initial search formulation; to add (a) query element(s) to a prepared search formulation.
S3. REDUCE	To minimise the number of elements of the query in the initial search formulation; to subtract (a) query element(s) from a prepared search formulation.
S4. PARALLEL	To make the search formulation broad (or broader) by including synonyms or otherwise conceptually parallel terms.
S5. PINPOINT	To make the search formulation precise by minimizing (or reducing) the number of parallel terms, retaining the more perfectly descriptive terms.
S6. BLOCK	To reject, in the search formulation, items containing or indexed by certain term(s), even if it means losing some sections of relevance.

2.13.4 Term tactics

Bates (1979a: 211) describes term tactics as "tactics to aid in the selection and revision of specific terms within the search formulation". She lists and discusses 11 term tactics, namely "super, sub, relate, neighbour, trace, vary, fix, rearrange, contrary, respell and respace".

Tl. SUPER. To move upward hierarchically to a broader (superordinate) term. Searchers may be assisted by pointers in a thesaurus or may have to rely on their own knowledge to devise the term.

T2. SUB. To move downward hierarchically to a more specific (subordinate) term.

T3. RELATE. To move sideways hierarchically to a coordinate term.

T4. NEIGHBOR. To seek additional search terms by looking at neighboring terms, whether proximate alphabetically, by subject similarity, or otherwise. Coates pointed out many years ago that all manual (and we should add today, most automated) information organization systems do two fundamental things: locate and collocate. The primary function of such systems is, of course, to enable the searcher to find, or locate, desired materials. However, such systems also necessarily *collocate* entries. In any ordered file everything must be next to something else. Many of the historical arguments over the relative merits of classification and indexing systems were as much about collocation as location. Consider, for example, the old debate over whether to have classified or alphabetico-specific subject catalog access. A classified catalog collocates entries by their conceptual relationship; an alphabetico-specific catalog collocates entries only by their alphabetical order. These two approaches have different strengths and weaknesses and different consequences for search strategy.

To use this tactic is to expand the search by examining the proximate entries, whatever they are. In on-line searching, one examines whatever proximate entries are made available by the on-line program one is using. (NEIGHBOR happens to be the current term for the appropriate command in the SDC ORBIT® search language.) Incidentally, the use of NEIGHBOR may be extended beyond term selection to resource selection as well. Since classification systems collocate books, it is easy to extend a search by examining related sources collocated on the shelves of the reference stacks.

T5. TRACE. To examine information already found in the search in order to find additional terms to be used in furthering the search. Two of the most common ways of doing this are to scan descriptor term lists in citations retrieved in on-line searching, and to scan on a catalog card the list of other headings that have been given to the document in question. These other headings on the catalog card are called the "tracings," hence the name for this tactic (cf. Josel's seventh “reference commandment”).

T6. VARY. To alter or substitute one's search terms in any of several ways. See remaining term tactics for some specific variations.

T7. FIX. To try alternative affixes, whether prefixes, suffixes, or infixes. Several may be done at once through truncation routines.

T8. REARRANGE. In any system where terms may contain more than one word, word order may make a difference in retrieval success. To REARRANGE is to reverse or rearrange the words in search terms in any or all reasonable orders.

T9. CONTRARY. To search for the term logically opposite from that describing the desired information. For example, one may want information on “cooperation” and, after an unsuccessful search, change the term to “competition.”

T10. RESPELL. To search under a different spelling. CORRECT dealt with maintaining correct spelling, among other things. But with RESPELL the concern is not with correctness, but with effectiveness. Particularly in current on-line search systems, there are a great many spelling variations that show up in the citations. One must expand the spelling variations to insure good recall. RESPELL is occasionally needed in manual systems too, where, for example, one needs to change from U.S. to British spelling to search successfully in a source.

T11. RESPACE. Spacing, particularly in hyphenated words, or words that appear with various spacings, can be critical in search success. To RESPACE is to try spacing variants. While spacing problems are most glaring in some automated search files, such problems can also be serious with manual files. The two fundamental variants in filing rules—word-by-word filing and letter-by-letter filing—differ on how the blank space is to be treated in filing. Both of these rules are in wide use. The searcher who is thinking in terms of one filing rule and enters a source that uses the other may miss the desired material.

Table 2.10 - Term tactics (Bates, 1979a: Summary)

Term tactics	Tactics to aid in the selection and revision of specific terms within the search formulation.
T1. SUPER	To move upward hierarchically to a broader (super-ordinate) term.
T2. SUB	To move downward hierarchically to a more specific (subordinate) term.
T3. RELATE	To move sideways hierarchically to a coordinate term.
T4. NEIGHBOUR	To seek additional search terms by looking at neighbouring terms, whether proximate alphabetically, by subject similarity, or otherwise.
T5. TRACE	To examine information already found in the search in order to find additional terms to be used in furthering the search.
T6. VARY	To alter or substitute one's search terms in any of several ways.
T7. FIX	To try alternate affixes, whether prefixes, suffixes, or infixes.
T8. REARRANGE	To rearrange the words in search terms in any or all reasonable orders.
T9. CONTRARY	To search for the term logically opposite from that describing the desired information.
T10. RESPELL	To search under a different spelling.
T11. RESPACE	To try spacing variants.

Bates (1979a: 212) suggests that "a few steps may be taken in moving from a facilitation model of tactics to a facilitation model of *strategy*". That is, "to a model that suggests helpful search strategies or techniques for developing strategies by distinguishing typical stages of searches and then looking for useful patterns in tactics used at those stages" (Bates, 1979a: 212). Other models, such as Kuhlthau's Information Search Process model and Hsieh-Yee's Information Retrieval model have been considered, but were found to be inappropriate for this study. The researcher believes that Bates (1979a) model of Information Search Tactics is well suited to the research objectives of this study.

2.14 Summary of the chapter

This chapter examined empirical and theoretical literature on the challenges of information retrieval on the Web, Web searching strategies, search engines and the "invisible Web". Since it has been established that several studies have confused a tactic with a search strategy, the definitions of these terms have been discussed in order to differentiate them. Other aspects are discussed, namely the classification of strategies by other researchers, search engines, the "invisible Web", novice vs experienced searchers, precision and recall, user satisfaction and domain knowledge. Although the overview of the conceptual framework was discussed in

Chapter 1, it is further explored in this chapter by defining each of the 29 search tactics of Bates (1979a) model of Information Search Tactics.

Chapter 3

Research Methodology

3.1 Introduction

The previous chapter examined studies on Web searching strategies and defined a search strategy as a combination of tactics used to locate information which meets the searcher's information need. The primary focus of this chapter is to explain the research design and methodology used to address the research objectives specified in Chapter 1. It also explains the research instruments used (i.e., questionnaire and interview), the research population, the data analysis methods and the techniques used to establish validity and reliability of the data. Table 2.4 in Chapter 2 lists several studies that focus on Web searching strategies, as well as the methods used in each study. Researchers have used multiple data-gathering techniques (i.e., quantitative and qualitative in a single study) to corroborate their findings on Web searching strategies (Hsieh-Yee, 2001; Thatcher, 2006; Bhavnani *et al*., 2006; Chu & Law, 2007; Kules & Shneiderman, 2008; Tseng & Wu, 2008; Hung *et al*., 2008; Jeonghyun, 2009; Tseng *et al*., 2009). According to Hsieh-Yee (2001), the employment of multiple methods is the component that distinguishes a great deal of studies on Web searching behaviour from other studies on searching behaviour since the phenomenon being investigated is multifaceted and complex.

3.2 Research design

This study focuses on determining the Web searching strategies employed by postgraduate students at UKZN in order to provide a list of best practices for undergraduate students so that they may retrieve information via the Web more effectively. Although several studies on search strategies have been rather more comprehensive and descriptive in nature than other studies, Thatcher (2006) highlights the fact that those strategies have been obtained from high school pupils.

There are four research designs, namely survey research, experimental research, ethnography and mixed methods (Creswell & Clark, 2007). The researcher believes that a mixed methods approach is best suited to the study. According to Johnson & Onwuegbuzie (2004: 17), "Mixed methods research is formally defined here as the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or

language into a single study". The main idea behind the mixed methods approach is that the combination of qualitative and quantitative approaches offers a better insight to the problems under investigation than either approach isolated (Creswell & Clark, 2007).

The combination of quantitative and qualitative data is necessary for this study as it offers a thorough picture by noting change, in addition to a comprehensive understanding of participants' perceptions (Creswell & Clark 2007; Johnson & Onwuegbuzie, 2004). Another reason that the mixed methods approach is appropriate for this study is that purely quantitative results need to be further interpreted in order to ascertain the Web searching strategies used by postgraduate students. This approach allows for the identification of relationships between the Web searching strategies used and the information literacy skills necessary to conduct effective Web searches. The respondents' search patterns are then quantified, which makes it possible to determine predominant search strategies.

Creswell & Clark (2007) emphasise that it is not simple to conduct mixed methods research, because more time and resources is required to collect and analyse qualitative and quantitative data. However, they claim that the advantages of a mixed methods study outweigh the possible difficulties of this approach. Creswell & Clark (2007) suggest that the major benefit associated with the mixed method research design is that the weaknesses are offset by the strengths of both qualitative and quantitative research. It also provides "more comprehensive evidence for studying a research problem than either quantitative or qualitative research alone" (Creswell & Clark, 2007: 9). Furthermore, the mixed methods research draws on multiple paradigms, whilst giving the researcher freedom to utilise all possible methods to deal with a research problem (Creswell & Clark, 2007).

According to Creswell & Clark (2007), there are five paradigms used in research, namely postpositivism, constructivism, advocacy and participatory and pragmatism. This study uses the pragmatism paradigm, which is usually associated with mixed methods research (Tashakkori & Teddlie, 2003; Creswell & Clark, 2007). They claim that the outcome of the study is the main focus of pragmatism (Creswell & Clark, 2007). The problems under investigation are informed by the question asked, instead of the data collection methods (Creswell & Clark, 2007). Since "multiple methods of data collection inform the problems under study", pragmatism is therefore said to be pluralistic in nature, and oriented to "what works" as well as practice (Creswell & Clark, 2007: 23). Thus, pragmatism best suits this study as it addresses the research objectives outlined in Chapter 1.

Creswell & Clark (2007) discuss the ontology, epistemology, axiology, methodology and rhetoric in relation to pragmatism as follows: The ontology for pragmatism may be singular or multiple realities (e.g., a researcher tests hypotheses and provides multiple perspectives). The epistemology is practicality (e.g., a researcher collects data by "what works" to address the research questions). The axiology is based on multiple stances (e.g., a researcher includes both unbiased and biased perspectives). The methodology is combining (e.g., a researcher collecting both qualitative and quantitative data and merging them). Finally, the rhetoric or language of the research is formal or informal (e.g., a researcher may employ formal and informal writing styles).

3.3 Mixed methods design

The explanatory design: follow-up explanations model is used for this study, which consists of two distinct phases, the first phase being quantitative and the second phase qualitative (Creswell & Clark, 2007). The main idea behind this design is that the qualitative data assists in explaining or building upon the quantitative results (Creswell et al., 2003). The quantitative results of this study are further explained with the qualitative data. Creswell & Clark (2007) explains that the major advantage of this mixed methods design is that it is straightforward to implement due to its two-phased structure, as two methods are conducted in separate phases and one type of data is collected at a time. However, the challenge associated with this design is that the implementation of the two phases depends on a substantial amount of time (Creswell & Clark, 2007).

The quantitative method carries a greater weighting in this study than the qualitative method. The timing of the qualitative and quantitative methods was sequential. According to Creswell & Clark (2007) sequential data collection involves three stages. For this study, in the first stage, the qualitative data was collected and analysed. In the second stage, decisions were made as to how the results were to be used in order to influence stage three, which involved a second data collection and analysis. The qualitative data was then collected and analysed in the second phase in order to explain and elaborate on the quantitative data. The rationale behind this approach is that the qualitative data and its analysis provide an explanation for the statistical results by investigating the respondents' stance in greater detail (Rossman & Wilson, 1985; Tashakkori & Teddlie, 1998; Creswell, 2003; Creswell & Clark, 2007).

3.4 Research instruments

The instruments employed for the quantitative component were questionnaires, which have been successfully employed in similar research exercises (Aula *et al*., 2005; Bhavnani *et al*., 2006; Chu & Law, 2007; Tseng & Wu, 2008). Structured interviews were conducted for the qualitative component and have also been successfully employed in previous research (Thatcher, 2006; Chu & Law, 2007; Tseng & Wu, 2008). These quantitative and qualitative methods of data collection are discussed separately.

3.4.1 Quantitative (via questionnaires)

Questions in the questionnaire were based on three studies (Bates, 1979a; Nachmias & Gilad, 2002; Aula *et al*., 2005). However, the questionnaire was further enhanced to included advancement in technology and additional search tactics. Aula *et al*. (2005) based their questions on existing guidelines (Boudreau et al., 2001; Kitchenham & Pfleeger, 2002a; Kitchenham & Pfleeger, 2002b) and previous research (Hölscher & Strube, 2000; Aula & Käki, 2003). Aula *et al*. (2005) indicates that the pre-test of their questionnaire was done by five people and, once it was adjusted appropriately, a pilot study was undertaken by administering their questionnaire to 30 personnel of the Department of Computer Sciences at the University of Tampere. Some questions were based on the findings by Nachmias & Gilad (2002).

The questionnaire comprised closed-ended and open-ended questions. The open-ended questions permitted respondents to reply freely (see Appendix A for the questionnaire). In contrast, the closed-ended questions compelled respondents to choose from a list of alternatives. According to Sekaran & Bougie (2010), closed-ended questions assist respondents to make quick decisions by enabling them to choose from several alternatives. The disadvantage of using a questionnaire is that some respondents may not understand certain questions (Sekaran & Bougie, 2010). However, this drawback was addressed by pre-testing the questionnaire to ensure that questions were apparent, unambiguous and did not lead the respondent. The questionnaire relied on the respondent's individual estimation and recollection on the subject in question, which overcomes the limitation of researcher-defined tasks as discussed by Thatcher (2006). Nevertheless, the potential cause of these concerns is reduced as a result of the thorough questionnaire design (Aula *et al*., 2005).

3.4.1.1 Pre-testing of the questionnaires

Pre-testing was important for the researcher to ensure that the questions were simple to comprehend (i.e., the respondents understood what was being asked of them), unambiguous and to identify any unclear concepts/questions in the questionnaire (Powell, 1997; Sekaran & Bougie, 2010). Pre-testing involves the use of a few participants to test the questions' suitability, as well as participants understanding, which assists in rectifying any shortfalls prior to the administration of the instrument (Sekaran & Bougie, 2010). A pre-test was conducted with 10 postgraduate students from the Pietermaritzburg campus. Students involved in the pre-test did not form part of the eventual sample population. Questionnaires were returned with a few minor concerns, which were rectified before being administered to the respondents.

3.4.1.2 Distribution of the questionnaires

The questionnaires were distributed in two ways. One method involved personally administering the questionnaires to Honours students, in addition to accessible Master's and PhD students. The advantage of personally administering questionnaires is that the researcher can collect completed responses in a shorter time frame (Sekaran & Bougie, 2010). Since some Master's and PhD students work in industry and were therefore inaccessible, the researcher found it necessary to e-mail them in order to achieve a better response rate.

Sekaran & Bougie (2010) suggest that the response rate of questionnaires e-mailed to respondents is only 30%, which makes it difficult to establish the representativeness of the sample population. They emphasise that, with such a low response rate, those responding to the survey may not at all represent the entire population. For this reason, personally administering the questionnaires to students was adopted as the chosen approach. A considerable number of Master's and PhD students that study part-time would not have been surveyed if only a single method (i.e. personally administering the questionnaires) of distribution was used. Therefore, the researcher found it necessary to use two methods to collect the data.

3.4.2 Qualitative (via structured interviews)

The rationale for conducting qualitative research was to enhance the theoretical understanding of Web searching strategies, which depend on the gathering and interpretation of deeper and richer forms of data (Creswell & Clark, 2007). Structured, face-to-face or direct interviews were

conducted in order to acquire the qualitative data. Structured interviews are typically conducted when it is identified up front what information is required (Sekaran & Bougie, 2010). According to Sekaran & Bougie (2010), by conducting interviews, the researcher is able to identify new factors, resulting in a deeper understanding. The relevant information obtained helped to better identify and understand best practices of information retrieval on the Web from postgraduate students' perspective.

3.4.2.1 Pre-testing of the interviews

The interview questions were pre-tested to ensure that each question was clear and unambiguous. The pre-testing of interview questions was conducted with postgraduate students at UKZN in order to test appropriateness, comprehension and identify any inadequacies before the actual interviews took place. These candidates were selected for the pre-testing of the interview questions because they had given a substantial amount of feedback during the pre-testing of the questionnaire. They were also knowledgeable in this field of study. A few issues were highlighted by the pre-testing candidates and the changes were made accordingly.

3.4.2.2 Interviews

A total of six questions were used in each face-to-face interview, which helped in gaining further insight to the quantitative data (see Appendix B for interview questions). Written notes were taken during the interview, which were then transcribed to a software package called NVivo. Sekaran & Bougie (2010) suggest that the advantage of face-to-face interviews is that the researcher can elucidate uncertainties and to make sure that the questions are correctly understood by repeating or rephrasing the questions when necessary. Moreover, practically a 100 percent response rate is ensured (Sekaran & Bougie, 2010).

On the other hand, face-to-face interviews are subject to geographical limitations, a limitation that was managed by including postgraduate students at UKZN, Pmb campus only. In addition, respondents may have felt uneasy about anonymity of their responses when they interacted directly with the interviewee (Sekaran & Bougie, 2010). However, this potential apprehension was addressed by notifying respondents prior to the interview that no reference would be made to specific individuals in the study. As mentioned in Section 3.4, interviews have been employed successfully in previous research.

3.5 Research population

The research population refers to the group of individuals under investigation (Sekaran & Bougie, 2010). Many undergraduate students in their first year of study are first-time computer users as opposed to postgraduate students who would have already had at least three to four years of Web searching experience. Kriewel & Fuhr (2010) argue that novices seldom employ sophisticated search strategies and frequently use counter-productive methods, therefore the research population for this study comprised postgraduate students at UKZN, Pmb campus. The respondents consisted of part-time and full-time postgraduate students studying towards a postgraduate certificate, postgraduate diploma, Honours degree, Master's degree or PhD. The total population is 2,344 (UKZN, 2011).

3.5.1 Respondents for quantitative data collection (sampling the population)

Surveying the entire population (i.e. 2,344 postgraduate students on the Pmb campus) would have taken a considerable amount of time, money and effort. It was therefore necessary to survey only a sample, which is a subset of the population (Ghauri *et al*., 1995; Sekaran & Bougie, 2010). Stratified random sampling, which is a probability sampling technique, was used to collect data. As the name suggests, this sampling technique involves the stratification of the sample population followed by subjects being randomly selected from each stratum (Vockell & Asher, 1995; Blumberg *et al*., 2005; Sekaran & Bougie, 2010).

Proportionate stratified random sampling was used, whereby the numbers in the groups (identified below) selected for the sample reflect the relative numbers of the target population (Robson, 2002). The population was divided into five mutually exclusive groups (i.e., postgraduate diploma, postgraduate certificate, Honours, Master's and PhD) that were pertinent, suitable, and meaningful in the context of the study (Blumberg *et al*., 2005; Sekaran & Bougie, 2010).

With stratified random sampling, the stratification of the research population ensures that all groups are adequately sampled when a subset of the population is underrepresented (Ghauri *et al*., 1995; Robson, 2002; Sekaran & Bougie, 2010). This is useful because some Master's and PhD students study part-time and are difficult to access. The major advantage of this sampling design is that it is effective and is appropriate when differential information is required with regard to different strata in the population (Zikmund, 1984; Robson, 2002). However, the

disadvantages of stratified random sampling are that it requires more time and costs are typically high (Zikmund, 1984; Sekaran & Bougie, 2010).

Since Sekaran & Bougie (2010) indicate the need for a trade-off between precision and confidence, a 95 percent confidence level was used when determining the sample size, which worked out to 331 postgraduate students (Krejcie & Morgan, 1970; Sekaran & Bougie, 2010).

The sample size was calculated using the following formula from Krejcie & Morgan (1970):

$$= \frac{X^2NP(1-P)}{d^2\ (N-1)+ X^2P(1-P)}$$

$$= \frac{1.96^2*2344*0.5\ (0.5)}{0.05^2\ (2344-1)+1.96^2*0.5\ (0.5)}$$

$$= \frac{3.841*2344*0.25}{0.0025\ (2343)+3.841*0.25}$$

$$= \frac{2250.826}{6.8177}$$

= 330.1421 (rounded to 331 to obtain a smaller maximum error of the estimate)

Krejcie & Morgan (1970: 607) explain the variables used in the equation above, as follows:

s = required sample size

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)

N = the population size

P = the population proportion (assumed to be .50 since this would provide the maximum sample size)

d = the degree of accuracy expressed as a proportion (.05)

The size of this sample overcomes the limitations of small sample sizes as highlighted by Thatcher (2006). The sample population was then divided into the five mutually exclusive groups of postgraduate students (as discussed earlier). The next step involved working out the proportion of each group in relation to the sample population (as depicted in the table below).

Table 3.1 - Proportions of postgraduate students

Qualification level name	Number of students in relation to total population (i.e. 2,344)	Number of students in relation to sample population (i.e. 331)	Percentage in relation to sample population
Postgraduate certificate	548	76	23%
Postgraduate diploma	231	36	11%
Honours degree	453	63	19%
Master's degree	657	93	28%
Doctorate	455	63	19%
Total	**2344**	**331**	**100%**

3.5.2 Respondents for qualitative data collection

The respondents for the interviews were drawn from those that had participated in the survey. The respondents were determined based on their responses in Section C of the questionnaire (see Appendix A for the questionnaire). For example, when a respondent indicated in the questionnaire that there were aspects related to Web searching that they wanted to explain in more detail, such as strategies not mentioned in the questionnaire. Due to time constraints, a total of ten respondents were identified as interview candidates, as they used the highest number of search tactics listed on the questionnaire. Since these candidates used the highest number of tactics, they are, in the researcher's opinion, likely to have more search strategies (i.e. combination of search tactics) than those respondents that use fewer search tactics.

3.6 Data analysis

According to Babbie & Mouton (2001), it is essential to conduct the analysis of data to check for completeness, ambiguity, internal consistency, comprehensibility, reliability and relevance. The quantitative data was organised and captured into a statistical program called SPSS 18. The qualitative data from the interviews was transcribed to text and then stored electronically in a software package called NVivo 9.

3.6.1 Quantitative data analysis

Once the data was captured into SPSS, it was checked to ensure that the data was complete and that no typographical errors were made. The direct consequence of inaccurate data is incorrect

results of findings. Therefore, it is important to check the data once it has been captured. According to Fowler (2002), when an error is discovered, the original source must be consulted and the corrections must be made. Thematic analysis was performed on the quantitative data to identify patterns and trends. This involves collecting and organising data systematically in a format that enables conclusions to be drawn concerning the significance and characteristics of the data (Babbie & Mouton, 2001). The data was then further analysed to determine correlations between key factors.

3.6.2 Qualitative data analysis

Thematic analysis was then used to analyse the data from the interviews, which assisted in analysing the data and then identifying its properties systematically, for instance themes, concepts or characters (Sekaran & Bougie, 2010). To conduct the thematic analysis, the text was organised into categories and then analysed using conceptual and relational analysis. According to Sekaran & Bougie (2010), the frequency and existence of concepts is established by conceptual analysis, in addition to analysing and interpreting content by sorting it into content categories.

3.7 Validity and reliability

The research instruments were evaluated using factor analysis to validate the subscales and a reliability analysis was performed to assess the internal consistency of the subscale items (Creswell & Clark, 2007).

3.7.1 Validity

Validity, in context of the mixed methods approach, is defined as "the ability of the researcher to draw meaningful and accurate conclusions from all of the data in the study" (Creswell & Clark, 2007: 146). A potential threat to the validity of this sequential design is not selecting respondents for follow-up who may have helped explain significant results. Creswell & Clark (2007) suggests a method of minimising this threat is to choose the same individuals for the qualitative follow-up and the quantitative first phase. The individuals that were surveyed were the same individuals that were interviewed. However, it was not feasible to obtain qualitative

data from all the quantitative respondents due to the considerable size of the research population.

The content of the questionnaire was validated by research professionals in the School of Information Systems & Technology to ensure content validity, which is described as a function of how well the scope and aspects of a concept have been outlined (Sekaran & Bougie, 2010). The questionnaire was then pre-tested with participants that resemble the research population of this study.

3.7.2 Reliability

According to Sekaran & Bougie (2010), the extent to which a measure is without bias is denoted by the reliability of a measure and therefore guarantees constant measurement across the different items in the instrument and across time. "The ability of a measure to remain the same over time, despite uncontrollable testing conditions or the state of the respondents themselves, is indicative of its stability and low vulnerability to changes in the situation" (Sekaran & Bougie, 2010: 162). They further indicate that parallel form reliability and test-retest reliability are methods for evaluating the stability of a measure.

3.8 Ethical Clearance

Ethical clearance was obtained once the questionnaire and interview questions had been drafted. Permission was sought from the office of the Registrar before the questionnaires were administered to the sample population (see Appendix C). The questionnaires included reasons for the research undertaking, an indication that the information gathered would be strictly confidential and that no reference would be made to a specific individual. The students' signatures on the questionnaires is proof of their voluntary participation and consent. The students that were interviewed also provided signatures on a separate document to indicate their acknowledgement and consent. Once the quantitative and qualitative data had been transcribed electronically, all questionnaires along with the data from SPSS and Nvivo were sent to the School of Information Systems & Technology for archiving. This data is usually archived for a period of five years.

3.9 Summary of the chapter

This chapter outlined the mixed methods research design adopted for this study and the data collection techniques used to extract the relevant information in order to meet the research objectives. The explanatory design: follow-up explanations model was used for this study, where quantitative data was collected in the first phase of the data collection and qualitative data was obtained for the second phase. Questionnaires were used as the quantitative data collection instrument, followed by interviews, which was the qualitative data collection instrument. A pre-test of the questionnaire and interview questions was conducted to ensure reliability and validity of the study. SPSS was used to capture the quantitative data and NVivo was used to capture the qualitative data. The next chapter deals with the findings and analysis of the study.

Chapter 4

Findings and analysis

4.1 Introduction

This chapter contains the findings and analysis of this study. The results of the survey will be presented first, followed by the results of the interview, as the findings from the interview build on the findings from the survey.

4.2 Response rate

As outlined in Chapter 3, questionnaires were distributed to postgraduate students at UKZN. A total of 331 were administered and 315 were returned, yielding a response rate of 95%. The high response rate was arguably achieved as the questionnaires were distributed and collected personally by the researcher (Sierles, 2003). This response rate is considered acceptable. It is suggested that the response rates for surveys and face-to-face interviews can be as low as 50% (Owen & Jones, 1994; Kervin, 1999; Saunders *et al*., 2000).

Once the quantitative results were captured and analysed, ten respondents that had completed the questionnaires then qualified as interviewees. However, only eight respondents agreed to be interviewed. This is an 80% response rate for the interviews, which is also acceptable (Owen & Jones, 1994; Kervin, 1999; Saunders *et al*., 2000).

4.3 Quantitative results (of the questionnaires)

The questionnaire answers the first research question outlined in Chapter 1. The symbol N indicates the number of respondents that have answered a question and frequencies are rounded off to one decimal place. The analysis for each section in the questionnaire is discussed separately.

4.3.1 Section A - Demographics of respondents

This section provides background on the respondents, such as gender, age, ethnic group, which degree they are registered for and which School they belong to.

4.3.1.1 Cross-tabulation between age and gender

Table 4.1 illustrates that there were 314 respondents, of which 158 (50.3%) were female, 156 (49.7%) were male and that one (0.3%) respondent indicated that s/he was not willing to reveal his/her gender. This result is similar to the study undertaken by Aula *et al.* (2005), where there were 50.6% males and 49.4% females. Whilst this table may not answer any of the research questions, it provides demographic information about the respondents in order to have a general picture of the sample population.

The majority of respondents (54.5%, N=171) were between the ages of 21 and 25, 21% (N=66) were between 26 and 30, 9.2% (N=29) were between 31 and 35, and 15.3% (N=48) were 36 years and older. The table below shows that just under a third of the respondents were female students between the ages of 21 and 25. There were twice as many males than females in the 36 years and above category.

Table 4.1 - Respondents' age * gender cross-tabulation

Respondent's Age		Gender		Total
		Female	Male	
21-25	Count	100	71	171
	% of Total	31.8%	22.6%	54.5%
26-30	Count	31	35	66
	% of Total	9.9%	11.1%	21.0%
31-35	Count	11	18	29
	% of Total	3.5%	5.7%	9.2%
36+	Count	16	32	48
	% of Total	5.1%	10.2%	15.3%
Total (N)	Count	158	156	314
	% of Total	50.3%	49.7%	100.0%

4.3.1.2 Cross-tabulation between ethnic group and type of study

The table below shows that the majority of respondents (69.5%, N=216) were black students, whilst coloured students formed the minority (1.6%, N=5). Indian students formed 11.3% (N=35), whilst white students formed 17.7% (N=55). Four students (1.3%) did not indicate the racial group they belonged to. Once again, this table does not answer any of the research questions, but it provides a general picture of the sample population.

The table below shows that respondents studying towards a postgraduate diploma (PGDip) constituted 11.3% (N=35) of respondents, respondents studying towards a postgraduate certificate (PGC) constituted 22.2% (N=69), respondents studying towards an Honours degree constituted 19.6% (N=61), respondents studying towards a Master's degree constituted 29.6% (N=92) and respondents studying towards a PhD constituted 17.4% (N=54).

Table 4.2 - Ethnic group * type of study cross-tabulation

Ethnic group		Type of study					Total
		PGDip	PGC	Honours	Masters	PhD	
Black	Count	30	44	39	57	46	216
	% of Total	9.6%	14.1%	12.5%	18.3%	14.8%	69.5%
Coloured	Count	0	1	1	3	0	5
	% of Total	0%	0.3%	0.3%	1%	0%	1.6%
Indian	Count	0	9	13	8	5	35
	% of Total	0%	2.9%	4.2%	2.6%	1.6%	11.3%
White	Count	5	15	8	24	3	55
	% of Total	1.6%	4.8%	2.6%	7.7%	1%	17.7%
Total (N)	**Count**	**35**	**69**	**61**	**92**	**54**	**311**
	% of Total	**11.3%**	**22.2%**	**19.6%**	**29.6%**	**17.4%**	**100%**

4.3.1.3 Faculties from which respondents were surveyed

For Question 5, respondents were required to indicate which School s/he belongs to. However, some respondents specified their Faculty instead of their School. Due to this inconsistency in the data, Schools were grouped into Faculties and displayed in the table below. This question was asked to form a picture of which Faculties the respondents belonged to.

Table 4.3 - Faculties from which respondents were surveyed

Faculty	Frequency	Percentage
Science & Agriculture	88	27.9%
Humanities, Development & Social Science	60	19.0%
Education	44	14.0%
Management Studies	28	8.9%
Law	11	3.5%
No response	84	26.7%
Total (N)	**315**	**100%**

4.3.2 Section B - Level of computer experience and Web usage

This section provides information on the respondents' Web usage and level of experience.

4.3.2.1 Cross-tabulation between type of study and number of years Web searching

Table 4.4 shows that the majority (59.4%, N=187) of respondents have been searching the Web for six years or longer, whilst 4.1% (N=13) have been searching the Web for less than two years. Thirty-two (10.2%) have been searching the Web from two to less than four years and 83 (26.3%) have been searching the Web from four to less than six years. The cross-tabulation assists in establishing if a significant relationship exists between type of study and the number of years respondents have been searching the Web.

In order to apply a chi-square test to this data, the expected values in at least 80% of the cells in Table 4.4 must be greater than five (Preacher, 2001). Because this condition is violated here, the categories '0 – 2' and '2 – 4' have been combined into one category '0 – 4' (as shown in Table 4.5 below) (Dayton & Macready, 1976; Bryman & Cramer, 1990).

Table 4.4 - Type of study * number of years respondents have been searching the Web cross-tabulation

Type of study		How long have you been searching the Web?				Total
		0-2	2-4	4-6	6+	
Postgraduate diploma	Count	4	4	13	14	35
	% of Total	1.3%	1.3%	4.1%	4.4%	11.1%
Postgraduate certificate	Count	4	7	18	40	69
	% of Total	1.3%	2.2%	5.7%	12.7%	21.9%
Honours degree	Count	2	11	21	29	63
	% of Total	0.6%	3.5%	6.7%	9.2%	20%
Masters degree	Count	2	5	25	62	94
	% of Total	0.6%	1.6%	7.9%	19.7%	29.8%
PhD	Count	1	5	6	42	54
	% of Total	0.3%	1.6%	1.9%	13.3%	17.1%
Total (N)	**Count**	**13**	**32**	**83**	**187**	**315**
	% of Total	**4.1%**	**10.2%**	**26.3%**	**59.4%**	**100%**

Table 4.5 - Type of study * number of years respondents have been searching the Web (grouped) cross-tabulation

Type of study		How long have you been searching the Web? (Grouped)			Total
		0-4	4-6	6+	
Postgraduate diploma	Count	8	13	14	35
	% of Total	2.5%	4.1%	4.4%	11.1%
Postgraduate certificate	Count	11	18	40	69
	% of Total	3.5%	5.7%	12.7%	21.9%
Honours degree	Count	13	21	29	63
	% of Total	4.1%	6.7%	9.2%	20%
Masters degree	Count	7	25	62	94
	% of Total	2.2%	7.9%	19.7%	29.8%
PhD	Count	6	6	42	54
	% of Total	1.9%	1.9%	13.3%	17.1%
Total (N)	**Count**	**45**	**83**	**187**	**315**
	% of Total	**14.3%**	**26.3%**	**59.4%**	**100%**

The Chi-square tests were then run again with the grouped columns (as shown in Table 4.6).

Null hypothesis 1 - there is no relationship between different levels of study of students and the number of years they have been searching the Web.

Table 4.6 - Chi-square test for hypothesis 1

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.537[a]	8	.004
Likelihood Ratio	23.943	8	.002
N of Valid Cases	315		

a. 0 cells (.0%) have expected count less than five. The minimum expected count is 5.00.

The test shows that less than 20% of cells have an expected count less than five, which is acceptable (Yates *et al*., 1999). The p-value for Pearson Chi-square is 0.004, which is highly significant. This means that a significant relationship exists between type of study and the number of years respondents have been searching the Web. This finding justifies the target population chosen for this study.

Closer analysis of the data shows that fewer than expected respondents studying towards a PhD have searched the Web from four to less than six years. However, more than expected of these students have searched the Web for six years or longer. This is probably due the fact that PhD students have been doing research for longer than respondents undertaking any other postgraduate study.

The results also show that more than expected of the postgraduate diploma and Honours students have been searching the Web for up to six years. Fewer than expected Master's students have searched for up to four years. Therefore, the higher the level of study, the greater the number of years respondents have been searching the Web (Chu & Law, 2007).

4.3.2.2 Cross-tabulation between the number of years searching the Web and the average time spent searching the Web in a week

The table below shows that most postgraduate students (36.3%, N=114) searched for information on the Web for five to ten hours a week. Seventy-two respondents (22.9%) searched less than five hours a week, while 21.3% (N=67) respondents searched from ten to less

than 15 hours a week and 19.4% (N=61) respondents searched the Web for information more than 15 hours a week. One respondent did not answer this question.

Table 4.7 - Number of years searching the Web * average time spent searching the Web in a week cross-tabulation

How long have you been searching the Web?		How much time do you spend in a week searching for information on the Web?				Total
		<5	5-10	10-15	>15	
0-2	Count	9	3	1	0	13
	% of Total	2.9%	1%	0.3%	0%	4.1%
2-4	Count	9	12	6	5	32
	% of Total	2.9%	3.8%	1.9%	1.6%	10.2%
4-6	Count	25	35	13	10	83
	% of Total	8%	11.1%	4.1%	3.2%	26.4%
6+	Count	29	64	47	46	186
	% of Total	9.2%	20.4%	15%	14.6%	59.2%
Total (N)	**Count**	**72**	**114**	**67**	**61**	**314**
	% of Total	**22.9%**	**36.3%**	**21.3%**	**19.4%**	**100%**

Once again, a problem of small expected values was overcome by combining categories (see Table 4.8).

Table 4.8 - Number of years searching the Web (grouped) * average time spent searching the Web in a week cross-tabulation

How long have you been searching the Web? (Grouped)		On average, approximately how much time do you spend in a week searching for information on the Web?				Total
		<5	5-10	10-15	>15	
0-4	Count	18	15	7	5	45
	% of Total	5.7%	4.8%	2.2%	1.6%	14.3%
4-6	Count	25	35	13	10	83
	% of Total	8%	11.1%	4.1%	3.2%	26.4%
6+	Count	29	64	47	46	186
	% of Total	9.2%	20.4%	15%	14.6%	59.2%
Total (N)	**Count**	**72**	**114**	**67**	**61**	**314**
	% of Total	**22.9%**	**36.3%**	**21.3%**	**19.4%**	**100%**

Null hypothesis 2 – there is no relationship between the number of years respondents have been searching the Web and the average time spent searching the Web in a week.

Table 4.9 - Chi-square test for hypothesis 2

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.965[a]	6	.001
Likelihood Ratio	22.845	6	.001
Linear-by-Linear Association	18.797	1	.000
N of Valid Cases	314		

a. 0 cells (0%) have expected count less than five. The minimum expected count is 8.74.

The p-value for Pearson Chi-square is 0.001, which is highly significant. This means that a significant relationship exists between the number of years searching the Web and the average time spent searching the Web in a week.

More than expected respondents that have been searching the Web for up to six years spend on average less than five hours a week searching the Web; while more than expected of those that have been searching the Web for more than six years spend in excess of 10 hours a week searching the Web. Therefore, the greater the number of years that respondents have been searching the Web, the more time they spend searching in a week, on average. This finding provides insight into the respondents' Web searching behaviour and may contribute to future studies, although it does not answer any of the critical research questions.

4.3.2.3 Cross-tabulation between formal training or experience and the number of years searching the Web

Most respondents (73.9%, N=232) gained their knowledge on Web searching through experience and only 26.1% (N=82) have been given formal training on Web searching. This finding contributes to the argument that there is a lack of formal training (Markland, 2005; Chu & Law, 2007). The training received was either library orientation, computer literacy courses, workshops or tutorials. If complex Web searching services are to be used to the best of their advantage, then training in these services should be part of every student's academic experience (Nachmias & Gilad, 2002; Asemi, 2005; Markland, 2005). This finding suggests that first year students should receive formal training in complex Web search services/ tools, so that they may be more efficient in their searches, early in their studies, than learning through trial and error. Trial and error will most probably take much longer for many novice searchers than formal training.

Of those that gained their knowledge on Web searching from experience, 3.2% (N=10) have been searching the Web for less than two years, 7.3% (N=23) have been searching the Web for two to less than four years, 19.1% (N=60) have been searching the Web for four to less than six years and 44.3% (N=139) have been searching the Web for six years or longer.

Table 4.10 - Formal training or experience * number of years searching the Web cross-tabulation

How long have you been searching the Web?		Were you given formal training on searching for information on the Web, or did you gain your knowledge through experience?		Total
		Experience	Formal Training	
0-2	Count	10	3	13
	% of Total	3.2%	1%	4.1%
2-4	Count	23	9	32
	% of Total	7.3%	2.9%	10.2%
4-6	Count	60	23	83
	% of Total	19.1%	7.3%	26.4%
6+	Count	139	47	186
	% of Total	44.3%	15%	59.2%
Total (N)	**Count**	**232**	**82**	**314**
	% of Total	**73.9%**	**26.1%**	**100%**

Of those that gained their knowledge on Web searching from formal training, 1% (N=3) have been searching the Web for less than two years, 2.9% (N=9) have been searching the Web for two to less than four years, 7.3% (N=23) have been searching the Web for four to less than six years and 15% (N=47) have been searching the Web for six years or longer.

Null hypothesis 3 - there is no relationship between formal training or experience gained and the number of years searching the Web.

Table 4.11 - Chi-square test for hypothesis 3

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.308[a]	3	.959
Likelihood Ratio	.307	3	.959
N of Valid Cases	314		

a. 1 cell (12.5%) has an expected count less than five. The minimum expected count is 3.39.

The p-value for Pearson Chi-square is 0.959, which is not significant. This means that there is no significant relationship between formal training or experience gained and the number of years searching the Web. This finding does not contribute to any of the research questions under investigation but it provides a general picture of the relationship between these two variables and may be of potential use to future studies in this area.

4.3.2.4 Cross-tabulation between respondents' rating of their expertise level and the number of years searching the Web

More than half (64.8%) of respondents rated their expertise as intermediate, while 94 (29.8%) rated their expertise as expert and only 17 (5.4%) rated their expertise as novice. This finding shows how respondents perceive their expertise and is not indicative of their actual expertise level.

Table 4.12 - Respondents' rating of their expertise level * the number of years searching the Web cross-tabulation

How long have you been searching the Web?		How would you rate your expertise in Web searching?			Total
		Novice	Intermediate	Expert	
0-2	Count	3	10	0	13
	% of Total	1%	3.2%	0%	4.1%
2-4	Count	5	21	6	32
	% of Total	1.6%	6.7%	1.9%	10.2%
4-6	Count	4	61	18	83
	% of Total	1.3%	19.4%	5.7%	26.3%
6+	Count	5	112	70	187
	% of Total	1.6%	35.6%	22.2%	59.4%
Total (N)	**Count**	**17**	**204**	**94**	**315**
	% of Total	**5.4%**	**64.8%**	**29.8%**	**100%**

Once again the expected values condition is violated here, therefore the categories 'Intermediate' and 'Novice' have been combined into one category 'Non-Expert' (as shown in Table 4.13 below).

Respondents (12.4 %) that have been searching for zero to less than four years perceive themselves to be non-experts. Thatcher (2008: 1325) suggests that "respondents who have less experience with the Web would need to devote their cognitive resources to the search task at hand within a complex searching environment rather than spend extra cognitive resources

switching between browser windows". Therefore, if training in the use of Web searching tools is not acquired by students in their first year of study, then they will need to devote more cognitive resources in trying to figure out how to search the Web effectively rather than spending their cognitive resources on the sources retrieved.

Table 4.13 - Respondents' rating of their expertise level (grouped) * the number of years searching the Web cross-tabulation

How long have you been searching the Web?		Experience Rating Grouped		Total
		Non-expert	Expert	
0-2	Count	13	0	13
	% of Total	4.1%	0%	4.1%
2-4	Count	26	6	32
	% of Total	8.3%	1.9%	10.2%
4-6	Count	65	18	83
	% of Total	20.6%	5.7%	26.3%
6+	Count	117	70	187
	% of Total	37.1%	22.2%	59.4%
Total (N)	**Count**	**221**	**94**	**315**
	% of Total	**70.2%**	**29.8%**	**100%**

Null hypothesis 4 - there is no relationship between experience rating and the number of years searching the Web.

Table 4.14 - Chi-square test for hypothesis 4

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.194[a]	3	.002
Likelihood Ratio	19.008	3	.000
Linear-by-Linear Association	14.196	1	.000
N of Valid Cases	315		

a. 1 cell (12.5%) has expected count less than five. The minimum expected count is 3.88.

The test shows that less than 20% of cells have an expected count less than five, which is acceptable (Utts & Heckard, 2002). The p-value for Pearson Chi-square is 0.002, which is highly significant. This means that a significant relationship exists between the number of years respondents have been searching the Web and the rating of their experience level. More than

expected respondents have been searching the Web for six years and longer rated themselves as expert; while more than expected that have been searching the Web less than two years rated themselves as novice. Therefore, the greater the number of years respondents have been searching the Web, the higher the experience ratings. Once again, this finding does not answer any of the research questions but it provides general picture of the relationship between these two variables and could be of potential use to future studies.

4.3.2.5 Web browsers used

For Question 10, respondents were asked to specify which Web browsers they used. This was a multiple response question, whereby respondents could select more than one Web browser. One respondent did not indicate any Web browsers used. From 314 respondents, there were 531 responses to this question.

The most commonly used Web browser was Internet Explorer (71.8%), followed by Google Chrome (53%) and then Mozilla Firefox (32.7%). Only 15 (4.8%) used other Web browsers, namely Opera, Safari, Netscape, Camino and Opera Mini. Aula *et al.* (2005) had a similar finding, whereby 62.3% used Internet Explorer as their primary browser. Again, this finding does not answer any of the research questions but it helps build context and could be of potential use to future studies as it identifies the most commonly used Web browser.

Table 4.15 - Web browsers used

Web browsers used	Yes		No	
	Count	%	Count	%
Internet Explorer	246	71.8%	69	21.9%
Mozilla Firefox	103	32.7%	212	67.3%
Google Chrome	167	53%	148	47%
Other Web browsers	15	4.8%	300	95.2%

4.3.2.6 Web search engines used

For Question 11, the respondent was asked to specify which Web search engine s/he used. From 315 respondents, there were 547 responses. This was a multiple response question, whereby respondents could select more than one Web search engine used.

The top five most used search engines were Google (99.4%), Yahoo (36.5%), Ask.com (10.2%), Windows Live (7.6%), MSN (6%), other search engines (5.7%), Bing (5.4%) and finally AOL (2.9%). This finding is similar to The Nielsen Company's report (Table 2.6 in Chapter 2) on the top five United States search providers in one month for each year between 2008 and 2010 (Johnson, 2008; Nielsen Wire, 2009; Nielsen Wire, 2010). Since the search engine used is seen as a search tactic, this finding helps in answering the first research question (i.e., What Web search tactics do postgraduate students currently use?).

Aula *et al.* (2005) had a similar finding, whereby Google was used by 99.2% of the respondents. Not much has changed in the last six years as Google is still the search engine of choice (Aula *et al.*, 2005; Griffiths & Brophy, 2005; Kim *et al*., 2007; Nazim, 2008, Lefkowitz *et al.*, 2012). It was concluded that Google is the best search engine as its index proved to be the most accurate, comprehensive and timely of them all and it is faster than Yahoo and MSN (Bertolucci, 2007; Liu, 2007). This may be the reason why Google is still the search engine of choice.

Other search engines used by respondents were Ananzi, Aardvark, AltaVista and Dogpile.

Table 4.16 - Web search engines used

Web search engines used	Yes		No	
	Count	%	Count	%
Google	313	99.4%	2	0.6%
Yahoo	115	36.5%	200	63.5%
Ask.com	32	10.2%	283	89.8%
Windows Live	24	7.6%	291	92.4%
MSN	19	6%	296	94%
Other search engines	18	5.7%	297	94.3%
Bing	17	5.4%	298	94.6%
AOL	9	2.9%	306	97.1%

4.3.2.7 Favourite Web search engines

For Question 12, the respondent was asked to specify which Web search engine was their favourite. Even though the question specified that the respondent should tick only one option, some respondents provided more than one response. Since they did not follow the instructions in answering this question, the results were inconsistent and could therefore not be used.

4.3.2.8 Reasons for the Web search engines being their favourite

For Question 13, respondents were required to provide an explanation as to why the search engine they indicated in Question 12 was their favourite. All respondents answered this open-ended question. Themes were formed from the responses and the frequency of each theme was then calculated.

The top three reasons that most respondents chose a particular search engine as their favourite was because it was quick, user-friendly and yielded the required information (49.2%), the search engine gave broader search options and results (11.1%) and it was the only search engine they knew (9.5%). Cohen (2006) and Bertolucci (2007) had similar findings from their studies.

The remaining respondents indicated a combination of the above reasons (2.5%), while 5.4% did not respond to the question. This finding assists in understanding the reasons for respondents choosing one search engine over another and does not directly answer any of the research questions.

Table 4.17 - Explanations for selecting favourite search engine

Explanation	Frequency	Percent
Quick, user-friendly and gets required information	155	49.2%
Gives broader search options and results	35	11.1%
Only one I know	30	9.5%
Efficient and effective	20	6.3%
No response	17	5.4%
Provides academic materials and latest information	17	5.4%
Gets best search results	16	5.1%
A combination of explanations below	8	2.5%
Offers convenience	7	2.2%
Fast, reliable and accessible even on cellular telephones	5	1.6%
More experienced with it	5	1.6%
Total (N)	**315**	**100%**

4.3.3 Section C - Web search tactics

This section describes the Web search tactics used by respondents and how often these tactics are used. This section also provides the building blocks for the analysis on the interview data that follows in the next section. The tactics discussed in Section 4.3.3.1 to 4.3.3.24 answer the first research question as discussed in Chapter 1.

For Question 14, respondents were given 23 Web search tactics where they had to indicate the frequency of use of each of these tactics. The options were: 'never', 'rarely', 'sometimes', 'often' or 'always'. This question was displayed as a matrix (see page 4 of Appendix A).

Table 4.18a and 4.18b below shows that from a total of 315 respondents, the top three Web search tactics that were 'always' used were Web search engines (47.6%, N=150), the opening of multiple Web browser tabs (42.2%, N=133) and the opening of multiple Web browser windows (26%, N=82).

The top three Web search tactics that were 'often' used were finding the relevant information in the first page of the search results (44.1%, N=139), using multiple keywords (42.5%, N=134) and searching the UKZN online library databases (41%, N=129).

The top three Web search tactics that were 'sometimes' used were using single keywords (34.9%, N=110), browsing through a directory or catalogue (33%, N=104) and using advanced search features (32.1%, N=101).

The top three Web search tactics that were 'rarely' used were searching for specific phrases using quotation marks (33.7%, N=106), using multiple search engines (27.9%, N=88) and browsing through a directory or catalogue (27.3%, N=86).

Finally, the top three Web search tactics that were 'never' used were search the "invisible Web" (54.9%, N=173), the use of meta-search engines (49.8%, 157) and the use of truncation or wildcards (46.7%, N=147).

Table 4.18a - Frequency distribution of Web search tactics used

Web search tactics	Never		Rarely		Sometimes		Often		Always		No response	
	N	%	N	%	N	%	N	%	N	%	N	%
Open multiple Web browser windows?	28	8.9%	59	18.7 %	63	20%	79	25.1 %	82	26%	4	1.3 %
Open multiple tabs?	8	2.5%	32	10.2 %	52	16.5 %	86	27.3 %	133	42.2 %	4	1.3 %
Type in the Web address?	15	4.8%	66	21%	89	28.3 %	80	25.4 %	59	18.7 %	6	1.9 %
Browse through a directory or a catalogue?	39	12.4 %	86	27.3 %	104	33%	58	18.4 %	17	5.4%	11	3.5 %
Access a specific portal?	34	10.8 %	77	24.4 %	94	29.8 %	69	21.9 %	27	8.6%	14	4.4 %
Use Web search engines?	7	2.2%	10	3.2%	35	11.1 %	107	34%	150	47.6 %	6	1.9 %
Find req. info. in the first page of the results?	10	3.2%	29	9.2%	93	29.5 %	139	44.1 %	38	12.1 %	6	1.9 %
Use multiple search engines?	67	21.3 %	88	27.9 %	78	24.8 %	59	18.7 %	19	6%	4	1.3 %
Use advanced search features?	31	9.8%	84	26.7 %	101	32.1 %	66	21%	26	8.3%	7	2.2 %
Use single keywords?	36	11.4 %	77	24.4 %	110	34.9 %	69	21.9 %	17	5.4%	6	1.9 %
Use multiple keywords?	9	2.9%	22	7%	61	19.4 %	134	42.5 %	79	25.1 %	10	3.2 %
Search for specific phrases?	73	23.2 %	106	33.7 %	68	21.6 %	47	14.9 %	18	5.7%	3	1%
Use truncation or wildcards?	147	46.7 %	86	27.3 %	48	15.2 %	23	7.3%	7	2.2%	4	1.3 %
Modify your query?	14	4.4%	24	7.6%	88	27.9 %	122	38.7 %	61	19.4 %	6	1.9 %
Use synonyms?	38	12.1 %	77	24.4 %	99	31.4 %	71	22.5 %	24	7.6%	6	1.9 %
Use Boolean operators?	67	21.3 %	85	27%	86	27.3 %	63	20%	12	3.8%	2	0.6 %
Use the find feature?	114	36.2 %	85	27%	54	17.1 %	32	10.2 %	22	7%	8	2.5 %

Table 4.19b - Frequency distribution of Web search tactics used

Web search tactics	Never		Rarely		Sometimes		Often		Always		No response	
	N	%	N	%	N	%	N	%	N	%	N	%
Use proximity searching?	146	46.3 %	78	24.8 %	52	16.5 %	32	10.2 %	2	0.6%	5	1.6 %
Use meta-search engines?	157	49.8 %	76	24.1 %	46	14.6 %	17	5.4%	5	1.6%	14	4.4 %
Search the invisible Web?	173	54.9 %	70	22.2 %	37	11.7 %	9	2.9%	6	1.9%	20	6.3 %
Search the UKZN online library OPAC catalogue system?	25	7.9%	39	12.4 %	79	25.1 %	11 9	37.8 %	53	16.8 %	0	0%
Search the UKZN online library databases?	20	6.3%	29	9.2%	70	22.2 %	12 9	41%	66	21%	1	0.3 %
Collaborate with colleagues?	23	7.3%	81	25.7 %	99	31.4 %	64	20.3 %	33	10.5 %	15	4.8 %

Chi-square tests were used to test for 'goodness of fit' for all sub-questions of Question 14. The chi-square test may be used to compare frequencies on a single variable to observe how closely they 'fit' to those expected or predicted on a theoretical basis (Robson, 2002). If $p<0.05$, the result is significant, which means that the response options are not selected equally.

4.3.3.1 Multiple Web browser windows

For this sub-question, the respondent was required to indicate how often s/he opens multiple Web browser windows when searching the Web.

The majority of respondents (51.1%, N=161) open multiple Web browser windows 'often or always', while only 8.9% (N=28) 'never' open multiple Web browser windows. Thatcher (2008) suggests that significant cognitive resources is required when searching with multiple Web browser windows. The requirement of significant cognitive resources may be the reason that opening multiple Web browser tabs (as discussed below) is used more often than the opening of multiple Web browser windows.

4.3.3.2 Multiple tabs within a Web browser

For this sub-question, the respondent was required to indicate how often s/he opens multiple Web browser tabs when searching the Web.

The majority of respondents (69.5%, N=219) 'often' or 'always' open multiple Web browser tabs, while only, 12.7% (N=40) 'rarely' or 'never' open multiple Web browser tabs.

4.3.3.3 Type in the Web address (URL) of the relevant Web page

For this sub-question, the respondent was required to indicate how often s/he types in the URL of the relevant Web page when searching the Web.

The majority of respondents (44.1%, N=139) 'often or always' type in the URL of the relevant Web page, while 25.8% (N=81) 'rarely or never'. It has been noted that the use of URLs on a Web page are not that important (Aula *et al.,* 2005). This may be the reason that a quarter of the respondents 'rarely or never' type in the URL of the relevant Web page.

4.3.3.4 Browse through a directory or a catalogue

For this sub-question, the respondent was required to indicate how often s/he browses through a directory or a catalogue when searching the Web.

The majority of respondents (60.3%, N=190) 'rarely or sometimes' browse through a directory or a catalogue, while 5.4% (N=17) 'always' browse through a directory or a catalogue.

4.3.3.5 Access a specific portal

For this sub-question, the respondent was required to indicate how often s/he accesses a specific portal when searching the Web.

The majority of respondents (54.2%, N=171) 'rarely or sometimes' accesses a specific portal, while only 8.6% (N=27) 'always' accesses a specific portal.

4.3.3.6 Use Web search engines to search for information

For this sub-question, the respondent was required to indicate how often s/he uses a Web search engine when searching the Web.

The majority of respondents (81.6%, N=257) 'often or always' use Web search engines, while only 5.4% (N=17) 'never or rarely' use Web search engines. This search tactic seems to dominate the respondents' information-seeking strategies. Griffiths & Brophy (2005) also found that search engines dominated students' information-seeking strategies.

4.3.3.7 Find what you are looking for on the first page of the search results

For this sub-question, the respondent was required to indicate how often s/he finds the information that s/he is looking for, in the first page of the search results.

The majority of respondents (44.1%, N=139) 'often' find what they are looking for in the first page of the search results, while only 3.2% (N=10) 'never' find what they are looking for in the first page of the search results. Jansen & Spink (2006) had a comparable finding and suggest that the viewing of only the first page of the search results may be an indication of the increasing ability of Web search engines to retrieve and rank Web documents more effectively. This could explain why the majority of respondents 'often' find what they are looking for in the first page of the search results.

4.3.3.8 Use multiple of search engines

For this sub-question, the respondent was required to indicate how often s/he uses multiple search engines when searching the Web.

The majority of respondents (52.7%, N=166) 'rarely or sometimes' use multiple search engines, while only 6% (N=19) 'always' use multiple search engines. However, Asemi (2005) suggests that to effectively search the Web, a Web searcher should utilise multiple search engines, as one search engine may present superior quality results for certain queries than others (Asemi, 2005). Only a few respondents use this search tactic, which has shown to produce superior quality results. This finding suggests that respondents require training on Web search tactics as

respondents may not be aware of such a tactic, therefore the poor usage of multiple search engines.

4.3.3.9 Use of advanced search features

For this sub-question, the respondent was required to indicate how often s/he uses advanced search features when searching the Web.

The majority of respondents (58.8%, N=185) 'rarely or sometimes' use advanced search features, while only 8.3% (N=26) 'always' use advanced search features. Nowicki (2003) found that most students did not utilise the advanced search features and when they did, they used them incorrectly. Nowicki's (2003) finding is similar to the findings of this study, however respondents in this study were not tested to see if the advanced search features were used correctly.

4.3.3.10 Use single keywords

For this sub-question, the respondent was required to indicate how often s/he uses single keywords when searching the Web.

The majority of respondents (61%, N=187) 'rarely or sometimes' use single keywords, while only 6% (N=17) 'always' use single keywords. The reason for the relatively low usage of single keywords may be that this search tactic is inefficient. Although single keyword search was found to be widely used in two previous studies, this strategy was found to be inefficient (Nachmias & Gilad 2002, Nowicki 2003).

4.3.3.11 Use of multiple keywords

For this sub-question, the respondent was required to indicate how often s/he uses multiple keywords when searching the Web.

The majority of respondents (70%, N=213) 'often or always' use multiple keywords, while only 3% (N=9) 'never' use multiple keywords. Chu & Law (2007) had a similar finding in that they found 60% of the participants used multiple keywords when searching for information.

4.3.3.12 Search for specific phrases using quotation marks

For this sub-question, the respondent was required to indicate how often s/he searches for specific phrases using quotation marks when searching the Web.

The majority of respondents (34%, N=106) 'rarely' search for specific phrases using quotation marks, while only 6% 'always' search for specific phrases using quotation marks. O'Reilly (2007) explains that one should search in phrases or questions and those phrases are then highlighted in the results to make browsing easier. Therefore, to make the search more efficient, it is recommended that more searchers should search in phrases.

4.3.3.13 Use of truncation or wildcards

For this sub-question, the respondent was required to indicate how often s/he uses truncation or wildcards when searching the Web for information using a computer or laptop.

The majority of respondents (75%, N=233) 'never or rarely' use truncation or wildcards, while only 2% (N=7) 'always' use truncation or wildcards. Chu & Law (2008: 175) suggest that "training provided to the students should comprise various search skills such as truncation and proximity search, as these were considered important by the students". The lack of training may be the reason that most students rarely use truncation or wildcards.

4.3.3.14 Modify query to find more accurate information

For this sub-question, the respondent was required to indicate how often s/he modifies his/her query to find more accurate information when searching the Web.

The majority of respondents (67%, N=210) 'sometimes or often' modifies his/her query to find more accurate information, while only 5% (N=14) 'never' modifies his/her query to find more accurate information. The reason for this may be due to the finding by Jansen & Spink (2006), where users would rather reformulate the query than navigate through the results pages.

4.3.3.15 Use of synonyms

For this sub-question, the respondent was required to indicate how often s/he uses synonyms when searching the Web.

The majority of respondents (57%, N=176) 'rarely or sometimes' use synonyms when searching the Web for information, while only 8% (N=24) 'always' use synonyms. Bates (1979a: 211) refers to this tactic as "Parallel", which is "to make the search formulation broad (or broader) by including synonyms or otherwise conceptually parallel terms".

4.3.3.16 Use of Boolean operators

For this sub-question, the respondent was required to indicate how often s/he uses Boolean operators when searching the Web.

The majority of respondents (54%, N=171) 'rarely or sometimes' use Boolean operators, while only 4% (N=12) 'always' use Boolean operators when searching the Web for information. Nachmias & Gilad (2002: 3) advises that the "ability to apply Boolean logic rules" (for example and, or, not) is a skill that" is required for the effective use of Web search tools".

4.3.3.17 Use of the find feature

For this sub-question, the respondent was required to indicate how often s/he uses the find feature when searching the Web.

The majority of respondents (65%, N=199) 'never or rarely' use the find feature, while only 7% 'always' use the find feature when searching the Web for information.

4.3.3.18 Use of proximity searching

For this sub-question, the respondent was required to indicate how often s/he uses proximity searching when searching the Web.

The majority of respondents (72%, N=224) 'never or rarely' use proximity searching, while only 1% (N=2) 'always' use proximity searching when searching the Web for information. Chu

& Law (2008) suggest that training provided to the students should comprise proximity searching, in addition to other search skills, as these were considered important by the students. The lack of training may be the reason that most students rarely use truncation or wildcards.

4.3.3.19 Use of meta-search engines

For this sub-question, the respondent was required to indicate how often s/he uses meta-search engines when searching the Web.

The majority of respondents (77%, N=233) 'never or rarely' use meta-search engines, while only 2% (N=5) 'always' use meta-search engines when searching the Web for information. This finding is similar to Hochstotter & Koch (2009), whereby meta-search engines were not utilized as often as general search engines. However, the reason for this finding is unknown.

4.3.3.20 Search the "invisible Web"

For this sub-question, the respondent was required to indicate how often s/he uses the "invisible Web" when searching the Web.

The majority of respondents (83%, N=243) 'never or rarely' use the "invisible Web", while only 2% (N=6) 'always' use the "invisible Web" when searching the Web for information. The quality of the resources on the "invisible Web" is much higher than that of the visible Web (Pedley, 2001; Yang *et al.*, 2009). Therefore, more respondents should be searching the "invisible Web", in addition to commercial search engines.

4.3.3.21 Search the UKZN online library OPAC catalogue system

For this sub-question, the respondent was required to indicate how often s/he searches the UKZN online library OPAC catalogue system.

The majority of respondents (63%, N=198) 'rarely or sometimes' search library OPAC catalogue system, while only 8% (N=25) 'never' search the library OPAC catalogue system. The possible reason that not many students make use of the OPAC catalogue system is probably due to students searching the Web for their information requirements, due to its convenience.

4.3.3.22 Search the UKZN online library databases

For this sub-question, the respondent was required to indicate how often s/he searches the online library databases.

The majority of respondents (63%, N=199) 'sometimes or often' search the UKZN online library databases, while only 6% (N=20) 'never' search the online library databases. This information is useful to the university in order to establish what percentage of students are utilising the resources that they spend thousands of Rand on.

4.3.3.23 Collaborate with colleagues

For this sub-question, the respondent was required to indicate how often s/he collaborates with colleagues when searching the Web.

The majority of respondents (60%, N=180) 'rarely or sometimes' collaborate with colleagues, while only 8% (N=23) 'never' collaborate with colleagues when searching the Web for information. Lazonder (2005) found that undergraduate students who collaborated produced better search results more efficiently than students that searched on their own. Based on this finding, more students should take advantage of collaborative searching in order to search more efficiently.

4.3.3.24 Other Web search tactics used

For this sub-question, the respondent was required to indicate how often s/he uses other tactics when searching the Web.

Table 4.19 shows that from the 315 respondents surveyed, 98.7% (N=311) respondents do not use other Web search tactics. One respondent accesses links on Web pages, another respondent saves a Web page as a bookmark and captures the Web page. Finally, one respondent uses professional networks to post questions on research, whilst another respondent indicated that s/he uses other search tactics but did not specify the tactic used.

Table 4.20 - Other Web search tactics used

Other Web search tactics used	Frequency	Percent
Valid	311	98.7
Access links on Web pages	1	0.3
Save Web page as a bookmark, and capture the Web page	1	0.3
Use professional networks to post questions on research	1	0.3
No response	1	0.3
Total (N)	**315**	**100.0**

4.3.3.25 Goodness of fit test results

Results from the chi-square goodness-of-fit tests on each of the search tactics discussed in Sections 4.3.3.1 to 4.3.3.23 are summarised below.

Significantly ($p<0.05$) fewer than expected postgraduate students 'never': open multiple Web browser windows, type in the URL of the relevant Web page, use advanced search features nor use multiple keywords when searching the Web for information.

Significantly fewer than expected postgraduate students 'always': browse through a directory or a catalogue, use multiple search engines, search for specific phrases using quotation marks, use advanced search features or use Boolean operators when searching the Web for information.

Significantly more than expected postgraduate students 'never': use truncation or wildcards, use the find feature, use proximity searching, use meta-search engines or the "invisible Web" when searching the Web for information. This significantly low usage of the "invisible Web" needs to be addressed as the higher quality resources found on the "invisible Web" will most likely be more beneficial to students. Students need to be trained on how to access the "invisible Web" as well as how to use it efficiently.

Significantly more than expected postgraduate students 'rarely' search for specific phrases using quotation marks.

Significantly more than expected postgraduate students 'sometimes': access a specific portal, browse through a directory or a catalogue, use advanced search features, use single keywords, use synonyms or collaborate with colleagues when searching the Web for information.

Significantly more than expected postgraduate students 'often': find what they are looking for on the first page of the search results, modify queries to find more accurate information, search the OPAC catalogue system, search the UKZN online library databases, use multiple keywords, open multiple Web browser windows or use Web search engines when searching the Web for information.

Significantly more than expected postgraduate students 'always': open multiple Web browser windows, use Web search engines or open multiple Web browser tabs.

The findings from Sections 4.3.3.1 to 4.3.3.24 have contributed to answering the first research question outlined in Chapter 1.

4.3.3.26 Number of result pages viewed on average

For Question 15, the respondent was required to indicate how many result pages s/he views on average.

Table 4.20 shows that respondents (60%, N=189) mostly viewed the first three result pages. Hoeber (2008) suggests that when queries are specific, search engines display highly relevant results, most of which are in the first few pages. This may be the reason for the majority of respondents viewing the first three result pages. This finding is similar to the findings by Jansen & Spink (2006) and Hoeber (2008) and contributes to answering the fourth research question.

However, only 6.3% (N=20) viewed between four and all the result pages, on average. Five (1.6%) of the respondents did not answer this question.

Table 4.21 - Number of results pages viewed on average

Number of results pages viewed	Frequency	Percent
First three pages	189	60
First page only	61	19.4
All pages	40	12.7
Other	20	6.3
No response	5	1.6
Total responses	310	98.4
Total (N)	**315**	**100**

Significantly ($p<0.05$) more than expected viewed the first three results pages.

4.3.3.27 Respondents' understanding of a query containing multiple terms

For Question 16, the respondent was required explain his/her understanding of how a query containing multiple terms is understood by a search engine.

The smallest number of respondents (13.3%, N=42) indicated they know how a query containing multiple terms is understood by a search engine, while the majority (45.4%, N=143) were not sure. This is a similar finding to that of Aula *et al.* (2005) and provides an insight into the respondents' understanding of how a query containing multiple terms is understood by a search engine. Since a relatively small number of respondents indicated that they were knowledgeable about this, the researcher proposes that students be enlightened on this subject matter as this knowledge could contribute to increasing their efficiency in Web searching.

Table 4.22 - Respondents' understanding of how a query containing multiple terms is understood by a search engine

Responses to question 16	Frequency	Percent
I am not sure	143	45.4
Yes, I think I know	65	20.6
I do not know	64	20.3
Yes, I know	42	13.3
No response	1	0.3
Total responses	314	99.7
Total (N)	**315**	**100**

Significantly ($p<0.05$) more than expected indicated that they were not sure how a query containing multiple terms is understood by their primary search engine.

Respondents that indicated that they know or think they know how a query containing multiple terms is understood by a search engine were asked to explain their understanding. Table 4.22 below shows the respondents' perceptions of their understanding in this regard.

Table 4.23 - Respondents' explanations of how a query containing multiple terms is understood by a search engine

Respondents' explanation to question 16	Frequency	Percent
No response	43	13.7
Finds pages containing all terms then some terms	40	12.7
Finds pages containing all terms	5	1.6
Looks for combinations of term if can't find all	5	1.6
Finds pages containing some terms	4	1.3
Finds keywords and meta tags	3	1.0
Returns relevant information	2	0.6
Finds terms in sequence	1	0.3
Highlights terms in results	1	0.3
Returns current information	1	0.3
Searches certain keywords and excludes words like "and"	1	0.3
Sifts and limits term depending on probability	1	0.3
Uses latent semantic indexing	1	0.3
Total (N)	**108**	**34.3**

4.3.3.28 Respondents' understanding of how a search engine orders the results

For Question 17, the respondent was required explain his/her understanding of how a search engine orders the results in a list. Table 4.23 shows that the smallest number of respondents (12.4%, N=39) indicated they know how a search engine orders the results, while the majority (39.4%, N=124) were not sure. This finding is again similar to the finding by Aula *et al.* (2005). Once again, this finding merely provides an insight into the respondents understanding of how a search engine orders the results in a list and is not designed to answer any of the research questions.

Table 4.24 - Respondents' understanding of how a search engine orders the results

Responses to question 17	Frequency	Percent
I am not sure	124	39.4
I do not know	82	26
Yes, I think I know	67	21.3
Yes, I know	39	12.4
No response	3	1
Total	312	99
Total (N)	**315**	**100**

Significantly ($p<0.05$) more than expected indicated that they were not sure how their primary search engine orders the results in a list.

Respondents that indicated they know or think they know how a search engine orders the results in a list were asked to explain their understanding. Table 4.24 shows the respondents' perceptions of their own understanding of how a search engine orders the results in a list. Most respondents (16.2%, N=51) explained that the search engine orders the results according to date and relevance. Twenty-two (7%) respondents did not answer this question.

Table 4.25 - Respondents' explanations of how a search engine orders the results

Respondents' explanations	Frequency	Percent
Searches according to date and relevance	51	16.2
Most commonly visited sites with most keywords	24	7.6
No response	23	7.3
Popularity and advertising	4	1.3
Displays most matches first	2	0.6
Whoever pays more	2	0.6
Based on phrases similar to input query	1	0.3
Searches database for keywords	1	0.3
Search engine optimisation's located in Web pages	1	0.3
Uses ranking algorithm	1	0.3
Total (N)	**110**	**34.8**

This section has addressed the first research question on determining the Web search tactics used by postgraduate students by analysing the results of the survey.

4.3.3.29 Aspects related to Web searching that respondents explained

For Question 19, the respondent was asked if there were any aspects relating to Web searching that s/he would like to explain in more detail. Only 33 (10.5%) respondents completed this question (see Appendix D), while 65 (20.6%) respondents indicated that s/he did not have any aspects s/he would have liked to explain.

Section 4.3 has analysed the various search tactics that are currently used by the postgraduate students at UKZN (Pmb) and has therefore answered the first research question (i.e. What Web search tactics do postgraduate students currently use?).

4.4 Results of the interviews

While the survey results answer the first research question, the interview results answer the following research questions:

- What Web search strategies (i.e. combinations of tactics) do postgraduate students use?
- How do postgraduate students determine whether Web searches have been successful or not?
- What are the best practices with regard to Web search strategies that undergraduate students can follow?
- Which search tool do postgraduate students prefer?

The interview consisted of six questions (see Appendix B). Thematic analysis was used to analyse the qualitative data. Each question will be discussed separately.

Xie (2007) points to research that has observed information searching strategies from various levels, namely browsing strategies and cognitive search strategies, but concludes that the classification of information searching strategies is primarily centred on the "query formulation and reformulation". Xie (2007) therefore emphasises that the identification of various strategies for information searching is essential. This study focuses on multiple information-seeking strategies, therefore it fills the gap of a lack of empirical studies relating to several information searching strategies in the existing body of knowledge.

4.4.1 Web search strategies used in a single Web search when searching for *academic* information

Question 1 required interviewees to indicate which combination(s) of tactics s/he used in a single Web search. The interviewees listed the search tools used, namely search engines, meta-search engines, the "invisible Web", library OPAC catalogue system and library databases. These tools were included in the questionnaire to determine the preferred tool when searching for information. The interviewees then indicated the search strategy (i.e. combination of search tactics) used to search each information source. Tactics that were not used on a search tool are not listed in the respective table.

The headings labelled one to eight in Tables 4.25 to 4.29 signify each interviewee and/or strategy. Heading one therefore indicates a single strategy and heading two indicates a second strategy and so on. This was done because the respondents were informed that no reference to specific individuals would be made when the results for this study were analysed and presented. Sections 4.4.1.1 to 4.4.1.5 answers the second research question as discussed in Chapter 1. In addition, these sections answer the fourth research question (i.e. What are the best practices with regard to Web search strategies?) as the search strategies discussed in sections 4.4.1.1 to 4.4.1.5 are used by respondents who used the most search tactics compared to the other respondents surveyed. Tables 4.25 to 4.29 can also be seen as best practices with regard to searching strategies.

4.4.1.1 Web search strategies used when searching search engines

The table below shows that the interviewees mostly used advanced search features, Boolean operators and multiple keywords when searching for information using search engines. The least used tactics were typing in the Web address and the use of single keywords.

Table 4.26 - Web search strategies used when searching for academic information using search engines to search

Search Engines									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information			1	1	1		1		4
Open multiple tabs		1		1	1	1	1	1	6
Open multiple windows	1	1		1	1				4
Search for specific phrases using quotation marks			1	1	1	1			4
Type in the Web address								1	1
Use advanced search features	1	1	1		1	1	1	1	7
Use Boolean operators	1	1	1	1	1	1		1	7
Use multiple keywords	1	1	1	1		1	1	1	7
Use multiple search engines						1	1	1	3
Use proximity searching		1			1		1	1	4
Use single keywords			1						1
Use synonyms			1	1	1		1	1	5
Use the find feature	1				1			1	3
Use truncation and wildcards	1	1	1		1	1	1		6
Total tactics used per interviewee	**6**	**7**	**8**	**7**	**10**	**7**	**8**	**9**	

Of the 14 Web search tactics listed above, the highest number of tactics used to form a single strategy is ten and the least was six. The average number of tactics used for a single strategy when using search engines was eight. Nazim (2008) found that the most preferred Web search tool was the search engine. This study reveals a similar finding, as not as many interviewees use the other search tools discussed below when compared to the use of search engines.

4.4.1.2 Web search strategies used when searching meta-search engines

The table below shows that the tactic most commonly used was the use of Boolean operators, followed by the opening of multiple Web browser tabs, the use of advanced search features, the use of multiple keywords and truncation. The least popular tactics were typing in the Web address, the use of multiple search engines and the use of single keywords.

Table 4.27 - Web search strategies used when searching for academic information using meta-search engines to search

Meta-search engines									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information			1	1	1		1		4
Open multiple tabs		1		1	1	1	1	1	6
Open multiple windows	1			1	1				3
Search for specific phrases using quotation marks			1	1	1	1			4
Type in the Web address								1	1
Use advanced search features	1		1		1	1	1	1	6
Use Boolean operators	1	1	1	1	1	1		1	7
Use multiple keywords	1	1		1		1	1	1	6
Use multiple search engines						1			1
Use proximity searching		1			1		1	1	4
Use single keywords			1						1
Use synonyms			1	1	1		1	1	5
Use the find feature	1				1			1	3
Use truncation and wildcards	1	1	1		1	1	1		6
Total tactics used per interviewee	**6**	**5**	**7**	**7**	**10**	**7**	**7**	**8**	

Of the 14 tactics listed above, the highest number of tactics used to form a single search strategy is ten, while the least is five. The average number of tactics used in a single search when using meta-search engines is seven.

4.4.1.3 Web search strategies used when searching the "invisible Web"

The table below shows that the most commonly used tactic was the use of multiple keywords, while the least used tactic was typing in the Web address and the use of multiple search engines.

Of the 13 Web search tactics listed in the table below, the highest number of tactics combined to form a single strategy is once again ten, while the least is three. The average number of tactics used when searching the "invisible Web" is six.

Table 4.28 - Web search strategies used when searching for academic information using the "invisible Web"

"invisible Web"									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information	1		1		1		1		4
Open multiple tabs		1		1	1	1	1	1	6
Open multiple windows	1			1	1				3
Search for specific phrases using quotation marks					1	1			2
Type in the Web address								1	1
Use advanced search features			1		1	1	1	1	5
Use Boolean operators	1	1			1	1		1	5
Use multiple keywords	1	1	1	1		1	1	1	7
Use multiple search engines						1			1
Use proximity searching		1			1		1	1	4
Use synonyms	1			1	1		1	1	5
Use the find feature	1				1			1	3
Use truncation and wildcards	1	1			1	1	1		5
Total tactics used per interviewee	**7**	**5**	**3**	**4**	**10**	**7**	**7**	**8**	

4.4.1.4 Web search strategies used when searching the UKZN library OPAC catalogue system

The table below shows the various Web search strategies used when interviewees search for information using the UKZN library OPAC catalogue system. The majority of interviewees used advanced search features, followed by the use of multiple keywords, while the least used tactic is the use of single keywords.

Of the 12 Web search tactics listed in the table below, the highest number of tactics used to form a single strategy is nine, while the least is three. The average number of tactics used when searching the UKZN library OPAC catalogue system is six.

Table 4.29 - Web search strategies used when searching for academic information using the UKZN library OPAC catalogue system

UKZN library OPAC catalogue system									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information			1		1		1		3
Open multiple tabs		1		1	1		1	1	5
Open multiple windows	1			1	1				3
Search for specific phrases using quotation marks			1	1	1	1			4
Use advanced search features	1	1	1		1	1	1	1	7
Use Boolean operators	1		1		1			1	4
Use multiple keywords	1	1		1		1	1	1	6
Use proximity searching					1		1	1	3
Use single keywords			1						1
Use synonyms			1	1	1		1	1	5
Use the find feature					1			1	2
Use truncation and wildcards			1				1		2
Total tactics used per interviewee	**4**	**3**	**7**	**5**	**9**	**3**	**7**	**7**	

4.4.1.5 Web search strategies used when using the UKZN online library databases

Table 4.29 below shows the various Web search strategies used when interviewees search for information using the UKZN online library databases. The most commonly used search tactics were the opening of multiple Web browser tabs, the use of advanced search features, the use of multiple keywords and the use of synonyms. The least commonly used tactics is the use of single keywords.

Of the 12 Web search tactics listed in the table below, the highest number of tactics used to form a single strategy is ten and the least is two. The second interviewee does not use the UKZN online library databases. The average number of tactics used when searching the UKZN online library databases is six.

Table 4.30 - Web search strategies used when searching for academic information using the UKZN online library databases

UKZN online library databases									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information			1		1		1		3
Open multiple tabs				1	1	1	1	1	5
Open multiple windows	1			1	1				3
Search for specific phrases using quotation marks			1	1	1	1			4
Use advanced search features			1		1	1	1	1	5
Use Boolean operators			1		1	1		1	4
Use multiple keywords			1	1		1	1	1	5
Use proximity searching					1		1	1	3
Use single keywords			1						1
Use synonyms			1	1	1		1	1	5
Use the find feature	1				1			1	3
Use truncation and wildcards			1		1	1	1		4
Total tactics used per interviewee	**2**	**0**	**7**	**5**	**10**	**6**	**7**	**7**	

4.4.1.6 The total Web search tactics used for each search tool

The table below is based on the total Web search tactics used by the interviewees for each search tool discussed in Sections 4.4.1.1 to 4.4.1.5. This section provides an overview of which search tactics are the most popular, so that a searcher attempting to use these tactics above will have a better idea of which tactics may work better. The tactics are listed in descending order, from the most commonly used tactic to the least used. From Table 4.30, it is evident that the top three Web search tactics are the use of multiple keywords and the use of advanced search features, followed by the opening of multiple Web browser tabs. Tseng & Wu (2008) found that the most frequent approach was the use of keywords at the initial stage of the search process, followed by the use of related words, then the use of broader terms and finally the use of narrower terms.

The opening of multiple browser windows features further down Table 4.30. This is arguably in line with the finding by Thatcher (2008: 1325) that "searching with multiple browser windows requires significant cognitive resources" and "participants using these strategies had to pay attention to more than one searching session at a time, constantly reminding themselves of the

search and the progress in that search". Aula *et al.* (2005) suggests that multiple tabs are used more frequently than multiple windows and may be due to the disadvantage of multiple browsers cluttering the workspace.

Table 4.31 - The total Web search tactics used for each search tool

Tactic	Total
Use multiple keywords	31
Use advanced search features	30
Open multiple Web browser tabs	28
Use Boolean operators	27
Use synonyms	25
Use truncation and wildcards	23
Modify query to find more accurate information	18
Search for specific phrases using quotation marks	18
Use proximity searching	18
Open multiple Web browser windows	16
Use the find feature	14
Use multiple search engines	5
Use single keywords	4
Type in the Web address	3

4.4.2 Reasons for preferred Web search strategies when searching for academic information

For Question 2 of the interview, interviewees were required to reasons as to why they preferred to use the strategies mentioned in Question 1 when they searched for academic information. This section helps in understanding the reasons (as specified by the interviewees) for using the search tactics specified in the section above.

Most interviewees indicated that the reason why they prefer to use the search strategies that they currently use is because they believe that information is easier to locate and that the strategies used are effective and efficient in returning precise search results. Other reasons were that these strategies were the only ones they know and that they believe that with these strategies more precise information is retrieved, which are ordered by relevance.

One interviewee mentioned that these combinations make it easier to get the latest articles and dissertations in PDF format, especially when using the UKZN library OPAC catalogue system and the UKZN online library databases. The interviewee also mentioned that this method allows the student to obtain all the necessary PDF files without opening many Web sites. One interviewee noted that the UKZN library OPAC catalogue system, the "invisible Web" and the library database mostly deal with scholarly works, so one should use a library database and/or an OPAC catalogue system rather than utilising commercial search engines, as those tools may be more likely to return the desired information when doing academic searches. A final point that some interviewees noted was that if these combinations are not used, then most search results are irrelevant.

This section did not answer any of the research questions but it provides an explanation for the interviewees' choice of searching strategies when searching for academic information.

4.4.3 Web search strategies used in a single Web search when searching for *non-academic* information

Question 3 required interviewees to indicate which combination(s) of tactics s/he used in a single Web search when searching for *non-academic* information. Sections 4.4.3.1 to 4.4.3.4 contribute to answering the second, as well as the fourth, research questions. The reason for splitting the search strategies into academic and non-academic searches, is to identify the differences in search strategies used for these two types of searches.

Since the strategies in this section were for searching for non-academic information, the interviewees listed only four of the five search tools listed in Section 4.4.1, namely search engines, meta-search engines, the "invisible Web" and library databases. The interviewees then indicated the search strategy (i.e. combination of search tactics) used to search each information source. Once again, tactics that were not used on a search tool were not listed in the table. Since the UKZN library OPAC catalogue system and library databases were not used for non-academic information searching, this section was omitted.

The headings labelled one to eight of Tables 4.31 to 4.34 signifies each interviewee and/or strategy. These tables can also be seen as best practices with regard to searching strategies.

4.4.3.1 Web search strategies used when searching for non-academic information using search engines

The most commonly used search tactics used are the opening of multiple tabs and the use of multiple keywords. Typing in the Web address, using single keywords and using the find feature are the least commonly used.

Table 4.32 - Web search strategies used when searching for non-academic information using search engines

Search engines									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information			1		1		1		3
Open multiple tabs		1		1	1	1	1	1	6
Open multiple windows		1		1	1				3
Search for specific phrases using quotation marks			1		1	1			3
Type in the Web address								1	1
Use advanced search features					1	1	1	1	4
Use Boolean operators		1			1	1		1	4
Use multiple keywords		1	1	1		1	1	1	6
Use multiple search engines						1	1	1	3
Use proximity searching		1			1		1	1	4
Use single keywords			1						1
Use synonyms			1		1		1	1	4
Use the find feature								1	1
Use truncation and wildcards		1			1	1	1		4
Total tactics used per interviewee	**0**	**5**	**4**	**3**	**9**	**7**	**8**	**9**	

Of the fourteen Web search tactics listed in the table above, the highest number of tactics used to form a single strategy is nine and the least is three. The first interviewee does not use search engines to search for non-academic information. The average number of tactics used when using search engines is six.

4.4.3.2 Web search strategies used when searching for non-academic information using meta-search engines

For this search tool, the tactics typing in the Web address, using multiple search engines and the use of single keywords were omitted from the table below as these tactics were not used on meta-search engines. The most commonly used tactics were opening multiple tabs, use of advanced search features and the use of truncation and wildcards.

Table 4.32 shows that the highest number of tactics to form a single Web search strategy is nine. Five of the eight interviewees do not use meta-search engines to search for non-academic information. The average number of tactics used when using meta-search engines is seven.

Table 4.33 - Web search strategies used when searching for non-academic information using meta-search engines

Meta-search engines									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information					1		1		2
Open multiple tabs	1				1		1		3
Open multiple windows					1				1
Search for specific phrases using quotation marks					1				1
Use advanced search features	1				1		1		3
Use Boolean operators	1				1				2
Use multiple keywords	1						1		2
Use proximity searching					1		1		2
Use synonyms					1		1		2
Use the find feature	1								1
Use truncation and wildcards	1				1		1		3
Total tactics used per interviewee	**6**	**0**	**0**	**0**	**9**	**0**	**7**	**0**	

4.4.3.3 Web search strategies used when searching for non-academic information using the "invisible" Web

For this search tool, the tactics typing in the Web address and the use of multiple search engines were omitted from the table below as these tactics were not used when searching for non-academic information on the "invisible" Web. Only two interviewees use the "invisible" Web to search for non-academic information.

Table 4.33 shows that the highest number of tactics to form a single Web search strategy is nine, once again. Six of the eight interviewees do not use the "invisible" Web to search for non-academic information. The average number of tactics used when using the "invisible" Web is eight.

Table 4.34 - Web search strategies used when searching for non-academic information using the "invisible" Web

"Invisible" Web									
Tactics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modify query to find more accurate information	1				1				2
Open multiple tabs					1				1
Open multiple windows	1				1				2
Search for specific phrases using quotation marks					1				1
Use advanced search features					1				1
Use Boolean operators	1				1				2
Use multiple keywords	1								1
Use proximity searching					1				1
Use synonyms	1				1				2
Use the find feature	1								1
Use truncation and wildcards	1				1				2
Total tactics used per interviewee	**7**	**0**	**0**	**0**	**9**	**0**	**0**	**0**	

4.4.3.4 Web search strategies used when searching for non-academic information using the UKZN online library databases

Only one of the eight interviewees uses the UKZN online library databases to search for non-academic information. The table is not displayed, as the interviewee uses only two search tactics to form a single strategy when searching the Web for non-academic information, namely the opening of multiple Web browser windows and the using the find feature. The online library databases are mainly used for academic searching. This student could have misinterpreted this question or s/he could be searching for information to increase his/her knowledge, independent of the academic institution.

4.4.3.5 The total Web search tactics used for each search tool

The table below is based on the total Web search tactics used by the interviewees for each search tool discussed in Sections 4.4.3.1 to 4.4.3.4. This section also provides an overview of which search tactics are more popular for non-academic searches, so that a searcher attempting to use these tactics will have a better idea of which tactics may work better. Once more, the tactics are listed in descending order. Table 4.34 shows that the top three Web search tactics are the opening of multiple Web browser tabs, the use of multiple keywords and the use of truncation and wildcards. Nachmias & Gilad (2002) found that although the participants' widely used strategy was a single keyword search, this strategy was found to be inefficient. This may be the reason that most postgraduate students use multiple keywords when searching for information as opposed to single keywords.

Table 4.35 - The total Web search tactics used for each search tool

Tactic	Total
Open multiple tabs	10
Use multiple keywords	9
Use truncation and wildcards	9
Use advanced search features	8
Use Boolean operators	8
Use synonyms	8
Modify query to find more accurate information	7
Open multiple windows	7
Use proximity searching	7
Search for specific phrases using quotation marks	5
Use the find feature	4
Use multiple search engines	3
Type in the Web address	1
Use single keywords	1

Nowicki (2003) used 75 undergraduate students in her research and found that most students did not utilise the advanced search features (such as Boolean operators) and when they did, they used them incorrectly. Table 4.34 shows that this is not the case with postgraduate students at UKZN, Pmb. Multiple keywords were used far more than single keywords. This result may be due to greater levels of experience, since the interviewees were postgraduate students. This finding is similar to the findings of Chu & Law (2007).

Aula *et al.* (2005) notes that some strategies recommended in previous studies are not that important, such as the use of URLs on a Web page. This may be the reason why typing in the Web address was one of the least used Web search tactics. Markey (2007a) reviewed 25 years of published research findings on information retrieval on the Web and found that Boolean searching was not as popular in the past, as only 20% of queries included Boolean operators. This study shows that this trend seems to be changing, at least in the UKZN, Pmb postgraduate context.

4.4.4 Reasons for preferred Web search strategies when searching for non-academic information

For Question 4 of the interview, interviewees were required to give reasons as to why they preferred to use the strategies mentioned in Question 3 when they searched for non-academic information. This section helps in understanding the reasons (as specified by the interviewees) for using the search tactics specified in the section above, when searching for non-academic information.

The majority of interviewees use search engines to locate non-academic information as they are efficient in locating non-academic information. Another reason given is that better results are retrieved using search engines for non-academic resources than using library databases. The reason for this may be that library databases only index academic and scholarly content.

The overall impression that interviewees gave was that there was no need to be too specific in the search queries when searching for non-academic information because the combinations (mentioned in Question 3) usually retrieved relevant results. One interviewee indicated that Google is used for non-academic searching because it is user-friendly and provides a wide variety of information regarding the search terms.

Another interviewee mentioned that it is quick and convenient, especially when applying for jobs, while some were of the opinion that these combinations displayed relevant information and prevented them from having to sift through irrelevant information. One reason conveyed was that it worked better when the tactics are used in a combination as it is more likely to return required results, while another respondent emphasised that it was the best way s/he currently knew how to search for non-academic content.

This section did not answer any of the research questions but it provides an explanation for the interviewees' choice of searching strategies when searching for non-academic information.

4.4.5 The criteria used to determine if a Web search was successful

Question 5 of the interview required interviewees to indicate what criteria they use to determine if a Web search was successful. This section contributes to answering the third research question (i.e. How do postgraduate students determine whether Web searches have been successful or not?). Cummins (2001) suggests that the most fundamental aspects of Web searching are not only to develop a good Web searching strategy by asking specific questions, but also to follow up by thinking critically in addition to evaluating the search results.

Two interviewees indicated that for academic searches, they read the abstract, while one of the two interviewees goes further to look for files in PDF format, then reads the heading and finally the abstract. On the other hand, with the same two interviewees, for non-academic information, one skim reads and looks for pictures, whilst the other looks for the PDF file extension as well as the file size.

This section contributed to answering the third research question on how postgraduate students determine whether Web searches have been successful.

One interviewee determines that a search is successful if at least 70% of the links are relevant, while two other interviewees determine this if at least 60% of the links are relevant. Only one interviewee determines that a search is successful if at least 50% search results are relevant.

Other criteria include reading the information under each link on the results pages, looking to see how current the material is and if the required information is found in one hour, then the search was considered successful.

4.4.6 Explanation of criteria used to determine if a Web search was successful

Question 6 of the interview required interviewees to briefly explain the criteria mentioned in the previous question.

For academic information, the first interviewee reads the heading, table of contents and then abstract, and for non-academic information s/he first reads the heading, then skim reads the text until the required information is found.

The second interviewee looks for PDF files, and then reads the heading and finally the abstract when searching for academic information. For non-academic information, s/he looks below each search result, for the file size and file extension.

The third interviewee looks for keywords in search results and then reads the abstract to determine if information is relevant.

The fourth interviewee opens each link for academic information, then checks for keywords using the find feature and finally reads the abstract of the article. However, for non-academic information, s/he just browses through the list of search results looking for keywords.

The fifth interviewee also reads the title and abstract, then uses the find feature to search for keywords. However, this interviewee also uses the find feature to look for synonyms. At the end, s/he reads the conclusion to determine if information is relevant.

The sixth interviewee simply checks if 75% of the information is relevant to the search query, then the regards the search as successful.

The seventh interviewee reads the abstract for articles, reads the summary of books, and also reads the table of contents, then the first and last paragraph of the first page.

The final interviewee reads the information on the results page first and if s/he considers it is relevant, then s/he opens the link in a new tab and reads the abstract and keywords to determine if information is relevant.

Section 4.4 has answered research questions two to five by identifying the search strategies used by postgraduate students, establishing how they determine whether searches have been successful, providing best practices with regard to Web search strategies and establishing which are their preferred search tool.

4.5 Summary of the chapter

This chapter revealed the findings and analysis of the study, which aimed to determine the Web search strategies used by postgraduate students at UKZN, Pmb. The results of this study have addressed all five research questions as outlined in Chapter 1. The results from the questionnaire provided background information of the respondents, their level of experience and Web usage, in addition to the Web search tactics used to search for information on the Web. The questionnaire provided the Web search tactics used, while the interviews helped in building on the quantitative results by determining the Web search strategies (i.e. combinations of tactics) used by postgraduate students at UKZN, Pmb. In addition, the interview assisted in establishing how postgraduate students determine if a search was successful and provides best practices with regard to Web search strategies. The next section entails concluding remarks on the study, the limitations of the research exercise and recommendations for future work.

Chapter 5

Conclusion and recommendations

5.1 Introduction

Chapter 5 contains a recap of the key research questions, a summary of the study and concluding remarks with regard to the two-phased methodological approach. Recommendations are made in response to the research questions and the findings and analysis. Based on the results of this study, Bates' (1979a) model of Information Search Tactics is adapted to better represent information searching on the Web.

5.2 Key research questions revisited

This study has answered the following key research questions:

a) What Web search tactics do postgraduate students use?
b) What Web search strategies (i.e. combinations of tactics) do postgraduate students use?
c) How do postgraduate students determine whether Web searches have been successful or not?
d) What are the best practices with regard to Web search strategies that undergraduate students can follow?
e) Which search tool do postgraduate students prefer?

5.3 Summary of the study

Chapter 1 presented an introduction to the study, a brief background, the research problem, the research objectives, key research questions, definitions of significant terms, the conceptual framework, limitations of the study and an overview of the study. The conceptual framework was briefly discussed in Chapter 1, but the finer details were discussed in Chapter 2.

Chapter 2 contained an examination of several studies relating to Web searching. The chapter included a discussion on the difference between a move, a tactic and a strategy in relation to Web searching, classifications of searching strategies by other researchers, the challenges of

information retrieval on the Web and the role of search engines in information searching. In addition, the chapter entailed a discussion on the value of the "invisible Web", Web searching strategies identified by previous studies and, finally, the details of the conceptual framework were unfolded.

Chapter 3 provided an explanation of how the two sets of data were collected. Surveys were undertaken in Phase 1 of the data collection, whilst interviews were carried out for Phase 2. This two-phased approach enabled the researcher to build on the survey data by carrying out structured interviews with specific individuals based on their responses to the questionnaire.

Chapter 4 involved the analysis of the two datasets, as well as the findings of the study. The following section aims at concluding the both phases of this study.

5.4 Conclusion

This section includes a separate discussion on each of the two phases of this study and gives a brief summary of the results.

5.4.1 Conclusion of Phase 1 - quantitative method (i.e. survey)

The survey contributed to answering the first research question. The survey revealed that the majority (59.4%) of postgraduate students have been searching the Web for six years or longer and that a significant relationship exists between the level of study and the number of years respondents have been searching the Web. Most postgraduate students (36.3%) searched for information on the Web from five to ten hours a week. Tests concluded that the greater the number of years that respondents have been searching the Web, the more time they spend searching in a week on average.

It was found that most respondents (73.9%) gained their knowledge on Web searching through experience and only 26.1% of respondents have been given formal training on Web searching. This clearly indicates a lack of training on Web searching. No significant relationship was found between the number of years searching the Web and the average time spent searching the Web in a week. More than half (64.8%) the population rated their expertise as intermediate, whilst 29.8% rated their expertise as expert and only 5.4% rated their expertise as novice. The results

showed that the greater the number of years respondents have been searching the Web, the higher the experience ratings.

The most commonly used Web browser was Internet Explorer (46.3%), followed by Google Chrome (31.5%) and Mozilla Firefox (19.4%). The top five search engines used were Google (99.4%), Yahoo (36.5%), Ask.com (10.2%), Windows Live (7.6%) and MSN (6%). Question 12 of the survey (see Appendix A) was not analysed due to inconsistent responses. The top three reasons that most respondents chose a particular search engine as their favourite was because it was quick, user-friendly and provided the required information (49.2%), the search engine gave broader search options and results (11.1%) and it was the only search engine that the respondent knew (9.5%).

The top three Web search tactics that were 'always' used were the use of Web search engines (49%), the opening of multiple Web browser tabs (43%) and the opening of multiple Web browser windows (26%). The top three Web search tactics that were 'often' used were finding the relevant information in the first page of the search results (45%), using multiple keywords (44%) and searching the UKZN online library databases (41%) (See Table 4.18a and 4.18b in Chapter 4 for a summary of frequencies of other Web search tactics used).

Significantly more respondents than expected 'never' used: truncation or wildcards, the find feature, proximity searching, meta-search engines or the "invisible Web" when searching the Web for information. The lack of training received could be the contributing factor to this finding. In contrast, significantly more respondents than expected 'always': open multiple Web browser windows, use Web search engines or open multiple Web browser tabs.

When browsing through search results, most respondents (60%) viewed the first three result pages. Only 13.3% of respondents indicated that they knew how a query containing multiple terms is understood by a search engine, whilst the majority (45.4%) were not sure. Again, only 12.4% of respondents indicated they knew how a search engine orders the results, while the majority (39.4%) were not sure. The next section deals with the conclusions of Phase 2 of the study.

5.4.2 Conclusion of Phase 2 - qualitative method (i.e. interviews)

Each strategy discussed in Chapter 4 could be tried by a novice Web searcher in order to determine which strategy works best for him/her as these tactics are heuristic (Bates, 1979a).

S/he could then adopt the search strategy that works for him/her and could possibly refine the strategy adopted to retrieve information via the Web even more effectively. This way, the inexperienced user increases his/her knowledge of the various search tactics available, thereby moving from being a novice searcher to becoming an intermediate searcher and possibly even an expert searcher over time.

The interviews revealed that interviewees used more search tactics in combination when searching for academic information than when searching for non-academic information. Interviewees also used a wider variety of search tactics when using search engines and meta-search engines to locate academic, as well as non-academic, information. These findings contribute to answering the fourth research question. Whilst some strategies worked for one search tool, they did not necessarily work for another. In addition, no two interviewees used exactly the same combination of tactics to form a single search strategy. Furthermore, tactics that worked for non-academic searches did not necessarily work for academic searches. The Web search strategies used for academic and non-academic searches have also been discussed separately. These findings contribute to answering the second research question.

The criteria used by the interviewees to determine if a search was successful or not was determined by reading the heading and then the abstract, as well as looking for files in PDF format. A search was also regarded as successful if at least 50% search results are relevant. Other criteria included reading the information under each link on the results pages, how current the material was and if the required information was found within the first hour of the search. This finding answers the third research question.

When searching for non-academic information, the search engine was the search tool of choice, whilst the other search tools were not so popular. This finding answers the fifth research question. The top three Web search tactics used by interviewees for non-academic searches are the opening of multiple Web browser tabs, the use of multiple keywords and the use of truncation and wildcards. The top three Web search tactics used by the interviewees for academic searches are the use of multiple keywords, the use of advanced search features and the opening of multiple Web browser tabs. In contrast, the use of multiple search engines, single keywords and typing in the Web address were the least used search tactics when searching for academic, as well as non-academic, information.

The tactics typing in the Web address, using multiple search engines in addition to using single keywords were not used on meta-search engines. Again, typing in the Web address and the use of multiple search engines were not used when searching for non-academic information on the

"invisible Web". When searching library databases for non-academic information, only two search tactics were used, namely the opening of multiple Web browser windows and using the find feature. The next section includes an adaptation of Bates' (1979a) framework of Information Search Tactics which may be used to form Web search strategies. The adapted framework was not the initial intention of the study but data obtained contributed to this finding.

5.5 The adaptation of Bates' (1979a) model of Information Search Tactics to suit Web searching

Bates' (1979a) model of Information Search Tactics was created for both manual and online searching. The model consists of four parts, namely term tactics, search formulation tactics, monitoring tactics and file structure tactics. In a personal conversation with Marcia Bates, she indicated that the model of Information Search Tactics may be adapted to suit Web searching just as it was adapted to suit the online environment. Therefore, the researcher has attempted to adapt the model based on both the results of this study and on previous research (i.e. Carstens *et al.*, 2009). The tactics are said to be heuristic in nature, in that they may work better for some searches than others (Bates, 1979a).

Section 5.5.1 below deals with preliminary tactics that may be used to browse the Web which have been added to the model by the researcher based on the findings of this study. Some tactics of the model have been adjusted to suit Web searching and are therefore highlighted in *italics*. An additional tactic has also been added to the monitoring tactics section, namely M6.FIND (see Section 5.5.4). The terms used to name the search tactics that have been added to the model have been identified by the researcher to best describe each search tactic. To avoid repetition of the tactics that have already been discussed in Chapter 2, only the "new", edited and removed tactics have been discussed below.

5.5.1 Web browsing tactics

Web browsing tactics are preliminary tactics used to select a search medium at the outset of the search and are aimed at increasing efficiency.

B1. DIRECT. To type in the Web address (i.e. URL) directly into the address bar of the Web browser. This tactic requires the searcher to know the exact Web address or the relevant Web site that the required content is located on. This tactic is a re-access tactic (Aula *et al*., 2005).

B2. BROWSE. To browse through a subject directory, a catalogue system or an academic library Web site searching for relevant content. Depending on the nature of the content required, it may be more feasible to browse through a library database for academic content than to use a commercial search engine. Lui (2008: 6) emphasises that "academic library Web sites provide considerably higher quality and better scholarly information", as these Web sites "provide access to online catalogues, electronic databases, subject resources, library instruction/tutorials and digital collections".

B3. PORTAL. To access a specific portal when searching for subject-specific content. This tactic requires the searcher to possess some background knowledge of the subject being searched as well of the existence of specific portals (Nachmias & Gilad, 2002).

B4. ENGINE. To search for content using a search engine or a meta-search engine. The searcher decides at the outset if a search engine or a meta-search engine will be used to search the Web. General search engines and meta-search engines are favoured by most Web users for information retrieval (Hochstotter & Koch, 2009).

B5. EXPLORE. To explore is to seek information on the "invisible Web", which commercial search engines fail to index. There are several "invisible Web" search engines to assist in searching the "invisible Web".

B6. MULTI-TASK. To multi-task is to use multiple search engines, multiple meta-search engines, multiple Web browser windows or multiple Web browser tabs when searching for content. This tactic may increase the efficiency of the search but requires significant cognitive resources (Thatcher, 2008).

B7. ADVANCE. One way to narrow the search results is to use the advanced search features provided by the search facility. This tactic enables the searcher to narrow the search by year, title or keywords, subject, author and publication.

B8. COLLABORATE. This is when searchers work together during the search process. Lazonder (2005) found that students who collaborated produced better search results more efficiently than students who searched on their own.

B9. BOOKMARK. The searcher bookmarks a Webpage that includes the required content so that it is easier to return to the page when similar content is required in the future.

5.5.2 Term tactics

Once again, to avoid repetition of the tactics that have already been discussed in Chapter 2, only the "new", edited and removed tactics have been discussed below.

T12. PROXIMITY. To search for words that are close to each other (i.e. solar NEAR system OR energy) or to find an equivalent, such as solar system or solar energy. Term proximity has recently been integrated into a number of retrieval models to improve effectiveness in information retrieval (Yan et al., 2010).

5.5.3 Search formulation tactics

Once again, only the "new", edited and removed tactics have been discussed below.

S1. SPECIFY. "To search on terms" and/or phrases "that are as specific as the information desired. Specificity is one of the crucial concepts in systems of information access. Almost all systems of classification and indexing require that descriptions assigned to materials be as specific as the content of the materials and as the indexing system itself allows" (Bates, 1979a: 210).

5.5.4 Monitoring tactics

Only the "new", edited and removed tactics have been discussed below.

M6. FIND. The searcher uses the find feature (Ctrl+F) within the Web browser, PDF file or word document to search for terms that are indicative of the relevance of the information retrieved. This tactic increases efficiency in locating exact information within a document. The searcher will not have to read through an entire document manually searching for keywords.

5.5.5 File structure tactics

Only the "new", edited and removed tactics have been discussed below.

F6. SCAFFOLD. This tactic was removed as it does not apply to Web searching.

F7. CLEAVE. This tactic was removed as it does not apply to Web searching.

5.5.6 Summary of the adapted model of Information Search Tactics

The adapted model has been summarised in the table below. For details on each of Bates' search tactics, see Section 2.13 (i.e. Chapter 2) and Section 5.5 above for details on the adapted search tactics.

Table 5.1 - Adapted model of Bates' (1979a) Information Search Tactics

Tactic category	Tactic
Web browsing tactics	DIRECT, BROWSE, PORTAL, ENGINE, EXPLORE, MULTI-TASK, ADVANCE, COLLABORATE, BOOKMARK
Term tactics	SUPER, SUB, RELATE, NEIGHBOUR, TRACE, VARY, FIX, REARRANGE, CONTRARY, RESPELL, RESPACE, PROXIMITY
Search formulation tactics	SPECIFY, EXHAUST, REDUCE, PARALLEL, PINPOINT, BLOCK
Monitoring tactics	CHECK, WEIGH, PATTERN, CORRECT, RECORD, FIND
File structure tactics	BIBBLE, SELECT, SURVEY, CUT, STRETCH

5.6 Recommendations

This study found that many postgraduate students still use single keyword searches and more than half the population surveyed did not make use of meta-search engines and the "invisible Web". This may be due to a lack of formal training in the use of Web search tools. Students require more exposure to these Web search tools since the cumulative quality of the resources on the deep or "invisible Web" is between 1,000 and 2,000 times more than that of the visible Web (Pedley, 2001; David, 2009).

Students should be trained in Web searching at undergraduate level in order to use Web search tools to their best advantage (Nachmias & Gilad, 2002; Asemi, 2005; Markland, 2005). The training will give them more exposure not only to the search tactics available, but also to a variety of search tools other than search engines (which is the most common Web search tool used). The training should certainly include tactics such as proximity searching, Boolean searching, truncation and wildcards, as these tactics were the least used by respondents in this study. Since students use the Web when searching for academic information, the library should

include training on the use of meta-search engines, the use of the "invisible Web", search formulation tactics and Web browsing strategies in their training programmes.

In addition, specifically pertaining to academic searching, students should be trained on how to efficiently search for information in academic repositories. The training should also provide a manual that can be used for future reference. These documents should be available electronically so that students may easily access the electronic manual. These training initiatives will help students search for information on the Web more efficiently and effectively.

Being able to effectively retrieve information is a major advantage to a student, but being able to assess the 'quality' of that information obtained will give the student a greater advantage. Therefore, in addition to formal training, students in their first year of study should be directed to other resources that will assist them in effectively retrieving 'quality' information. In enabling students to identify quality information, the quality of their work could improve, thereby improving their results. This in turn, may help in producing more capable graduates.

5.7 Suggestions for further research

Further research could be undertaken to determine:

a) The Web search strategies used by students after they have been given formal training. The results could then be compared to those of this study to determine the impact that training has on information retrieval tactics and/or strategies.
b) Why students prefer using search engines when searching for academic content, when there are academic search tools available, such as OPAC. A study like this could help identify possible flaws in academic search tools. In addition, these academic search tools could be enhanced so that students will choose academic search tools over commercial search engines.
c) The Web search strategies used by postgraduate students at UKZN, including all five campuses rather than Pmb only. A study in this area could compare how students in other faculties, such as medical students, search for information. In addition, other search tactics and/or strategies that have not been identified in this study could be identified and incorporated.
d) The Web search tactics used by postgraduate students at a university in a developed country. If additional tactics were found, the model of Information Search Tactics could be further adapted.

e) Why postgraduate students choose search engines over meta-search engines or the "invisible Web".
f) How postgraduate students assess the quality of the information retrieved via the Web. This finding will assist undergraduate students to better assess the quality of the information received for academic use.

5.8 Conclusion of study

This mixed methods study has uncovered the Web search strategies (i.e. combinations of tactics) used by postgraduate students at the UKZN, Pietermaritzburg campus. Although postgraduate students use varying combinations of search tactics to form their search strategies, they share some of the common search tactics. This study identifies search tactics that are commonly used and have been found to be effective in retrieving relevant information. More importantly, the results reveal that each respondent uses a different search strategy. This confirms Bates' (1979a) claim that the search tactics are heuristic, in that a strategy may work for some students and not for others.

Furthermore, this study has shown how postgraduate students determine whether their searches have been successful or not. Since the majority of the respondents usually find what they are looking for in the first three pages of the results, this implies that their strategies are effective. The search strategies obtained from the interviews contribute to the best practices with regard to Web search strategies. Undergraduate students can potentially follow these search strategies to improve their information retrieval activities.

The study was able to identify which Web search tool is the most preferred. This information is beneficial to librarians in developing training modules that assist undergraduate students to use these Web search tools more efficiently and effectively. Since academic search tools are not used as much as Web search engines, librarians can market the academic search tools, so that students can take advantage of the scholarly resources that UKZN pays large sums of money for on a yearly basis. The significance of this research is twofold. Firstly, the results can be used by trainers/librarians to identify gaps in postgraduate students' knowledge on Web searching, which they can try to address. Secondly, trainers/librarians can use the adapted model as a basis in developing their training modules for both undergraduate and postgraduate students.

Moreover, even though the adaptation of Bates' (1979a) model of Information Search Tactic was not an initial objective of this study, the results contribute to the adaptation of this

framework in order to have an application during Web searching. The adapted model could potentially be used to open new avenues of research, enabling researchers to utilise this expanded model as a framework for their own studies on Web searching.

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Appendix A

Masters Research Project – 2011

Strategies used by postgraduate students at the University of KwaZulu-Natal, Pietermaritzburg campus, to retrieve information using the Web

Researcher: Surika Civilcharran - civilcharran@ukzn.ac.za (033 260 6210)
Tutor, School of Information Systems & Technology

Supervisors:
Mr M. Hughes - hughesm1@ukzn.ac.za (033 260 6458)
Lecturer, School of Information Systems & Technology

Dr R. Hoskins - hoskinsr@ukzn.ac.za (033 260 5093)
Senior Lecturer, School of Sociology & Social Studies

Letter of informed consent

Dear Respondent

I, Surika Civilcharran, am a Masters student in the School of Information Systems & Technology at the University of KwaZulu-Natal (UKZN).

You have been identified as a potential respondent for the voluntary survey that I am conducting. You are required to complete the attached questionnaire, which will take approximately 10 - 15 minutes. I would appreciate your participation and your permission to use your responses for official research purposes. No reference to specific individuals will be made when the research results are published or presented, and all information gathered is strictly confidential. However, it important that you provide your contact details, either a cellular phone number or an e-mail address as you may be selected to be interviewed at a later date as part of the second phase of the research.

If you are willing to participate, please answer all questions, sign the declaration below that gives me permission to use your responses and complete the accompanying questionnaire. Would you like a copy of the letter of informed consent e-mailed to you? Yes ☐ No ☐

Declaration:

I, _____ (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

Cellular phone number _____

E-mail address _____

_____ _____
Signature Date

SECTION A: Demographic Details

NB. This information is required for statistical purposes and no reference to specific individuals will be made.

1. Gender	Male ☐ Female ☐
2. Age	21-25 ☐ 26-30 ☐ 31-35 ☐ 36+ ☐
3. Ethnic group	Black ☐ Coloured ☐ Indian ☐ White ☐ Other ☐ Specify: _____
4. Type of study (i.e., which qualification are you registered for?)	Postgraduate diploma ☐ Postgraduate certificate ☐ Honours degree ☐ Masters degree ☐ PhD ☐
5. School (e.g., Information Systems & Technology)	

SECTION B: Level of Experience and Web Usage

When answering questions, please tick (√) where necessary to indicate your selection. It would be highly appreciated if you could answer as honestly as possible.

6. How long have you been searching the Web?

Less than 2 years ☐

From 2 to less than 4 years ☐

From 4 to less than 6 years ☐

6 years or more ☐

7. <u>On average</u>, approximately how much time do you spend in a week searching for information on the Web?

Less than 5 hours ☐

From 5 to less than 10 hours ☐

From 10 to less than 15 hours ☐

15 hours or more ☐

8. **Were you given formal training on searching for information on the Web, or did you gain your knowledge through experience?**

Formal Training ☐ **Please specify type of training:** _____

Experience ☐

9. **How would you rate your expertise in Web searching?**

Novice ☐

Intermediate ☐

Expert ☐

10. **Which Web browser(s) do you use? (*Please tick all that you use*)**

Internet Explorer ☐

Mozilla Firefox ☐

Google Chrome ☐

Other ☐

If other, please specify: _____

11. **Which search engine(s) do you use? (*Please tick all that you use*)**

Google ☐ Windows Live ☐

Yahoo ☐ Bing ☐

MSN ☐ AOL ☐

Ask.com ☐ Other ☐

If other, please specify: _____

12. **Which of the following is your favourite search engine? (*Please tick one only)***

Google ☐ Windows Live ☐

Yahoo ☐ Bing ☐

MSN ☐ AOL ☐

Ask.com ☐ Other ☐

If other, please specify: _____

13. **Please explain why this is your favourite search engine (as specified in Question 12)?**

_____

_____

_____

_____

SECTION C: Web Search Tactics

14. When searching for information on the Web using a computer or laptop, how often do you:

Action	Never	Rarely	Sometimes	Often	Always
Open multiple web browser windows?					
Open multiple tabs?					
Type in the web address (i.e. URL's) of the relevant Web page?					
Browse through a directory or a catalogue?					
Access a specific portal?					
Use Web search engines to search for information?					
Find what you are looking for in the first page of the search results?					
Use multiple search engines?					
Use advanced search features?					
Use single keywords?					
Use multiple keywords?					
Search for specific phrases using quotation marks (e.g. “my search”)?					
Use truncation or wildcards (i.e., *, ? and #)?					
Modify your query to find more accurate information?					
Use synonyms?					
Use Boolean operator (i.e., AND, NOT, OR, “”, +, -)?					
Use the Find feature (i.e., Ctrl+F)?					
Use proximity searching (e.g., solar NEAR (system OR energy) - finding equivalents such as solar system or solar energy)?					
Use meta-search engines?					
Search the invisible Web?					
Search the UKZN online library OPAC catalogue system?					
Search the UKZN online library databases?					
Collaborate with colleagues?					
Other actions? Please specify:					

15. For each search, <u>on average</u>, how many result pages do you view?

First page only ☐

First three pages ☐

All pages ☐

Other ☐

If other, please specify: _____

16. **Do you know how a query containing multiple terms (e.g. research methods for business) is understood by your primary search engine? For example, it either returns information containing all of the terms, or it return pages containing only some of the terms. *Please answer based on your current knowledge*.**

Yes, I know ☐

Yes, I think I know ☐

I am not sure ☐

I do not know ☐

If yes, please explain your understanding: _____

_____

_____

_____

17. **Do you know how your primary search engine orders the results in a list (i.e. how does it determine which results will be the first ones in the result listing)? *Please answer based on your current knowledge*.**

Yes, I know ☐

Yes, I think I know ☐

I am not sure ☐

I do not know ☐

If yes, please explain your understanding: _____

_____

_____

_____

18. **If there are aspects related to Web searching that you would like to explain in more detail, I would be very interested to hear about them. For example, strategies you use that were not mentioned in the questionnaire or rationales for using certain strategies.**

_____

_____

_____

_____

Thank you for completing this questionnaire!

Appendix B

Interview questions

1. Which combination(s) of tactics do you use in a single Web search when searching for *academic* information?
2. Why do you prefer to use these combinations when searching for *academic* information?
3. Which combination(s) of tactics do you use in a single Web search when searching for *non-academic* information?
4. Why do you prefer to use these combinations when searching for *general* information?
5. What criteria do you use to determine if a Web search was successful?
6. Briefly explain the criteria mentioned in the previous question.

Appendix C

September 2011

To Whom It May Concern

PERMISSION TO CONDUCT A SURVEY AS PART OF A MASTER'S RESEARCH PROJECT

Name:	Surika Civilcharran
Student No:	202515580
Supervisors:	Mr Mitchell Hughes & Dr Ruth Hoskins
Project topic:	An Investigation into Web Search Strategies used by Postgraduate Students at the University of KwaZulu-Natal Pietermaritzburg

I, Mrs Khanyisile Nyembezi, Acting Deputy Dean of Students, hereby grant permission for the student, Surika Civilcharran (202515580) to gather data amongst students on the Pietermaritzburg campus as part of her practical research project.

To my knowledge and understanding, all information gathered from this research will be treated with respect. Furthermore, the student (Surika Civilcharran) must ensure that confidentiality and anonymity of all participants in this research is maintained at all times.

pp_____

Deputy Dean (Students)

Postal Address: Private Bag X01, Scottsville, Pietermaritzburg 3209, South Africa

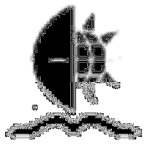
Telephone: +27 (0)33 260 5414 **Facsimile:** +27 (0)33 260 5798 **Email:** Nyembezi@ukzn.ac.za **Website:** www.ukzn.ac.za

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Appendix D - Aspects related to Web searching that respondents explained

	Frequency	Percent
No response	283	89.8
Use ISI web of knowledge database	3	1
Access links on Web pages	1	0.3
Although indicated expert in Q9, completing questionnaire shows so much I don't know	1	0.3
Assessing the credibility of results for academic purposes	1	0.3
Better to search specific webpage rather than starting at Google	1	0.3
Bubble-filtering depends on web history, search engines filter information it thinks you want to see	1	0.3
Ensures that search is complete as possible	1	0.3
Expired sites are not removed	1	0.3
Training is important to improve effectiveness of web searching	1	0.3
Found Google Scholar valuable for research	1	0.3
Google allows you to search by author or year	1	0.3
Google has provided articles for study	1	0.3
Google Scholar is multi-disciplinary. Better to use advanced search options	1	0.3
In Firefox, save the link or pin to menu bar	1	0.3
JSTOR retrieves better results than Google	1	0.3
Modify search criteria	1	0.3
Narrow and widen search criteria	1	0.3
New info obtained through completing questionnaire	1	0.3
OPAC system is useful for locating material	1	0.3
Questionnaire meets strategies	1	0.3
Ranking of the results	1	0.3
Search folders and archives	1	0.3
Search images to gain understanding of information required	1	0.3
Search all pages as the first page is not necessarily most informative	1	0.3
Use of keyword and year of publication helps find relevant info	1	0.3
Use wiki first then follow links to relevant sites	1	0.3
Uses broad search terms but takes time	1	0.3
Web browsers and search engines are intuitive	1	0.3
Well done	1	0.3
Would like to know more	1	0.3
Total (N)	**315**	**100**

Appendix E



UNIVERSITY OF
KWAZULU-NATAL

[redacted]

Research Office, Govan Mbeki Centre
Westville Campus
[redacted]

17 May 2012

Mrs Sunika Civilcharran (202515580)
School of Management, IT & Governance

Dear Mrs Civilcharran

[redacted]

at the University of KwaZulu-Natal, Pietermaritzburg campus"

[redacted]

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach/Methods must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years

Best wishes for the successful completion of your research protocol.

Yours faithfully

Professor Steven Collings (Chair)
Humanities & Social Sciences Research Ethics Committee

cc Supervisor Mr Mitchell Hughes
cc Dr Ruth Hoskins
cc Ms Deborah Cunynghame

[redacted]