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Towards a more detailed understanding of professional knowledge updating: A learning activity mediated by information sources

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Towards a more detailed understanding of professional knowledge updating: A learning activity mediated by information sources

A thesis submitted in fulfilment of the requirements for the award of the degree

DOCTOR OF PHILOSOPHY

from

THE UNIVERSITY OF WOLLONGONG

by

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SCHOOL OF EDUCATION
FACULTY OF SOCIAL SCIENCES, 2013
I, Madeleine Clare Shanahan, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Education, Faculty of Social Sciences, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Madeleine Shanahan 29 August 2013
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In loving memory of my mother, Mary Shanahan (nee Shovlin) and my father, Michael Shanahan, who passed away during my candidacy.
ABSTRACT

This research examined a fundamental aspect of delivery of high quality healthcare – the professional knowledge updating practice of health professionals. While prior studies have investigated aspects of professional knowledge updating, such as information sources utilised, factors influencing the level of activity or workplace access to needed information sources, there remains a need for an integrated investigative framework. This study adopted Engeström’s (2001) Activity System model as a framework to concurrently examine the contemporaneous value and use of electronic and non-electronic information sources for updating professional knowledge, as well as the factors that afford or constrain use of and workplace access to these tools. Each profession has their own unique disciplinary knowledge, whereby the information sources that disseminate new knowledge are contextually bound. The group selected for study was the Medical Radiation Science (MRS) profession.

The study was implemented using a two-phase sequential mixed methods design. Phase 1 adopted a qualitative methodology. Semi-structured interviews were conducted with 28 participants representing four distinct areas of specialisation within the MRS profession: nuclear medicine, radiation therapy, radiography and sonography. Phase 1 sought to establish what information sources were utilised by MRS professionals to update their professional knowledge and to identify the perceived value and use of these sources. The findings from Phase 1 were used to inform Phase 2, which involved the development and administration of a questionnaire to Australian MRS professionals. The resultant participation rate was N=362, representing 31.7% of the posted questionnaires. Phase 2 sought to provide a descriptive account of professional knowledge updating practice within the MRS profession and establish factors influencing use of and workplace access to primary information sources for updating knowledge.

The findings from this study identified that the primary information sources for updating professional knowledge, in ranked order of importance, were: seminars, conferences, Internet, books, electronic journals, health and
medical databases, print journals, formal study and journal club \( \chi^2 = 509.994, df = 8, p < .001 \). This study also provided baseline data on the areas of knowledge updated by MRS professionals. The majority of survey respondents reported that they seek current information on: medical diseases/ pathology (79.2\%, n=282), anatomy (65.4\%, n=233), new technologies (63.2\%, n=225), procedure or treatment techniques (62.6\%, n=223) and professional issues (52.5\%, n=187).

Statistically significant positive relationships were observed between use of information sources to update professional knowledge and enrolment in a CPD program, membership of a professional society, greater physical access and greater effective access in the workplace to the information source. More frequent use of Internet search engines (p<.001), web pages (p<.001), email (p<.001), listservs (p=.028), health and medical databases (p<.001) and journals (p<.001) to update professional knowledge was associated with Internet access being available on all workplace computers. In addition, this study identified that access to the contemporary range of information sources utilised to update professional knowledge was not uniform across or within workplaces. Significant relationships (p<0.05) were observed between seven factors and the individual’s workplace access to information sources. The factors were: workplace context (academic, clinical) and within clinical workplaces – health sector (public, private), workplace type (teaching hospital, non-teaching hospital, clinic), geographic location (metropolitan, regional, rural or remote), area of specialisation within the profession (nuclear medicine, radiation therapy, radiography, sonography), workplace role (manager, educator, senior practitioner, practitioner) and employment fraction (full time, part time).

This research offers a rich model of professional knowledge updating theorised as a learning activity mediated by information sources occurring within institutional settings that can support or constrain the level of activity. A number of policy and practice recommendations have been derived from the results of this study, which aim to support the pursuit of best practice in professional knowledge updating within and across organisational settings.
LIST OF PUBLICATIONS

The following refereed publications have arisen from the research associated with this study:


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CHAPTER 1 – INTRODUCTION

1.1 Background to the study

Healthcare systems worldwide are undergoing significant changes. Rapidly evolving technology, advances in diagnosis and treatment, and increased role responsibilities are now constant forces impacting on health professionals’ knowledge and practice (Health Professions Council, 2010; Maslin-Prothero, 2005; Thistlethwaite & Spencer, 2008). In order to provide the best possible care to their patients, health professionals must continually seek to update their own professional knowledge. In this context, professional knowledge encompasses the discipline knowledge publicly communicated through information sources alongside the knowledge the individual has gained through their embedded experience in professional practice (Eraut, 1994; Higgs & Titchen, 2001). It is the ongoing integration of new discipline knowledge with the individual’s knowledge that enables health professionals to continue to provide high-quality healthcare based on the most recent evidence to the patients they serve (Gosling & Westbrook, 2004; Runciman et al., 2012).

Healthcare standards set by government and professional bodies emphasise the importance of individuals maintaining currency of their professional knowledge. Continuing professional development (CPD) activities that involve knowledge updating are part of ongoing accreditation or registration requirements for health professionals (Australian Health Workforce Ministerial Council, 2010; Australian Institute of Radiography, 2007; Health Professions Council, 2010). Those who have failed to meet the mandated CPD requirements have seen their registration and professional memberships cancelled (Australian and New Zealand Society of Nuclear Medicine, 2008; Australian Institute of Radiography, 2009; Health Professions Council, 2012). Cancellation of registration means that the individual can no longer be employed in their professional capacity. Whilst
this may be perceived as a major consequence for the individual, other stakeholders are also impacted. Employing organisations and healthcare systems are reliant on the skilled and knowledgeable health profession workforce developed through extensive clinical experience and many years of education. With the education of new health professionals being a major worldwide expenditure, currently estimated to be US$100 billion per year (Frenk et al., 2010), it is important that health professionals can meet CPD standards so that they can remain in the workplace and continue to provide high quality healthcare.

Although continuing professional development requirements have been in place for some years, the importance of professional knowledge updating continues to be an issue, as identified in health professional practice research. The Australian CareTrack study (Runciman et al., 2012) compared healthcare delivered to patients against evidence-based or consensus guidelines and established that 43% of healthcare practice was not in accord with the latest standards. This suggests that a large number of health professionals base clinical practice decisions on professional knowledge that may no longer be current. Therefore, the issue of professional knowledge updating requires attention.

This study focuses on professional knowledge updating, which is defined as the practice by an individual health professional of using information sources to add new knowledge, relevant to their discipline, to their existing knowledge. For health professionals, new discipline knowledge is made available through a variety of information sources, such as websites of professional and commercial organisations (Davies, 2007; Herrington & Herrington, 2006), journals (Oermann et al., 2008), seminars and conferences (Keppell et al., 2001; Mamary & Charles, 2000; Rappolt & Tassone, 2002). In addition, governments in Australia and internationally have developed specialised online portals to provide health professionals with access within their workplace to current health information to update their knowledge and enable the provision of safe, high-quality healthcare (Gosling & Westbrook, 2004; Hall, 2008).
1.2 Statement of the problem

Despite the availability of new knowledge through a range of information sources, there is a body of evidence indicating that access within workplaces is insufficient for many Australian health professionals (Eley, Fallon, Soar, Buikstra, & Hegney, 2009; Gosling & Westbrook, 2002a, 2004; Hegney, Tuckett, Parker, & Robert, 2010; Herrington & Herrington, 2006; Klotz & Reis, 2005; Mills, Field, & Cant, 2011; Newman, Buckley, Dunn, & Cashin, 2009; Ross, Barr, & Stevens, 2013; Shaw, Lundy, & Larsen, 2006; Soar, 2010; Taylor & Lee, 2005; Westbrook & Gosling, 2001). These studies indicate that key electronic information sources such as journals, health and medical databases and web pages made available through government online health information portals or through the Internet, are not accessible to many health professionals within their workplace. For instance, although the Internet is portrayed as a ‘global library’ offering access to information at the time it is needed for learning (Bonk, 2009; Hill, Wiley, Nelson, & Han, 2004; Jarvis, 2007), access to the Internet within the workplace is problematic for many health professionals. Variation in access exists, with many health professionals in non-metropolitan workplaces experiencing greater difficulty accessing Internet-based health information than their colleagues in metropolitan locations (Newman et al., 2009; Shaw et al., 2006; Taylor & Lee, 2005). Furthermore, in workplaces where there is access to the Internet other factors such as lack of Internet-enabled computers, restrictions on who can access the Internet and what sites can be accessed, and lack of time to search for and read electronic information, have reduced opportunities for many health professionals to engage with current health information on a timely basis (Eley et al., 2009; Herrington & Herrington, 2006; Klotz & Reis, 2005; Soar, 2010).

Although large infrastructure investment has been made by governments to support broadband services, access to the Internet within the workplace continues to be problematic for many individuals. Recent data from Australia demonstrates that whilst over 90% of organisations have Internet access
(Australian Bureau of Statistics, 2012), just 52% of Australians employed in metropolitan locations report that they access the Internet at work and this is further reduced to 43% for those employed in non-metropolitan workplaces (Australian Bureau of Statistics, 2011b). Studies from the fields of health and education demonstrate that current use of electronic information and communication tools within organisations continues to be limited by lack of access to computers, restrictions on web sites that can be accessed including those used for learning and lack of time to engage with electronic learning tools due to heavy workloads (Bogossian & Kellett, 2010; Eley et al., 2009; Maher, 2010; Mills et al., 2011; Nisselle, Hanns, Green, & Jones, 2012; Turner et al., 2009). These studies also demonstrate that Internet access restrictions imposed by organisations negatively impact the learning for employees within health and education settings, as well as students (Bogossian & Kellett, 2010; Maher, 2010) and school-age patients (Nisselle et al., 2012).

Tensions within the workplace that generate time constraints on the individual or limit their access to key information sources, therefore, continue to exist. This suggests that merely increasing access to information in organisations through infrastructure developments, such as health information portals and the Australian Government’s National Broadband Network rollout, will not necessarily increase access to requisite information for individuals within the workplace. That is, the presence of computer hardware and Internet access within the workplace, whilst necessary infrastructure, are insufficient to guarantee that individuals can harness the benefits of utilising current health information in their workplace as part of their professional practice. To add to the problem of ongoing inequitable access to electronic information sources in workplaces, little attention has been paid to non-digital information sources such as seminars and conferences, which are also highly valued and utilised by health professionals to update their professional knowledge (Hegney et al., 2010; Keppell et al., 2001; Mills et al., 2011). There remains a pressing need to identify the factors that influence workplace access to key information
sources for individuals for whom new knowledge is critical for performing at the highest standards of professional practice.

As each profession has their own unique knowledge base (Calman, 1994; Oermann et al., 2008) the information sources that disseminate new knowledge are contextually bound to the profession being studied. Each occupational group must, therefore, identify what are relevant information sources for updating professional knowledge. This thesis utilises the medical radiation science (MRS) profession, which, like other health professions, is experiencing technological and professional change (Australian Institute of Radiography, 2007; Radiation Health and Safety Advisory Council Australian Government, 2011; Society of Radiographers, 2007). With the approval of the Continuing professional development registration standard, by the Australian Health Workforce Ministerial Council (2010), continuing professional development (CPD) is a mandatory condition of registration for ten health professions in Australia: chiropractic, dental, medical, nursing and midwifery, optometry, osteopathy, pharmacy, physiotherapy, podiatry and psychology. The MRS profession is one of four health professions included from 1 July 2012 (Australian Health Workforce Ministerial Council, 2009). This means that MRS professionals, like other regulated health professions, regardless of where they practice in Australia and whether or not they are members of a professional society, are compelled to maintain currency of their knowledge to meet registration requirements aimed at delivering safe and high-quality healthcare.

On the cusp of national regulatory enforcement of professional development, the MRS profession provides an important and relevant occupational group for study. Across health professions, workforce data demonstrates employment growth rates of 10%+ for medicine, nursing, physiotherapy, optometry and chiropractic and for the MRS profession 28.2% over a three-year period (Australian Institute of Health and Welfare, 2009). This rapid increase in number of health professionals may make an individual's workplace access to resources and support for learning more difficult. For example, Hegney et al (2010) identified that, for the nursing profession,
organisational financial support to attend CPD activities had decreased significantly in recent years. Given resource constraints within workplaces, it is important to examine how rapidly growing professions, such as the MRS profession, can meet the fundamental need to update professional knowledge. Moreover, a rapid increase in diagnostic and therapeutic services provided to patients by MRS professionals in Australia, due in part to the ageing population and increased prevalence of cancer and chronic diseases (Australian Institute of Health and Welfare, 2010), increases the relevance of the study of continuing professional learning practices of MRS health professionals. For example, in 2011 there were over 19 million diagnostic imaging examinations undertaken by MRS professionals in Australia (Medicare Australia, 2012). This represents a 28.3% increase in services to patients since 2006 (Medicare Australia, 2012). In addition, the Australian government is supporting, through infrastructure developments, substantial growth in therapeutic cancer services provided by MRS professionals (Australian Institute of Health and Welfare, 2010). The rapid rate in growth of health services provided by MRS professionals underscores the importance of exploring the learning domain within which quality healthcare by MRS professionals is pursued.

The analysis of the reviewed literature (discussed in Chapter 2) suggests that there is a paucity of research concerning professional updating activity within the MRS field. The reviewed literature points to a number of factors that potentially influence professional knowledge updating practice and an individual's access to information sources within workplaces. Factors that may influence level of professional knowledge updating activity include enrolment in a CPD program, membership of a professional society and workplace access to information sources. Within the workplace, variation in an individual's access to information sources span physical characteristics of the workplace (e.g., health sector and geographic location) and professional characteristics of the individual (e.g., their area of specialisation within the profession and their employment fraction). These variables are present in the membership characteristics of the MRS profession. The MRS profession should, therefore, provide rich data for studying the influence of each of these
factors on professional knowledge updating practice and individuals’ access within the workplace to the multiple information sources available to today’s health professional.

1.3 Objective of the study

The overarching objectives of the study are to develop a descriptive model of professional knowledge updating and to establish the interrelationships that exist within this model.

1.4 Significance of the study

This study is theoretically significant in examining professional knowledge updating as a learning activity mediated by information sources and situated within organisational structures that may influence this activity. Two embedded theoretical frameworks were adopted within this study to describe and examine professional knowledge updating practice. First, professional knowledge updating was theorised as an individual learning activity mediated by information sources by drawing upon Vygotsky’s (1981) model of mediated learning. In this model the subject (i.e., the learner) purposefully uses tools (i.e., information sources) to achieve their object (i.e., learning goal of updating their professional knowledge) (Engeström, 2001; Vygotsky, 1981; Wertsch, 1994). When information sources are purposefully used for learning, they become cognitive tools supporting active, intentional knowledge construction (Grabowski, 2004; Hill et al., 2004; Jonassen, 2000). In this case, the purposeful use of information sources to update professional knowledge. This model initially focused on the individual, was then broadened by utilising Engeström’s (2001) Activity System model to situate learning mediated by information sources within a world that “provides resistance and affordance” (Kaptelinin & Nardi, 2006, p. 66) to learning activity. The latter extension introduced greater ‘real world’ complexity by situating professional knowledge updating within organisational structures, in particular workplaces and professional associations, to identify tensions that constrain learning activity as well as incentives that promote learning. Finally,
the extended model was applied in the context of interest to this study, viz. healthcare and, in particular, medical radiation science.

This study is empirically significant as it addresses three important gaps in contemporary understanding of professional knowledge updating practice. First, this study investigates the contemporaneous value and use of electronic and non-electronic information sources for updating professional knowledge. Whilst various studies have raised the importance of examining information source use for professional updating of knowledge they have tended to focus on a single electronic information source such as the Internet (Gilmore, Scott, & Huntington, 2008; Herrington & Herrington, 2006) or government-provided electronic portals (Gosling & Westbrook, 2004; Scolaro & Archer, 2003) in lieu of a more-holistic and integrated study. In essence, this prior research has tended to study the impact of a single source of information in isolation rather than the range commonly integrated and adopted into the overall health professional's knowledge updating practice. For example, although the importance of non-electronic information sources, in particular conferences and seminars, for updating professional knowledge has previously been established (Garvey & Griffith, 1972; Garvey, Lin, Nelson, & Tomita, 1972; Keppell et al., 2001) there has been little attention paid to the role they play in contemporary professional knowledge updating activity. Thus, there is a need for investigating professional knowledge updating activity in relation to the multiple information sources that are available to today’s professionals.

Second, this study tests multiple factors that may influence professional knowledge updating. The factors examined stem from professional and workplace structures. For instance, whilst professional factors such as enrolment in CPD and membership of a professional society influence the level of formal learning activity (Landers, McWhorter, Krum, & Glovinsky, 2005), their influence on informal learning activity, such as using the Internet or reading journals to update professional knowledge, has not been established. In regard to workplace structure, this study examines the influence of individuals’ workplace access to information sources on level of
professional knowledge updating. While it has been previously determined that improved access to journals in the workplace is associated with increased levels of journal reading (Bohannon & Larkin, 1986; Nagy, Crisp, & Brodie, 1991), this study examines the influence of access in the workplace on level of activity for multiple information sources adopted by health professionals to update their professional knowledge.

Third, this study utilises multiple measures to examine in detail the access of individuals within workplaces to electronic and non-electronic information sources employed to update professional knowledge. Current studies examining access to electronic information sources are, according to Selwyn, Gorard and Furlong (2006), limited, as they use a single measure of physical access. These authors contend that whilst physical access to the information source may exist there is a “hierarchy of access” (p. 22) amongst individuals, and conclude it is the individual’s effective access in practice that is a more important measure. There is, therefore, a need to investigate individuals’ effective workplace access to multiple information sources utilised by health professionals to access new knowledge needed to provide the highest quality of healthcare.

In summary, this study investigates and informs a fundamental aspect of delivery of high-quality healthcare – the imperative that health professionals maintain currency of their knowledge. This is the first study to concurrently examine value and use of electronic and non-electronic information sources, individuals’ access within workplaces to these information sources and to utilise multiple measures of access. The findings from this study enrich the extant literature concerning learning mediated by information sources, factors that afford or constrain professional knowledge updating activity and employee access within the workplace to information sources. In doing so, this study not only examines the contemporaneous use of multiple information sources for updating professional knowledge but it also allows the perceived current value of electronic and non-electronic information sources for this learning activity to be ascertained. This study presents individuals’ access to information sources utilising multiple measures, that is,
both physical and effective measures. This analysis allowed for detailed comparison of individuals' workplace access across information sources as well as hierarchies of access to information sources within a profession to be determined.

1.5 Research questions and hypotheses

The research aimed to address the following five questions and related hypotheses.

Research Question 1 was: **What information sources do MRS professionals use as tools to update their professional knowledge and why are they used?**

Research Question 1 was operationalised into three sub-questions:

1a **What information sources are utilised as mediating tools in professional knowledge updating activity?**
1b **How frequently are these tools used?**
1c **What value is attributed to these tools?**

Research Question 2 was: **What areas of knowledge do MRS professionals update?**

Research Question 3 was: **What factors associated with professions influence the use of mediating tools in updating professional knowledge?**

This question was addressed by testing two null hypotheses:
H1 Level of use of mediating tools in professional knowledge updating activity will be no different for membership of a professional society

H2 Level of use of mediating tools in professional knowledge updating activity will be no different for enrolment in a CPD program

Research Question 4 was: Does workplace accessibility of mediating tools influence their use in updating professional knowledge?

This question was addressed by testing two null hypotheses:

H3 Level of use of mediating tools in professional knowledge updating activity will be no different for physical access to these tools in the workplace

H4 Level of use of mediating tools in professional knowledge updating activity will be no different for effective access to these tools in the workplace

Research Question 5 was: What factors influence workplace access to mediating tools in professional knowledge updating activity and do hierarchies of access to these tools exist across workplaces?

Seven null hypotheses were generated from the reviewed literature to address this question:

H5 Workplace accessibility of mediating tools will be no different for workplace profile, work context (university, clinical).

H6 Workplace accessibility of mediating tools will be no different for clinical workplace profile, health sector (public, private).
H7 Workplace accessibility of mediating tools will be no different for clinical workplace profile, geographic location (metropolitan, regional, rural and remote).

H8 Workplace accessibility of mediating tools will be no different for clinical workplace profile, workplace type (teaching hospital, non-teaching hospital, clinic).

H9 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, area of specialisation (nuclear medicine, radiation therapy, radiography, sonography).

H10 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, employment role (manager, senior practitioner, practitioner, clinical educator).

H11 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, employment fraction (full time, part time)

1.6 Overview of the study

A two-phase, sequential, mixed methods design was implemented for the empirical component of this study.

Phase 1 was qualitative in nature and sought to establish the information sources used by MRS professionals to update their professional knowledge and the value attributed to these information sources for updating professional knowledge. The results of Phase 1 were utilised to develop the Phase 2 survey, which was distributed via post to a large sample of Australian MRS professionals.

Phase 2 was quantitative in nature and sought to establish the importance and use of multiple information sources in professional knowledge updating activity. Phase 2 also sought to establish factors influencing professional knowledge updating practice and individuals’ access within the workplace to
the multiple information sources available to today’s health professional. The use of multiple measures of access allowed for a detailed comparison of access across information sources as well as hierarchies of access to information sources within a profession to be determined.

1.7 Definition of keys terms as used in this thesis

- **Professional knowledge** consists of discipline knowledge publicly communicated through information sources and tacit knowledge gained through experience and embedded in professional practice.

- **Professional knowledge updating** is the practice by an individual of using information sources to add new knowledge, relevant to their discipline, to their existing knowledge.

- **Mediating tools** are used to support and enhance learning. Tools may be external or internal to the learner. The mediating tools examined in this study are external tools of information sources.

1.8 Structure of the thesis

This thesis consists of six chapters. Chapter 2 presents a synthesis of the literature reviewed to provide a theoretical and practical basis for this study. Chapter 3 describes the methodology adopted for Phase 1 and Phase 2 of this mixed methods research design. Chapter 4 presents the findings and discussion relating to research questions 1 and 2 providing a descriptive account of professional knowledge updating within the MRS profession. The findings from Chapter 4 were used to construct primary elements of the professional knowledge updating model — tools, object and outcome, adapted from Engeström’s (2001) Activity System model. Chapter 5 presents the findings and discussion relating to research questions 3, 4 and 5. This chapter tests hypotheses associated with the inter-relationships in Engeström’s (2001) Activity System model and applied to professional knowledge updating. Specifically, factors influencing professional knowledge
updating activity (research questions 3 and 4) and factors influencing individuals' access within the workplace to information sources used as tools to update their knowledge (research question 5) are discussed. The findings from Chapter 5 identified key inter-relationships and permitted a more-complex model of professional knowledge updating to be developed. Chapter 6 summarises the findings presented in chapters 4 and 5. This chapter discusses theoretical, policy and practical implications of the study, presents issues that may be elaborated through further investigation and concludes the thesis.
CHAPTER 2 – LITERATURE REVIEW

This chapter presents a synthesis of the literature that forms the theoretical and empirical foundation for this study. There were three main foci in the review of the literature. First, literature pertaining to learning as mediated activity was reviewed to introduce the theoretical basis. That is, for this study Vygotsky’s (1981) theoretical framework of learning as an activity mediated by tools. The second section provides a further extension of learning mediated by information sources by situating learning within structures that may afford or constrain learning activity. Engeström’s (2001) Activity System model, extends Vygotsky’s mediated learning model and provides an embedded framework introducing greater ‘real-world’ complexity for understanding learning mediated by information sources. The third and final section provides a detailed application of Engeström’s (2001) Activity System model to this study, examining professional knowledge updating as an activity mediated by information sources and situated within organisational structures, in particular professional associations and workplaces, that may influence the level of activity of individuals.

2.1 Introduction

Updating knowledge is central to the current focus on lifelong learning and continuing professional development. Whilst lifelong learning is not a new concept (Candy, 1991; Edwards, 2000), its contemporary importance is aligned to the need for continued learning in a rapidly changing society (Edwards, 2000; Field, 2000). The Organisation for Economic Co-operation and Development (OECD) (1996, 2004, 2007) identified that the arguments underpinning the need for lifelong learning reflected the increasing importance of knowledge and information within a society experiencing rapid technological change. Akin to technological-based change, knowledge is
also undergoing rapid transformation. This is well argued by Jarvis (2007), in noting that knowledge is constantly in a state of flux and its rate of change is rapidly increasing. Jarvis (2010) adds that when work-based changes are rapid, society emphasises the need for continued learning. This is evident in the importance attributed to lifelong learning as a mechanism for cultivating flexible employees required in today’s skilled and changing labour market (Australian Bureau of Statistics, 2010); high level of adult learning undertaken for work-related purposes (Australian Bureau of Statistics, 2007, 2010; Professional Associations Research Network, 2008); and the introduction of mandatory CPD requirements that aim to ensure professionals maintain currency of their knowledge (Australian Health Workforce Ministerial Council, 2010; CPA 2013; Engineers Australia, 2013; Health Professions Council, nd; Law Institute Victoria, nd).

In order to maintain currency of knowledge an individual must have ongoing access to new knowledge. As noted above, knowledge is not a static entity. Keeping pace means keeping abreast of changes in disciplinary knowledge and practice. This means, in a given work context, individuals update their knowledge with new knowledge relevant to their discipline (Candy, Crebert, & O’Leary, 1994; Thistlethwaite & Spencer, 2008). For professionals, new discipline knowledge is made available through information sources such as seminars, conferences, journals and websites (Candy, 1991; Estabrooks et al., 2005; Oermann et al., 2008). The practice, by individual professionals, of using information sources to add new knowledge relevant to their discipline to their existing professional knowledge is described, in this study, as professional knowledge updating. From this perspective, information sources are tools that mediate professional knowledge updating practice. This study heeds the concern raised and clearly articulated by Merriam and Cafarella (1999) when discussing resources and supports for adult learning “What opportunities are available ... are to a large extent determined by the society in which one lives” (p. 22). While information sources can mediate learning, a variety of factors can influence the use of these tools for learning. The view of learning as a complex system mediated by tools and situated within
structures that may support or hinder learning activity is examined in this study through an embedded theoretical framework. Section 2.2 outlines the theoretical framework of mediated learning utilised in this study, namely Vygotsky’s (1981) triadic model of learning as an activity mediated by tools. This is followed by an overview of Engeström’s (2001) Activity System model, as it extends Vygotsky’s simple triadic model of learning mediated by tools and situates it within the ‘real world’ that can afford or constrain level of learning activity (Section 2.3). Engeström’s (2001) Activity System model is then contextualised and applied to professional knowledge updating within the MRS profession (Section 2.4).

2.2 Learning as mediated activity

Information sources are primary tools for professional knowledge updating. Reading journals, attending conferences and seminars, and utilising the Internet to search for professionally relevant information are widely adopted practices to update professional knowledge (Professional Associations Research Network, 2008). Given the important role of information sources, Vygotsky’s (1981) model of learning mediated by tools is a theoretical framework useful for examining professional knowledge updating. This framework has resonance as information sources are examples of tools that support and enhance learning (Hill et al., 2004; Jonassen, 2000). Furthermore, information sources have a central role in knowledge updating disseminating new discipline knowledge to individuals (Eraut, 1994; Higgs & Titchen, 2001). Learning, as an act mediated by tools, is commonly expressed in Vygotsky’s triadic representation (Barab, Evans, & Baek, 2004; Engeström, 2001). The Vygotskian model of mediated learning has three central elements – subject, tool and object, as shown in Figure 2.1.
In the Vygotskian triad, the *subject* is defined as the learner. The learner is viewed as an active agent purposefully utilising mediating tools to achieve their learning goal (Engeström, 2001; Vygotsky, 1981; Wertsch, 1994). The view of adult learners as purposefully using tools such as information sources to learn is not new. Lindeman (1926) identified that adults self-determine how and when to bring subject matter, such as that found in books, into their specific situation or experience. Similarly, Tough (1979), in a study examining self-directed adult learners, reported that the participants determined what information sources they would use and also noted the high level of use of multiple information sources to support their particular learning need. Tough’s study also identified that only a small proportion (0.7%) of adult learning involved enrolment in educational institutions. This constituted a significant shift in understanding adult learning. Learning, for many adults, did not involve educational institutions. More recent studies of adult learning (Armstrong & Weidner, 2010; Australian Bureau of Statistics, 2007, 2010; Watson, 1999) continue to demonstrate that the majority of learning occurs outside of formal courses at educational institutions. Adult learning is, therefore, primarily a self-directed rather than a formally structured and taught activity. This means that the adult self-directed learner does not have a teacher providing high quality resources, such as information sources, for learning. Rather, the adult learner must determine what information is to be

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**Figure 2.1: Common representation of Vygotskian model of the mediated learning act.**

![Diagram of Vygotskian model](image)
acquired and must be able to acquire it. This is an important consideration for this current study as tools such as information sources, which are central to professional knowledge updating, must be readily accessible, not just through educational institutions where professional knowledge develops through formal courses (Eraut, 1994; McGee & Coles, 2009) but through the myriad of workplaces where information sources are utilised to extend and update professional knowledge and practice to improve patient care (Usher, 2011; Westbrook, Gosling, & Coiera, 2004).

Tools are utilised by the learner to support the learning process. Tools may be external or internal. External tools are material tools such as information sources. Internal tools include processes utilised by the individual to support knowledge construction, such as mnemonic techniques and schemas of objects or events (Merriam & Cafarella, 1999; Vygotsky, 1981). Both external and internal tools act as aids, or cognitive tools, enabling knowledge construction (Jonassen, 2000; Jonassen & Reeves, 1996). Information sources such as books have long been recognised as cognitive tools that support learning (Brookfield, 1985; Engeström, Hakkarainen, & Hedegaard, 1984). Modern cognitive tools are seen as computer-based educational technologies used to engage and facilitate learning (Jonassen, Howland, Marra, & Crismond, 2008; Jonassen & Reeves, 1996). For example, the Internet has been identified as an important cognitive tool facilitating learning (Hill et al., 2004; Jonassen et al., 2008). Jonassen et al. (2008) assert that purposeful searching transforms the Internet from a passive information source to a cognitive tool. The implication is that when the learner has a purpose for obtaining information they then use the information in some meaningful way. This may include personal knowledge construction when new information is integrated into the learners’ prior knowledge (Kintsch, 1994; Todd, 1999, 2006; Tynjala, 1999), solving a problem (Hill et al., 2004; Jonassen et al., 2008), or creating a knowledge artefact or object to share knowledge (Hill et al., 2004; Tolson, McAloon, Hotchkiss, & Schofield, 2005).
Information changes learners’ knowledge in two ways. First, new information is used to expand knowledge, building a more detailed and complete picture of the subject content (Todd, 1999, 2006; Tynjala, 1999). Second, new information can also reconstruct the learners’ existing knowledge by refining and linking concepts to provide a more robust explanatory framework (Kintsch, 1994; Todd, 1999, 2006; Tynjala, 1999). For example, Todd (1999) investigated the way information changed the knowledge of high school students and identified that information was used first to broaden or expand, clarify and verify what they already knew. New information also resulted in learners’ existing knowledge being revised. Before existing knowledge was revised, learners added the new information into their existing knowledge. The information was therefore used first to build a more detailed understanding before revising or replacing a previously held concept. Other studies (Todd, 2006; Tynjala, 1999) have similarly reported that new information is used to both build existing knowledge structures and also refine and link concepts to form a more robust explanatory framework. In essence, new discipline knowledge, made available through information sources, can increase both quantity and quality of an individual’s professional knowledge. Both changes are needed if an individual is to develop, maintain and use expert knowledge in their professional practice (Barba & Rubba, 1992; Bryce & Blown, 2012). Learning mediated by information sources can both inform and change the professional knowledge of individuals.

Learning with tools such as information sources can involve both individual and shared knowledge construction. As an individual activity, the learner actively works to construct meaningful understanding of new information (Grabowski, 2004; Hill et al., 2004). From the viewpoint of knowledge updating as an individual learning activity, the individual purposefully uses the information source, such as a journal or book, to incorporate new discipline knowledge into their professional knowledge. Through this active process, the individual extends, refines and links their professional knowledge to provide a more robust explanatory framework (Kintsch, 1994; Todd, 1999, 2006; Tynjala, 1999). Learning with information sources may
also be a shared knowledge construction activity. Through discussion of new information, face-to-face or online (Jarvis, 2006; Jonassen, 2000; Wenger, McDermott, & Snyder, 2002), learners can seek out and exchange opinions and ideas with others. Through this shared process, knowledge construction expands beyond the individual and is conceptualised as an active process of negotiating shared meaning amongst learners (Candy, 1991; Hill et al., 2004; Jonassen, 2000). Professional knowledge updating as a shared learning activity involves multiple learners with their existing professional knowledge, purposeful use of information sources that disseminate new discipline knowledge and their new understanding obtained through discussion and negotiation at, for example, journal clubs (Milinkovic, Field, & Agustin, 2004; Turner & Mjolne, 2001) and via listservs (Herrington & Herrington, 2006). For instance, participants at a journal club read the journal article that disseminates new knowledge and, through discussion, their new discipline knowledge can be unpacked and contextually applied to their workplace practice. Through this shared active process, the professional knowledge of multiple learners is extended, refined and linked to their professional practice (Billett, 1995; Lave & Wenger, 1991; Wenger et al., 2002). Professional knowledge updating, a learning activity mediated by information sources (tools), may incorporate both individual and shared knowledge construction.

The object is the final component of the Vygotskian triad and relates to the goal of the learning activity (Kaptelinin & Nardi, 2006). In this study, the goal of learning activity, is updating professional knowledge. Specifying the goal is an important consideration when examining learning mediated by information sources. Keppell et al. (2001), in a study investigating the use of a major online resource for health professionals, demonstrated that the selection of information sources, or as represented in the Vygotskian model as tools, is dependent on purpose of use, or object of activity. Keppell et al. reported that the four most frequently utilised information sources to refresh knowledge were workshops and seminars (85%), conferences (83%), textbooks (73%) and print journals (72%). When the activity was background research, these professionals utilised print journals (66%), academic-based
websites (65%), Internet search engines (61%) and electronic journals (57%). In contrast, the top four information sources utilised to assist with clinical diagnosis were consultation with colleagues (59%), textbooks (58%), print journals (43%) and academic-based websites (36%). These findings highlight that information source selection is dependent on the purpose, or object of activity, and that multiple information sources are utilised for a given purpose.

The Keppell et al. (2001) study is over ten years old. Many studies have examined information source use by health professionals since the Keppell et al. (2001) study, (e.g., Bertulis & Cheeseborough, 2008; Bryant, 2004; Gilmore et al., 2008; Gosling & Westbrook, 2004; Herrington & Herrington, 2006; Jackson et al., 2007; Masters, 2008; O'Leary & Mhaolrunaigh, 2011; Steel & Adams, 2011; Younger, 2010). However, these later studies have tended to either examine a single information source (Gilmore et al., 2008; Gosling & Westbrook, 2004; Herrington & Herrington, 2006; Younger, 2010), general use of information sources, without specifying a specific purpose, or object of activity, such as updating professional knowledge (Bryant, 2004; Guo, Bain, & Willer, 2008), or have specified a different purpose, such as clinical decision making (O'Leary & Mhaolrunaigh, 2011). These more recent studies are, therefore, of limited value in developing a contemporary holistic understanding of information sources currently utilised in updating professional knowledge.

It is, however, evident that electronic information sources are being used more frequently than was observed by Keppell et al. (2001). A recent study by O'Leary and Mhaolrunaigh (2011) investigated the clinical decision making of nurses and identified that for routine clinical decisions nurses were reliant on their own professional knowledge developed through integrating discipline knowledge with years of clinical experience. When decision making was non-routine, nurses used the knowledge of their nursing peers and, to a lesser extent, other health professionals and available information sources. While the finding that professional colleagues were the most
frequently utilised resource for decision-making accords with the earlier finding of Keppell et al. (2001), the Internet had assumed a more important role. In the more recent study by O’Leary and Mhaolrunaigh (2011), the Internet was being used as frequently as books to support and inform clinical decision making. With the increased importance attributed to electronic information for learning generally (Bonk, 2009; Organisation for Economic Co-operation and Development, 2009), and more specifically within the health professions (Gilmore et al., 2008; Hall, 2008), it may be reasonable to similarly expect that the information sources identified by Keppell et al. (2001), as most frequently utilised for refreshing knowledge, may not be those currently adopted by health professionals to update their professional knowledge. There is a need for further research to identify the range of information sources currently utilised by health professionals to update their professional knowledge.

Furthermore, as health professionals place a high reliance on their own professional knowledge and that of their peers for decision making (O’Leary & Mhaolrunaigh, 2011) and problem solving (Creswick, Westbrook, & Braithwaite, 2009) in the clinical environment, a more detailed understanding of knowledge updating practice, can also inform these other areas of research.

The Vygotskian triad of subject, tool and object portrays the learner as purposefully utilising tools, such as an information source, to construct their knowledge. This model suggests that learners will have access to and will use information sources for this purpose. However, as previously noted, a variety of factors may influence use of these tools for learning. The view of learning as a complex system mediated by tools and situated within structures that may support or hinder learning activity is in accord with Engeström’s (2001) Activity System model. The following section introduces this model and then a detailed application of the model to this study is provided.
2.3 Engeström’s (2001) activity system model

The Vygotskian model of mediated learning, composed of subject, tool and object, is a simple model for representing professional knowledge updating activity. Building on Vygotsky’s (1981) model, Engeström (2001) introduced greater ‘real world’ complexity by graphically extending the model with structures that can afford or constrain activity, namely rules, community and division of labour. An adaptation of Engeström’s Activity System model to represent knowledge updating is presented in Figure 2.2.

**Figure 2.2: Activity system model, adapted from Engeström (2001) for knowledge updating.**

The upper sub-triangle of Figure 2.2 represents the Vygotskian triad of subject, tool and object. In Activity System models, the focus moves away from an individual, recognising there will be multiple people engaged within a larger-scale collective activity system (Engeström, 2001; Kaptelinin & Nardi, 2006). In this case, members of a profession (subjects or learners), with their existing knowledge, purposefully use information sources (tools) to update their knowledge (object). As discussed (Section 2.2), knowledge construction facilitated by information sources can occur as an individual and
as a shared learning activity. As an individual learning activity, professional knowledge updating includes the individual learner with their existing knowledge plus the information source such as seminar, journal or book and the learner’s new understanding. When professional knowledge updating occurs as a shared learning activity, it extends to include learners with their existing knowledge, information sources used by learners and learners’ new knowledge informed by both information sources and the shared knowledge of other participants.

The development of a shared or more congruous meaning among learners is supported when there is a common language, shared practice and accepted norms of members of the given community (Billett, 1995; Lave & Wenger, 1991; Wenger, 1998). These characteristics underpin descriptors of communities of practice (CoPs). Wenger (1998) characterised CoPs as having mutual engagement (activity is organised around what people are there to do), joint enterprise (practice evolves through a shared communal response) and shared repertoire (of resources such as terminology, tools, artefacts and practice). Initially, CoPs were examined at individual workplaces, emphasising the importance of local interactions on development of practice within a given workplace (Lave & Wenger, 1991; Wenger, 1998). However, classifying CoPs only at the local or workplace level does not account for shared learning that extends beyond the workplace (Lathlean & le May, 2002). The practice within a workplace can then be influenced by external knowledge and practices, such as those shared through online communication tools, face-to-face at seminars and conferences and through journal articles. This introduction of external knowledge and practices into the workplace, the local CoP, is considered essential for developing best practice within organisations (Wenger, 1998; Wenger et al., 2002). To distinguish between the primary local CoP that exists in the workplace, Wenger et al. (2002) used the term “distributed communities” (p. 115) to describe the broader multitude of geographically dispersed CoPs that can add external knowledge into any given local CoP. Distributed communities thus extend the sharing of knowledge and practice.
beyond individual workplaces and involve members of a given local CoP sharing and extending their knowledge with others from a different workplace, or CoP, at, for example, conferences, seminars and workshops (Estabrooks et al., 2005; McDonald & Viehbeck, 2007), through online and/or face-to-face discussion groups (Rolls, Kowal, Elliott, & Burrell, 2008; Tolson et al., 2005), and journal clubs (Price & Felix, 2008). As an example, Tolson et al. (2005) used the national distributed community of gerontology nurses to review new research made available through information sources, to develop nurse-specific practice guidelines for implementation into local workplaces (CoPs), across Scotland. As the top four information sources identified in the Keppell et al. (2001) study for updating professional knowledge were workshops and seminars, conferences, textbooks and journals, this indicates that professional knowledge updating brings external knowledge into the local CoP of the workplace through multiple information sources. These information sources may be available within the workplace, such as books and journals, or may involve individuals advancing and sharing their knowledge external to the workplace at, for example, conferences and seminars. The ongoing provision of high quality and safe healthcare to patients requires health professionals to continue to integrate new knowledge, made available through a range of information sources that may be available within and external to the workplace, with their own knowledge (Gosling & Westbrook, 2004; Runciman et al., 2012). Whilst the provision of healthcare occurs within individual workplaces, professional knowledge updating can occur both within and external to the local CoP of the workplace.

Engeström’s Activity System model introduced an outcome of activity. The outcome of activity refers to the intended or unintended implications of activity (Kaptelinin & Nardi, 2006). The outcome of updating knowledge, constructed through individual or shared learning activities, can be utilised to support the individual’s personal development, their own employability and meeting the economic needs of their workplace, viewpoints typical in the lifelong learning and adult learning literature (Edwards, 2000; Knowles,
Holton, & Swanson, 1998; Senge, 1990; Watson, 1999). In addition, the concept of professionalism requires individual health practitioners to place the clients’ interests and welfare before their own personal gain (Freidson, 1994). According to Eraut (1994) professionals also have a moral responsibility to extend this concept beyond clients to include other stakeholders; for example utilising resources for maximum benefit for the community. Indeed the current emphasis on evidence-based practice in health promotes care of the individual patient based on best available evidence for effective use of resources (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). The outcome of updating knowledge (Figure 2.2), from the professionals’ perspective, would therefore extend beyond ensuring their own personal development, their own employability and meeting the economic needs of their workplace, to encompass the welfare and interests of clients and other stakeholders. As an example, research in the health professions demonstrates that professional learning is perceived to play a key role in improving patient safety, enhancing service provision as well as supporting individual knowledge development (Gosling & Westbrook, 2004; Jones & Lambros, 2003; Landers et al., 2005; Veness, Rikard-Bell, & Ward, 2003). For the purpose of this current study, it was presumed that the outcome of professional knowledge updating within the MRS profession would similarly include improving personal, organisational and patient outcomes.

Engeström’s Activity System model further expands the Vygotskian triangle with structures that influence activity, including rules, community and division of labour (Engeström, 1994, 2001). Rules refer to given or negotiated guidelines, directives or regulations that influence the activity system. Rules may be set by organisations external to the workplace, such as the introduction of mandatory CPD requirements that involve knowledge updating by professional societies or governments (Australian Health Workforce Ministerial Council, 2010; Australian Institute of Radiography, 2007; Health Professions Council, 2010). Community refers to the wider community that may influence a given activity. When the activity system is
focused on learning, workplaces are an important community (Engeström, 2001; Wenger, 1998) and they can influence the level of learning activity through the degree of access to information sources and learning supports they provide (Eraut, 1994; Lave & Wenger, 1991; Senge, 1990). For instance, the type of workplace has been shown to influence access to information sources, with health professionals employed in the public sector reporting greater access to the Internet (Jones & Lambros, 2003) and journals (McClusky, 2003) than their colleagues employed in the private sector. The *division of labour* refers to the social reality of participants in the activity system. Within workplaces, power structures can influence activity (Senge, 1990; Wenger, 1998). As an example, in their study of Internet usage by professionals in rural and remote Australia, Herrington and Herrington (2006) reported that busy employees who had to get their manager to log them into the Internet were unlikely to pursue finding new information that may improve patient care.

Engeström’s Activity System model (2001) provides a more complex model for examining knowledge updating activity. The Activity System model (Figure 2.2) situates knowledge updating within a world that consists of rules, community and division of labour, that “provides resistance and affordance” (Kaptelinin & Nardi, 2006, p. 66) to this activity. This means that each of these factors (rules, community and division of labour) can influence professional knowledge updating activity. This more complex model, therefore, provides a framework for concomitantly examining knowledge updating and the factors that influence this learning activity. This feature of the Activity System model is important, as this study aims to develop a descriptive account of professional knowledge updating within the MRS profession (Research Questions 1 and 2), factors that influence professional knowledge updating activity (Research Questions 3 and 4) and factors influencing individuals’ access within the workplace to information sources and tools used to update their knowledge (Research Question 5). The following section adopts Engeström’s (2001) Activity System to present and examine professional knowledge updating practice.
2.4 Activity system for updating professional knowledge

This section applies Engeström’s (2001) Activity System model to professional knowledge updating. The upper triangle of object, tools and subject are detailed. Factors, of rules, community and division of labour, which may influence professional knowledge updating activity, are then examined.

2.4.1 Updating professional knowledge as object of activity

In Engeström’s (2001) Activity System model, the object is the goal of the activity. In this study, the goal of learning activity is updating professional knowledge. Professional knowledge is composed of the public body of knowledge of the profession and the knowledge of the individual. Multiple terms are used to refer to this public body of knowledge. Propositional, theoretical, objective, scientific, discipline, explicit and formal knowledge are also utilised to represent the body of knowledge publicly communicated through the information sources that underpin a profession (Eraut, 1994; Higgs & Titchen, 2001; Popper, 1972; Wenger, 1998). The public body of knowledge, from now on described as discipline knowledge, is developed by research and provides the principles or theories, the ‘know why’, as well as domain content, the ‘know what’ of professional knowledge (Eraut, 1994; Tynjala, 1999).

The knowledge of the individual professional might be referred to as tacit knowledge. Tacit knowledge is characterised as embodied expertise and being difficult to articulate (Eraut, 1994; Wenger et al., 2002). Simply put, we know more than we can say. Higgs and Titchen (2001) divide tacit knowledge used by professionals into two categories, professional craft knowledge and personal knowledge. Professional craft knowledge is gained through experience and embedded in professional practice. Professional craft knowledge is akin to Schön’s (1991) ‘knowing-in-action’ and Eraut’s (1994) process knowledge, or ‘know how’ of professional practice.
Professional craft knowledge is developed through the internalisation and fine tuning of discipline knowledge that underpins the profession and through immersion in professional practice (Eraut, 1994; Higgs & Titchen, 2001; Schön, 1991). A second type of tacit knowledge, referred to as personal knowledge, is gained through life experiences (Higgs & Titchen, 2001). This type of knowledge allows health professionals to “enter the life-world of their patients” (p. 6), supporting empathic patient-centred professional practice. It is the integration of discipline knowledge acquired through information sources and tacit knowledge that enables professionals to confidently manage different cases (Cheetham & Chivers, 2001; Eraut, 1994; Higgs & Titchen, 2001) and base their professional practice on current health information (Gosling & Westbrook, 2002a; Hall, 2008; Meagher-Stewart et al., 2012).

To meet the fundamental requirement to maintain currency of their knowledge, health professionals must integrate new discipline knowledge into their existing knowledge. In relation to professional knowledge updating, the subjects are professionals with their existing knowledge, the tools are information sources disseminating new discipline knowledge and the object is updated professional knowledge. Updating professional knowledge can occur as an individual learning activity, such as when an individual professional (subject) reads about the latest research in a journal article (tool) and their knowledge is extended and updated (object). When there are multiple learners interacting, updating knowledge can occur as a shared learning activity. For example, health professionals attending a conference (tool) can hear the latest research through oral presentations or read it on a poster. Through discussion with presenters or other conference delegates (subjects), the individual’s updated professional knowledge (object) is mediated by both the information source, in this case the conference, and the knowledge of other participants. Their new or updated knowledge, developed by individual or shared learning, can then be utilised in the delivery of safe, high-quality healthcare within the local CoP of the workplace (Gosling & Westbrook, 2004; Hall, 2008; Tolson et al., 2005).
The rapid rate of change in discipline knowledge (Burns, 2002; Jarvis, 2007) means that information sources disseminating new knowledge must be readily available if professional practice is to be based on current health information. The information sources that disseminate new discipline knowledge are discussed in the following section.

### 2.4.2 Information sources as tools for updating knowledge

In Engeström’s (2001) Activity System model the tools mediate the object of activity. Primary tools for updating professional knowledge are information sources that disseminate new discipline knowledge. Based on research initially conducted within the field of psychology, Garvey and Griffith (1972) developed a model of knowledge dissemination within professions. The authors maintain that new discipline knowledge is first disseminated orally through local seminars and then at state or national conferences of their professional society. The feedback obtained from the seminars and conferences were then used to develop a manuscript for submission to a journal. Finally, Garvey and Griffith note that new knowledge is then cited in other journal articles and appears in books. This last stage of the model represents the assimilation of new knowledge into the discipline’s knowledge base. While the Garvey-Griffith (1972) model was developed from research based on the psychology profession, the succession of stages has been reported to be similar across other professional fields (Candy, 1991; Garvey et al., 1972). As the Garvey-Griffith model was developed in the early 1970’s, Hurd (2004) adapted the model for the digital era. Whereas the Garvey-Griffith model had new knowledge initially being disseminated through face-to-face seminars and annual conference of the professional society, the Hurd model showed new knowledge dissemination occurring initially through web pages, e-conferences and e-communication tools. The Hurd (2004) model reflects the increasing importance and use of electronic tools to disseminate new knowledge adopted by governments in Australia and internationally.
Governments in Australia and internationally are making new discipline knowledge more available electronically. One notable example of infrastructure to support high-speed electronic access to new knowledge for Australians is Federal Government investment in regional broadband services (Commonwealth of Australia House of Representatives, 2005). Specific examples of broader access to electronic information for health professionals, the subjects of this study, include free access to Cochrane Library, which contains authoritative health information, including full-text articles, systematic reviews and clinical trials (National Institute of Clinical Studies, 2002), and Electronic Information Portals for health professionals (Keppell et al., 2001; Liaw et al., 2004; Turner, Fraser, Gray, & Toth, 2002; Wilson, Droogan, Glanville, Watt, & Hardman, 2001). These portals provide health professionals with access to a range of electronic information sources, including health and medical databases, ejournals, ebooks and clinical guidelines. These information sources have been identified as important tools for assisting health professionals in updating their knowledge (Gosling & Westbrook, 2004; Liaw et al., 2004; Turner et al., 2002). Examples of electronic portals for health professionals are: NHS-net (Internet access for the National Health System) in the UK; National electronic Library for Health (NeLH) in the UK; Hospital Authority Library Information Systems (HALIS) in Hong Kong; Clinical Information Access Program (CIAP), New South Wales State Government; Clinicians Health Channel, Victorian State Government; and Clinical Information Access Online (CIAO), Western Australian State Government. While these portals are seen to provide consistent and easy access to sources of new knowledge, Davies (2007) and others (Cull, 2003; Herrington & Herrington, 2006; Keppell et al., 2001; Masters, 2008; Steel & Adams, 2011; Wong & Veness, 2005) have also noted that health professionals highly value other information sources, such as government, professional and commercial websites that similarly present new knowledge relevant to their disciplines. In addition, Internet-based communication tools of email, listservs and discussion forums are utilised by professionals to consult with colleagues nationally and internationally (Bennett, Casebeer,
Kristofco, & Strasser, 2004; Herrington & Herrington, 2006). While seminars and conferences were identified as more important for updating professional knowledge than web pages and Internet search engines at the beginning of the 21st century (Keppell et al., 2001; Mamary & Charles, 2000; Rappolt & Tassone, 2002), increased usage of the Internet (Bennett et al., 2004; Marcoux, Barlage, Davies, & Heller, 2004; O’Leary & Mhaolrunaigh, 2011) and improved infrastructure for broadband suggests that the value and use of electronic information sources may be changing. It is therefore timely and valuable to re-examine both electronic and non-electronic information sources utilised by professionals to update their knowledge.

Professions have distinctive knowledge bases and so information sources are specific to the professional group. This is apparent as core journals have been identified for many professional groups including, nursing (Allen, Jacobs, & Levy, 2006; Cull, 2003; Oermann et al., 2008), medicine (Haug, 1997; Schoonbert, 2004), physiotherapy (Bohannon, 1999; Maher, Moseley, Sherrington, & Herbert, 2001) and podiatry (Menz, 2002). To examine professional knowledge updating activity, a profession must therefore be identified as a focus for the study. The following section introduces professionals as subjects of activity and then examines the MRS profession – the focus for this study.

2.4.3 Professionals as subjects of knowledge updating activity

People involved in a given activity are subjects in Engeström’s (2001) Activity System model. In this study, the subjects of knowledge updating activity are MRS professionals. To understand contextual factors that may influence knowledge updating by professionals, the following section introduces three commonly identified attributes of professions and the relationship to the MRS profession and knowledge updating is discussed. The three attributes are: possession of specialised body of knowledge; altruistic service; and
autonomy to regulate their practice (Eraut, 1994; Higher Education Council, 1996; Johnson, 1972; Whitcombe, 2005).

The first attribute of professionals that has significance in relation to professional knowledge updating practice is possession of a specialised body of knowledge. Professions are noted as having a specialised and unique body of knowledge (Calman, 1994; Eraut, 1994). This body of knowledge is the discipline knowledge that underpins the profession and is made available through information sources (Eraut, 1994; Higgs & Titchen, 2001). The attribute of a specialised body of knowledge has been examined for the MRS profession, with Price and Paterson (1996) and Sim (2006) concluding that it has been met. This means that the MRS profession would have specialised information sources that they utilise to update their professional knowledge, although neither Price and Paterson (1996) nor Sim (2006) identified specific information sources, such as professional relevant journals.

There is limited research identifying key journals for the MRS profession. Research from the United States has identified core journals for the American professional groups of radiologic technology, nuclear medicine and sonography (Burnham, 1997; Hill, Gustave, & Levy, 1998; Hill, Stickell, Gustave, & Levy, 2001; Walcott, 1999). These groups are the equivalent of radiography, nuclear medicine and sonography respectively within the Australian context of the MRS profession (Australian Institute of Health and Welfare, 2003). In addition, core journals have also been identified for the radiology profession (Chew, 1986). The radiology profession is comprised of specialised medical practitioners working in the field of medical radiations. Medicine underpins the knowledge base of the MRS profession (Decker & Iphofen, 2005; Larkin, 1978) and so there may be sharing of core journals across the MRS and radiology professions. Citation analysis was utilised in the studies by Burnham (1997), Walcott (1999) and Chew (1986) to identify sets of core journals. The study by Burnham (1997) identified four core journals for the MRS profession, namely Radiology, American Journal of Radiology, Journal of Nuclear Medicine and Journal of Computer Assisted
Tomography. In relation to sonography, Walcott’s (1999) study identified two core journals, namely *Journal of the American College of Cardiologists* and *Circulation*. Thus six core journals for the MRS profession were identified, four of which overlapped with the radiology profession (Chew, 1986). The observed overlap in core journals between MRS and radiology professions does reflect shared underpinning discipline knowledge from medicine. However, these reviewed studies did not identify specific nursing or physics journals, although these disciplines were also reported to underpin the knowledge base of the MRS profession (Decker & Iphofen, 2005; Larkin, 1978). Furthermore, this previous research has not identified as core journals those stemming from professional societies that represent MRS professionals. This is an important limitation of these studies as the most commonly read journals by professionals are those associated with the national professional society (Turner & Mjolne, 2001; Turner & Whitfield, 1997).

Journals originating from professional societies have been identified as key journals for MRS professionals. Hill et al. (1998, 2001) developed lists of core journal titles for a range of MRS professional groups. Their lists were developed through consultation with librarians, academics and the authors’ own personal opinion. While this methodology for identifying key journals may be considered less than robust, their lists did identify four journals associated with professional societies, namely *Radiologic Technology*, *Nuclear Medicine Technology*, *Journal of Diagnostic Medical Sonography* and *Canadian Journal of Medical Radiation Technology*. This list of professional journals does not, however, include those associated with professional societies outside of North America such as *Radiographer*, from the Australian Institute of Radiography, and *Radiography*, from the College of Radiographers, United Kingdom. In addition, core journals for radiation therapy, a recognised fourth area of specialisation within the MRS profession (Australian Institute of Health and Welfare, 2003, 2009), have not been identified in any of the reviewed studies. Studies examining core journals for the MRS profession are not inclusive of the four recognised areas of
specialisation, are over ten years old and primarily detail journals from North America. As journals are a primary tool for updating professional knowledge (Oermann et al., 2008) there is a need to extend the research in this area. In particular, to establish a contemporary list of journals, inclusive of the four recognised areas of specialisation within the Australian MRS profession, which are being utilised to update professional knowledge.

Altruistic service, a second attribute of professions (Eraut, 1994; Higher Education Council, 1996; Johnson, 1972; Whitcombe, 2005), may also influence professional knowledge updating. Altruistic service is reflected in voluntary professional updating activity. Discussing voluntary knowledge updating, Jarvis (1987) identified that nurses embodied the ideal of professionalism, as they were “keeping abreast of changes that are occurring in nursing for no other reason than a commitment to their work” (p. 51). This suggests that, regardless of whether or not they are compelled to do so, professionals would engage in activities to update their knowledge. In relation to altruistic service, Sim (2006) asserts the MRS profession does not meet this attribute as they were reluctant to engage in CPD programs. However, this appears to contradict reported levels of CPD activities undertaken by Australian MRS professionals. Brown (2000) evaluated the Australia Institute of Radiography’s pilot CPD program, reporting that the average number of CPD credits logged by MRS professionals was well in excess of the minimum requirement of credits per year. Similarly, Hopkins (2003) examined CPD activities undertaken by MRS staff in a small non-metropolitan department in New South Wales, Australia, noting that the average number of logged CPD credits over a two-year period was 36.3. Again, this exceeded the minimum requirement of 24 credits. Both Brown (2000) and Hopkins (2003) noted that all participants met or exceeded the minimum CPD requirements for the MRS profession. The core reason for introducing CPD is the need for professionals to maintain currency of their knowledge (ACT Health, 2005; Australian Institute of Radiography, 2004, 2007). While this suggests that MRS professionals (subjects) are purposefully utilising information sources such as seminars, conferences and
journals (tools) to update their professional knowledge (object), none of the reviewed studies specifically examined this core element of CPD within the MRS profession. This is an important consideration as CPD may be undertaken for other reasons (Friedman & Phillips, 2004). There is, therefore, a need to extend the research in this area to specifically examine professional knowledge updating practice within the MRS profession.

A third attribute of professions that may influence updating of knowledge undertaken by professionals is autonomy. Autonomy at the level of the profession has traditionally considered power relations of one professional occupation being subservient to another. In the health professions, this has typically focused on medical dominance over other health professions (Eraut, 1994; Etzioni, 1969; Johnson, 1972), while medical dominance has been examined in relation to the MRS profession (Lewis, 2002; Price & Paterson, 1996; Sim, 2006). However, Eraut (1994) asserts that, in relation to learning, it is the power or control that employing organisations exert over the individual that is of greater importance than interprofessional dominance issues. In noting the important role of the workplace in supporting professional learning activities, Eraut (1994) concluded “it is difficult for professionals to sustain … the continuing development of their knowledge base unless their employing organization has some genuine commitment” (p. 237). For professionals, the workplace (Eraut, 1994) and, as noted above, the profession (Australian Institute of Radiography, 2004, 2007; Hopkins, 2003) have important roles in supporting or constraining learning activity. Engeström’s (2001) Activity System model identifies three factors that afford or restrict activity. The following section introduces the factors, as they relate to professions and workplaces, and the application to knowledge updating activity is then discussed.

2.4.4 Factors influencing activity (Engeström, 2001)

The three factors that act as tensions in Engeström’s (2001) Activity System model are rules, community, and division of labour. Engeström’s (2001)
conceptual factors of community and division of labour are, in this study, limited to workplace characteristics. In the following sections, each of these factors is contextualised and applied to professional knowledge updating.

2.4.4.1 Rules

In Engeström’s (2001) Activity System model rules influence activity. Rules refer to given or negotiated guidelines, directives or regulations that influence the activity system (Engeström, 2001). For example, professional societies and governments set standards or rules for professional conduct, including standards that relate to CPD.

Membership of a professional society may act as a rule and influence professional knowledge updating activity. A feature of professions is representation by a professional organisation. While people may be members of a professional organisation for many reasons, these organisations typically set standards or rules that encourage members to continue to engage in professional learning throughout their career (Eraut, 1994; Goode, 1969; Higher Education Council, 1996). Membership of a professional society may therefore act as a rule in Engeström’s (2001) Activity System model. This suggests that professionals who choose to be members of professional organisations and adopt the norm of continued professional learning would engage in a higher level of professional updating activity than their colleagues who are not members. Whilst no study in the reviewed literature examined the influence of membership of a professional society on learning activity for the MRS profession, a study investigating the formal continuing education activities of physical therapists (Landers et al., 2005) supports the contention that membership of a professional society may influence level of knowledge updating activity. Landers et al. (2005) reported that physical therapists holding membership with their professional society engaged in 7.2 more hours per year of certified continuing education activity (35.6 hours per year) than their colleagues who were non-members (28.4
hours per year). The authors noted that a limitation of their study was it collected data only for formal learning activities.

As Landers et al. (2005) did not provide their definition of formal learning activities, it is uncertain what specific activities respondents included in their reported hours. It is likely, for example, that formal learning activities would include postgraduate study and attendance at conferences and seminars, as these are typically listed as formal learning activities in CPD policies (Alsop, 2004; American Society of Radiologic Technologists, 2006; Australian Institute of Radiography, 2007). In contrast, learning activities such as reading professional literature in journals and books and updating knowledge through the Internet are commonly categorised as informal learning activities within CPD policies (Alsop, 2004; American Registry of Radiologic Technologists, 2006; Australian Institute of Radiography, 2007). It is, therefore, unlikely that these types of informal learning activities were included in the data collected by Landers et al. (2005). This is an important consideration for this study as the most common form of learning in adulthood is informal learning (Australian Bureau of Statistics, 2007; Billett, 2001). For example, approximately three-quarters of Australians aged 25–64 years engaged in informal learning activities such as reading reference books and journals or using computers or the Internet for learning (Australian Bureau of Statistics, 2007). As this study specifically seeks to establish if voluntary membership of a professional society (considered in this research as a rule in Engeström’s (2001) Activity System model) influences the level of use of a broad range of information sources that span formal (e.g., conference attendance) and informal (reading journals and web pages) learning activities, it should address the recognised deficit in empirical research examining the influence of membership of professional society on level of informal professional learning activity as identified by Landers et al. (2005).

Enrolment in a CPD program may act as a rule and influence professional knowledge updating activity. The introduction of CPD standards by
professional societies and governments formalises the requirement of professionals to maintain currency of their professional knowledge, and so acts as a rule in Engeström’s (2001) Activity System model. This is evident across policy documents from professions and governments in Australia and internationally where the core reason articulated for introducing CPD is the need to keep knowledge up to date (ACT Health, 2005; American Society of Radiologic Technologists, 2006; Australian Institute of Radiography, 2004, 2007). Landers et al. (2005) compared the total number of hours engaged in formal continuing education activities by physical therapists residing in states with and without mandatory CPD requirements in the United States. The authors reported that physical therapists in states with mandatory CPD requirements engaged in 5.3 more hours per year of continuing education activity than their colleagues who resided in states without mandatory CPD requirements. As previously noted, the Landers et al. study examined only formal learning activities. As informal learning activities are a significant component of learning in adulthood (Australian Bureau of Statistics, 2007; Billett, 1995; Watson, 1999) there is need for further research to examine the influence of CPD enrolment on informal learning activity, such as using books, journals and the Internet to update professional knowledge. This study should therefore address this area of needed research.

To summarise, under the conceptual framework of rules in Engeström’s (2001) Activity System model, two profile characteristics of professionals, namely membership of a professional society and enrolment in a CPD program, have been identified as potentially influencing professional knowledge updating activity. The current research should add to the developing body of literature by examining if a relationship exists between membership of a professional society and enrolment in a CPD program, on level of use of multiple information sources for learning activity. More specifically, this study should provide an initial dataset for the MRS profession on factors influencing professional knowledge updating activity.
In the Activity System model, focused on professional learning, the workplace can operate both as an important learning community (Engeström, 2001) and as a structure that affords or constrains the learning activity of its members (Eraut, 1994; Lave & Wenger, 1991; Senge, 1990). The following section begins by outlining the espoused role workplaces should adopt in supporting learning activity and then examines workplace factors that may influence level of professional knowledge updating activity. These identified workplace factors are then aligned to Engeström’s (2001) Activity System model of community and division of labour, representing physical profiles of workplaces and professional profiles of employees respectively.

2.4.4.2 Workplace influence in a learning activity system

The role of workplaces in influencing learning activity is an important consideration for this study. Mandatory CPD linked to registration requirements compel health professionals to maintain currency of their professional knowledge so that safe and high-quality care is delivered to all patients. MRS professionals, like many other professionals, are not self-employed but are employees of organisations (Australian Institute of Health and Welfare, 2003, 2009). Workplaces, therefore, may have an important role in influencing learning activity aimed at maintaining currency of professional knowledge.

The role of workplaces in supporting the learning of health professionals is not uniformly recognised. In the United Kingdom, the workplace is identified in federal policy documents as a structure that should support learning activity through the provision of on-site resources such as information sources, time and support (Chartered Society of Physiotherapists, 2007; Society of Radiographers, 2007). In contrast, in Australia, there is no explicit role for the workplace in supporting learning (ACT Health, 2005; Australian Institute of Radiography, 2004, 2007). This suggests that health professionals in Australia may not have the necessary learning resources and supports available to them in their workplace. Turner and Mjolne (2001)
compared the workplace provision of journals to physiotherapists in Australia and England. Their study demonstrated that the majority of English workplaces (89%, n=81) provided access to the journal of their national professional association, *CSP Physiotherapy*. In comparison only half (50%, n=41) of the surveyed Australian workplaces provided access to the journal of the Australian professional association, *Australian Journal of Physiotherapy*. Apart from university libraries, which provided access to between 5–26% of listed journals, Turner and Mjolne (2001) reported alternate sources for physiotherapists to access key journals was limited in both England and Australia. The primary alternate source of access to physiotherapy journals was through personal subscription to the journal. Alternate access, that is access that excluded workplaces and universities, varied between 0% and 13% for a given journal. Therefore, when key journals are not available in the workplace the majority of professionals do not have access to them. As identified by Nagy et al. (1991), reading of journal articles increases when journals are available in the workplace. This suggests that workplace accessibility to other types of information sources may similarly influence the level of use of these tools for learning. However, literature examining the use of information sources such as the Internet and conferences in professional learning activity has not directly examined this relationship (Bennett et al., 2004; Casebeer, Bennett, Kristofco, Carillo, & Centor, 2002; Herrington & Herrington, 2006; Jones & Lambros, 2003; Keppell et al., 2001; Marcoux et al., 2004). Research is therefore needed to examine if workplace access to primary information sources for updating professional knowledge influences their level of use (Research Question 4).

Workplaces have an important role in supporting professional knowledge updating, Engeström’s (2001) conceptual factors of *community* and *division of labour* are, in this study, limited to workplace characteristics. This approach was adopted so that the influence of physical (considered in this study as *community*) and professional profile (considered in this study as *division of labour*) workplace characteristics on the accessibility of multiple information sources that exist within and external to workplaces could be
examined (Research Question 5). It is recognised that community also extends beyond the workplace. The integration of new knowledge that is external to the workplace, or local CoP, such as new discipline knowledge made available through conferences and journals, is essential for developing best practice within organisations generally (Wenger, 1998; Wenger et al., 2002) as well as the delivery of high-quality healthcare (Magrabi, Coiera, Westbrook, Gosling, & Vickland, 2005; Tolson et al., 2005). Indeed, if the primary information sources identified in the Keppell et al. (2001) study for updating professional knowledge such as seminars and conferences are also utilised by MRS professionals, then this current study should also identify that professional knowledge updating is an activity that occurs within the local CoP of the workplace as well as externally through distributed communities of learners that exist within and across professions (Wenger et al., 2002).

The following section examines the literature pertaining to professionals, with a particular focus on Australian health professionals’ workplace access to key information sources that disseminate discipline knowledge, as well as their workplace access to the provision of time to support professional learning activity. This approach allows workplace profile characteristics, influencing professionals’ access to a range of information sources and learning supports, to be identified. The factors are then aligned to Engeström’s (2001) conceptual factors of community (Section 2.4.4.2.1) and division of labour (Section 2.4.4.2.2), and thus become variables for testing the hypotheses associated with Research Question 5.

**Workplace access to the Internet**

While the Internet offers many resources to update professional knowledge, workplace access continues to be problematic for many employees (see Section 1.2). There is a need to examine empirical studies to identify factors that influence the access of individuals to the Internet within their workplace.
Physical characteristics of the workplace are associated with variation in individuals’ access to the Internet within their workplace. Jones and Lambros (2003) surveyed the population of Australian anaesthetists to determine the level of access and use anaesthetists made of the Internet for patient care. Access to the Internet across workplaces was not uniform with anaesthetists at large teaching hospitals reporting higher levels of Internet access (85%) than their colleague’s in small private hospitals (50%). This demonstrates that, at the time of this study, workplace characteristics of health sector (public, private) and workplace type (teaching hospital, non-teaching) influence workplace access to the Internet for some Australian health professionals.

Geographic location has also been reported to influence workplace access to the Internet. A study of health professionals in Western Australia (Shaw et al., 2006) showed rural nurse practitioners reported higher levels of Internet access in their workplace (85%) than their colleagues in metropolitan locations (67%). However, this was not the case for medical practitioners, with 100% of medical practitioners in metropolitan locations reporting workplace Internet access compared to 91% of their rural colleagues. Differential access to the Internet across geographic boundaries was also identified by Taylor and Lee (2005) and Newman et al. (2009), with rural health professionals reporting lower levels of access to the Internet within their department than their metropolitan colleagues. The influence of geographic location on workplace access to the Internet continues to exist for health professionals, although none of the reviewed studies included MRS professionals. Research is needed to determine if geographic location influences MRS professionals’ workplace access to the Internet.

Workplace structures and hierarchies associated with employment role can also influence individuals’ workplace access to the Internet for Australian health professionals. Herrington and Herrington (2006) investigated the use of the Internet to meet the professional learning needs of rural and remote health and education professionals in Australia and noted that the workplace
imposed restrictions associated with an employee’s role. For example, passwords were used to limit or restrict Internet access to selected employees, such as those with management responsibilities. Lack of time to access the Internet during work hours also reduced usage of this tool for professional learning activities (Herrington & Herrington, 2006). Klotz and Reis (2005) similarly noted that employment role influenced access to electronic information, with 68% of respondents indicating that they were required to seek management approval before accessing a computer at work. The influence of employment role on workplace access to the Internet continues to exist with Eley et al. (2009) observing that lack of access to the Internet in the workplace was perceived as a greater barrier by less-senior nursing staff compared to their more-senior colleagues.

There are a number of factors that influence an individual’s access to the Internet in the workplace. Type of health profession, health sector, type of workplace, geographic location and employee role all influence Australian health professionals’ access to the Internet (Herrington & Herrington, 2006; Jones & Lambros, 2003; Klotz & Reis, 2005; Shaw et al., 2006). In addition, lack of time during work hours to engage in professional learning activity has also been reported. These findings of restricted access to the Internet for health professionals in Australian workplaces are in accord with other international studies. A recent study by O’Leary and Mhaolrunaigh (2011), examining use of information sources in Irish hospitals, reported that nurses had very limited access to information sources, with 59% of respondents either having no Internet connection at work (34%) or Internet connection available but they were not allowed to use it (25%). Other international studies have similarly noted that access to the Internet and online resources in the workplace remains problematic for some health professionals (Estabrooks, O'Leary, Ricker, & Humphrey, 2003; Gilmore, Huntington, Broadbent, Strong, & Hawkins, 2012; Gilmore et al., 2008; Wilson et al., 2001), with differential access observed to occur across geographic location (Wilson et al., 2001) and profession (Estabrooks et al., 2003; Wilson et al., 2001). Lack of time to search and read information (Gilmore et al., 2012;
Nail-Chiawetalu & Ratner, 2006) has also been reported as limiting health professionals’ access to and use of health information available through the Internet. While none of the reviewed studies included MRS professionals, three physical characteristics of workplaces, namely health sector, workplace type and geographic location, and one professional profile characteristic, workplace role, may influence MRS professionals’ access to the Internet in the workplace.

**Workplace access to journals**

Although journals are important tools for updating professional knowledge (Bennett et al., 2004; Davies, 2007; Gosling & Westbrook, 2002a) access is difficult for many health professionals. For instance, open access to key journals through the Internet does not exist for many health professionals. The Kaufman-Wills Group (2005) investigated the access of scholarly journals in medicine, science and technology (N=9285) through the Internet. Open access to journals from non-profit organisations was typically permitted 6–36 months after publication. The vast majority (94%) of for-profit journals allowed delayed access to original articles solely via subscription. These findings indicate that open access to the most recent issues of professionally relevant journals through the Internet, is unlikely to be a reality for many professionals. This is in accord with a study investigating Australian and New Zealand radiation oncologists and registrars’ attitudes to evidence-based practice. Veness et al. (2003) reported that one-third of respondents had no access to journals through the Internet. This suggests that access to needed electronic journals for this professional group is subscription based. However, as noted by Cole (2001), the growth in scientific knowledge and rapid increase in number of journals means that “no individual or practice could afford to subscribe to the range of journals that might be needed to keep abreast of developments” (p. 84). Indeed, Cole identifies that apart from health professionals employed in universities and teaching hospitals, a large number of professionally relevant journals will remain inaccessible to health professionals employed in other workplaces. When this concern is
compared to research examining provision of journals (Turner & Mjolne, 2001), professionals in Australia and England were more likely to have access to relevant journals through their workplace than they were through university libraries. This highlights the important role that workplaces have in providing relevant journals to health professionals and, therefore, factors influencing access to journals in the workplace must be established.

Employment sector and area of specialisation of the health professional has been shown to influence workplace access to journals. McClusky (2003), in a small study of Australian occupational therapists, identified that access to journal articles varied according to sector of employment. More professionals employed in the private sector reported difficulty in accessing journal articles (75%) than their colleagues employed in the public sector (33%). Bawden and Robinson (1997) examined the use of information sources and information services by nurses working in specialist areas. This research reported that access to relevant journal titles varied according to the area of specialisation of the nurse with some specialisations not having key journals available to them through hospital libraries. Similarly, in Australia many health professionals reported that the government Health Information Portal did not contain key journals relevant to their profession (Gosling & Westbrook, 2002b). Access to key journals in the workplace appears difficult for many individuals. However, as these studies are over ten years old, it is unknown if access to journals within workplaces continues to be problematic.

Though it may appear reasonable to assume that professionals in the 21st century have access to the journals that disseminate new knowledge in their discipline area, empirical studies have demonstrated that this is not the case for many health professionals. It has been identified that many journals specialising in medicine, technology and science are not freely available through the Internet. It is, therefore, likely that for many health professionals they will not have access to the many subscription-based journals associated with their discipline. Whilst professional sub-specialisation was shown to
influence nurses’ access to relevant journals in the United Kingdom, the influence of professional sub-specialisation on Australian health professionals’ access to relevant journals has not been established. As the MRS profession has four distinct areas of specialisation (Australian Institute of Health and Welfare, 2003), this current research should contribute to the developing body of literature by examining the influence of area of specialisation within a profession on workplace accessibility to a range of information sources, including journals, within the Australian context.

It is also evident that fewer factors have been identified as influencing health professionals’ workplace access to journals than factors influencing their access to the Internet. This finding may reflect that journals are more accessible to health professionals in their workplace or the paucity of research in this area may reflect that less is understood about health professionals’ access to journals, an information source widely considered as fundamental in the process of communicating new research within professions. Further research is needed to establish factors that influence access to journals in the workplace.

Workplace support to attend conferences

Even though conferences are important tools for updating professional knowledge (Alsop, 2004; Eraut, 1994; Hegney et al., 2010; Keppell et al., 2001), access appears problematic for many health professionals. Factors that may influence conference attendance by professionals have been identified. Palarm, Jones and Gilchrist (2001) examined CPD in southeastern region of the United Kingdom and identified that one-third of radiographers (35%) employed part time attend conferences to update their knowledge compared to 56% of their peers in full-time employment. Palarm et al. concluded that either part-time radiographers do not take advantage of CPD opportunities available to them “or these opportunities do not exist” (p. 52). As no further analyses were reported, it is not known whether
radiographers employed part time were afforded the same degree of financial and time support to attend conferences as their full-time colleagues.

Workplaces can support their employees to maintain currency of their knowledge by providing financial support to attend CPD activities such as conferences. Henwood and Huggett (1999), in a small study of radiographers in the United Kingdom, examined CPD funding provided to radiographers. Whilst funding for specific CPD activities such as conference attendance were not identified in the study, CPD funding available to staff was reported to vary across clinical sites. No further description identifying which workplace characteristics were associated with increased or decreased funding was provided in the study. Further research is, therefore, needed to establish the factors that influence access to conferences for health professionals.

Government initiatives may also influence workplace support for learning. For example, the Strengthening Cancer Care Initiative, was a multi-pronged Australian Federal Government initiative that provided funding to reduce staff shortages, extend cancer services to regional areas and improve professional development for cancer health workers (Australian Federal Government, 2005). This initiative aimed to provide professionals, such as medical practitioners, nurses and medical radiation science practitioners working in cancer care such as those specialising in radiation therapy, improved support structures that provide greater access to resources, such as information sources and time and financial support to engage in learning activities. Support for professional learning may vary across area of specialisation, such that MRS professionals specialising in radiation therapy have improved access to information sources, including financial support to attend conferences and time for professional learning, than their colleagues specialising in nuclear medicine, radiography and sonography. Further research is needed to establish if financial and time support for learning varies across the MRS professions.
Employment fraction and area of specialisation have been identified as factors potentially influencing workplace accessibility of conferences to MRS professionals. Further research is needed to establish if these factors do influence access to conferences. In addition, it has not been established if other factors, such as workplace type, employment sector, and workplace role that have been shown to influence health professionals’ access to the Internet and journals, also influence their access to conferences.

**Workplace access to ‘protected time’**

Although the provision of dedicated time to employees is recognised as an essential aspect of workplace learning (Beckett, 1999), the adoption of this practice is not universal across workplaces. As noted earlier in this section, federal CPD policies from the United Kingdom specifically identify that employers should provide ‘protected time’ to professionals so they can engage in learning activities, such as updating their knowledge. In a study examining Australian and New Zealand radiation oncologists and registrars, views of evidence-based medicine, Veness (2001) identified that 58.1% of respondents were provided with ‘protected time’ for reading, research or study by their employing organisation. It is evident from this study that a large proportion (41.9%) of radiation oncologists have not been provided with ‘protected time’. Whilst this suggests workplace factors influence the provision of ‘protected time’ for learning, no further analysis was reported in this study. There is, therefore, a need to examine factors that influence workplace provision of time to professionals in Australia.

This review of the literature identifies that there is a disparate body of knowledge on factors influencing the workplace accessibility of information sources and supports to health professionals generally and, more specifically, to MRS professionals. Studies to date have typically examined access to a single information source. This is problematic, as professionals utilise a suite of information sources to update their professional knowledge.
This current research seeks to complement and build upon these studies by collecting data on multiple information sources and learning supports adopted by professionals to update professional knowledge. This study also seeks to provide a detailed analysis of factors influencing workplace access to multiple information sources and learning supports available to today’s health professionals. From the reviewed literature a number of factors have been identified that are reported to influence workplace access to one or more information sources or learning support. The following section aligns these factors with the two remaining conceptual factors that influence Engeström’s (2001) Activity System model, namely community and division of labour. These factors become variables for testing the hypotheses (H5–11) associated with Research Question 5.

2.4.4.2.1 Community of the workplace

Workplaces are an example of community where learning occurs (Engeström, 2001). While workplaces are the primary local CoP (Wenger, 1998; Wenger et al., 2002), health professionals can and do interact with other learners, both inside and outside of their workplace. For example, when the object of activity is decision making (O’Leary & Mhaolrunaigh, 2011) or problem solving (Creswick et al., 2009) health professionals place a high reliance on their own professional knowledge and that of peers in their own professional group within the workplace. When the object of activity is updating professional knowledge, Keppell et al. (2001) identified seminars, conferences, books and journals as primary tools. This means that when updating knowledge health professionals may engage in learning within the workplace, such as read a book or attend a workplace seminar. They may also engage in learning with others external to their workplace, such as at a seminar or conference run by their professional society. In doing so they participate in the distributed learning communities that exist within and across professions (Wenger et al., 2002). The selection of primary tools by MRS professionals to update their knowledge, addressed in Research Question 1
in this study, should identify if MRS professionals are engaging in distributed learning communities external to their workplace.

Workplaces can influence the level of learning activity through the degree of access to information sources and learning supports they provide (Eraut, 1994; Lave & Wenger, 1991; Senge, 1990). This includes access to the Internet and online health and medical databases in the workplace, so that health professionals can access new knowledge and integrate it into their professional practice. Workplaces can also support health professionals updating their knowledge by providing financial and time support to attend conferences that occur external to the workplace. For the purpose of this study, where Research Question 5 examines workplace access to information sources, community is limited to and represented by physical profiles of workplaces. Empirical research from the previously presented literature investigating workplace access to information sources and learning supports was utilised to identify physical profile characteristics shown to influence workplace access to one or more information sources or learning support. Four physical profiles were identified: workplace context; workplace type; health sector; and geographic location. These workplace profiles serve two functions. First, they allow comparison of access to a given information source to be made across workplaces. Second, they provide a useful framework for determining if the particular profile has been utilised to investigate access to more than one information source. Each workplace physical profile is addressed in the following section.

**Workplace context**

Descriptive analysis has shown that workplace context of university or clinical setting affects access to journals. Clinical workplaces provide professionals with higher levels of access to professional journals than university libraries (Turner & Mjolne, 2001). However, the influence of workplace context on access to other information sources, such as the Internet, health and medical databases and conferences, and learning supports such as ‘time for learning’
has not been determined. In this study, workplace context becomes a variable under community in Engeström's (2001) Activity System model, and its influence on access in the workplace to primary tools for updating professional knowledge is tested (Research Question 5, H5).

**Health sector**

Health sector has been shown to influence professionals’ workplace access to journals and the Internet. Professionals employed in the public sector report greater access to these information sources than their colleagues employed in the private sector (Jones & Lambros, 2003; McClusky, 2003). The influence of health sector on professionals’ access to other information sources, such as seminars, conferences, health and medical databases that are utilised for learning, has not been established. In this study, health sector becomes a variable under community in Engeström’s (2001) Activity System model, and its influence on workplace access to primary tools for updating professional knowledge in the workplace is tested (Research Question 5, H6).

**Geographic location**

Whilst geographic location has been shown to influence workplace access to the Internet, the results have not been consistent. For some professionals, such as medical practitioners and occupational therapists, higher levels of workplace access to the Internet exists for those employed in metropolitan locations (Shaw et al., 2006; Taylor & Lee, 2005); for others, such as nurses, (Shaw et al., 2006) this was not the case. This observed variation in workplace access to the Internet across professions demonstrates the need for each profession to investigate access to the Internet across geographic location. In addition, the influence of workplace geographic location on access to other information sources, such as the journals, health and medical databases and conferences, and learning supports such as ‘time for learning’ has not been ascertained. In this study, geographic location becomes a
variable under *community* in Engeström’s (2001) Activity System model, and its influence on access in the workplace to primary tools is tested (Research Question 5, H7).

**Workplace type**

Access to the Internet is influenced by workplace type. Jones and Lambros (2003) demonstrated that variation in access to the Internet occurred across teaching and non-teaching hospitals. Professionals employed in teaching hospitals reported higher levels of workplace access to the Internet than their colleagues in other workplaces. Although Cole (2001) suggests that professionals employed in teaching hospitals have higher levels of access to journals than their colleagues in clinics, the influence of workplace type on access to information sources such as health and medical databases, seminars and conferences has not been established. In this study, workplace type becomes a variable under *community* in Engeström’s (2001) Activity System model, and its influence on access in the workplace to primary tools is tested (Research Question 5, H8).

For the purpose of this study, *community* was focused on the workplace and represented by four physical profiles of workplaces: workplace context, health sector, workplace type and geographic location. Each physical profile has been shown to influence workplace access to an information source. It has also been established that each identified physical profile has not been utilised to investigate access across multiple information sources. This presents the need for further research to investigate the influence of these four physical profiles on access to the multiple information sources utilised by professionals to update their knowledge. MRS professionals are employed within workplaces that span the four physical profiles identified as influencing workplace access to information sources. This study allows a more detailed understanding to be developed of the influence of the four physical profile characteristics on workplace access to a range of information sources that
are utilised by health professionals as cognitive tools to update their knowledge.

2.4.4.2.2 Division of labour in the workplace

Division of labour refers to the social reality of participants in the activity system, with hierarchies of power creating different positions for different participants within the system (Engeström, 2001). Hierarchical structures within organisations were noted by Senge (1990) to influence access to learning resources within workplaces, with those in managerial positions having greater access than their less-senior colleagues. Similarly, Lave and Wenger (1991) posit that problems of power within workplaces can influence learners’ access to learning opportunities and information. Fenwick (2001) adds that inequities to learning opportunities and resources that exist within the workplace often lie hidden. There is a need to investigate factors that exist within workplaces so that inequities that exist can be exposed and addressed. For the purpose of this study, the division of labour is represented by professional profiles that exist within workplaces. Empirical research from the previously presented literature investigating workplace access to information sources was utilised to identify professional profile characteristics shown to influence workplace access to one or more information sources. Three professional profiles were identified: area of specialisation; workplace role; and employment fraction. Identification of these professional profiles serve two functions. First, they allow comparison of access to a given information source to be made within current workplace structures, to investigate if inequities exist. Second, they provide a useful framework for determining if the particular profile has been utilised to investigate access to more than one information source. Each workplace professional profile is addressed in the following section.
Area of specialisation

Workplace access to journals is influenced by area of specialisation of the professional. Research conducted by Bawden and Robinson (1997) demonstrated that access to relevant journal titles varied according to the area of specialisation, with some specialisations not having key journals available to them in their workplace. The MRS profession has four distinct areas of specialisation (Australian Institute of Health and Welfare, 2003, 2009) and so research is needed to investigate if area of specialisation influences workplace access to journals within the MRS profession. The influence of area of specialisation on access to other information sources, such as the Internet, health and medical databases and conferences within the MRS profession or health professions more generally, has not been determined. In this study, area of specialisation becomes a variable under division of labour in Engeström’s (2001) Activity System model, and its influence on access in the workplace to primary tools is tested (Research Question 5, H9).

Workplace role

Workplace role influences access to the Internet in the workplace. Studies by Klotz and Reis (2005) and Herrington and Herrington (2006) demonstrated that whilst Internet access was physically available in the workplace, passwords were used to restrict access to the staff in management roles. The influence of workplace role on access to the Internet within the MRS profession has not been established. In addition, the influence of workplace role on access to other information sources, such as journals, health and medical databases and conferences within the MRS profession or health professions more generally, needs to be established. In this study, workplace role becomes a variable under division of labour in Engeström’s (2001) Activity System model, and its influence on access in the workplace to primary tools is tested (Research Question 5, H10).
Employment fraction

Employment fraction may influence access to support to attend conferences within the MRS profession. Palarm et al. (2001) identified that fewer radiographers employed part-time attended conferences than their peers in full-time employment and questioned whether part-time radiographers are afforded the same opportunities to attend conferences as their full-time colleagues. Research is needed to investigate if employment fraction does influence access to conferences within the MRS profession. Furthermore, the influence of employment fraction on access to other information sources, such as journals, needs to be ascertained within the MRS profession and for health professions more generally. In this study, employment fraction becomes a variable under division of labour in Engeström’s (2001) Activity System model, and its influence on access in the workplace to primary tools is tested (Research Question 5, H11).

Empirical research was used to identify workplace professional profiles for division of labour that have been shown to influence workplace access to one or more information sources or learning support. Three workplace professional profiles were identified: area of specialisation; workplace role; and employment fraction (full time, part time). These three profiles exist within the MRS profession. This study allows a more detailed understanding to be developed of the influence of three professional profile characteristics on workplace access to a range of information sources that are utilised by health professionals to update their knowledge.

2.5 Summary

Updating knowledge is an essential activity for professionals. To do this they need access to information sources that disseminate new knowledge, including conferences, journals and the Internet. The typical professional is an employee (Dubin, 1990; Eraut, 1994) and the employing organisation has an important role to play in supporting their learning. It has been identified
through this review of the literature that workplace access to professionally relevant information sources is not uniform across or within workplaces, although all employed professionals face the same imperative to update knowledge. Whilst the reviewed research does identify a range of workplace profile factors (e.g., health sector, workplace type, geographic location) that influence professionals' workplace access to the Internet, which is one information source utilised to update knowledge, factors influencing access to other information sources are less well understood.

The information environment for professionals is complex with multiple information sources utilised to update professional knowledge. As demonstrated in the reviewed literature, studies examining professionals’ access to information are typically restricted to examining a single information source, such as the Internet. Thus, to develop a more detailed understanding of professional knowledge updating, it is necessary to examine multiple information sources available to today’s professional.

In addition, Selwyn et al. (2006) identified that studies examining access to the Internet typically are restricted to assessing physical access to the technological tool. Physical access, they argue, is a limited measure, being a dichotomous scale of either having or not having access to the technology. Selwyn et al. (2006) argue it is “an individual’s ‘perceived’ (or effective) access in practice” (p. 22) that is more important. Organisationally imposed Internet access restrictions, such as the practice of having to obtain management permission to access the Internet, as identified in the study by Klotz and Reis (2005), provide a good example of where a dichotomous measure of physical access to the Internet in the workplace is meaningless if individuals were not afforded management approval to be able to use it. Fidel and Green (2004), also differentiate between physical access to an information source and an individual’s perceived access to the information source, identifying that access to an information source can be measured in terms of an individual’s ‘physical proximity’ and ‘ease of access’ to the information source (Fidel & Green, 2004). Ease of access to an information
source, such as the Internet, within a workplace would, therefore, appear to have merit in providing a measure of an individual’s effective access to information sources in practice, although this form of measure does not appear to have been utilised in the prior studies reviewed here. Thus, if the Internet is available in the workplace but access is restricted to managers (Herrington & Herrington, 2006; Klotz & Reis, 2005), then it appears reasonable to suggest that managers rating of their ease of access would be higher than that of their subordinates. Using multiple measures of access, which include physical access and ease of access, would, therefore, be a useful feature for research examining workplace access to information sources.

Furthermore, professions are recognised to have their own unique knowledge base, therefore, to update knowledge, professionals must have access to information sources that disseminate new knowledge in their ‘unique’ discipline area. Each profession must identify what are professionally relevant information sources to that profession. In today’s society, knowledge is rapidly changing, and so maintaining currency of knowledge is an essential aspect of practice for professionals. The importance attributed to updating knowledge is clearly demonstrated by the introduction of mandatory CPD requirements by government regulatory authorities and professional societies. In professions with mandatory CPD requirements, knowledge updating is expected of all members of the profession regardless of their geographic location, workplace type, sector of employment or employment fraction. It is, therefore, important to examine professional knowledge updating and establish factors influencing level of learning activity within the system for each profession.

The specific methodologies utilised in this study are discussed in Chapter 3.
CHAPTER 3 – RESEARCH METHODOLOGY

This chapter outlines the research methodology, its purpose, design and implementation employed in this study. The chapter is divided into four main sections. First, a discussion of the two-phase exploratory sequential mixed methods research design and its appropriateness for this study is outlined. Next, the methods utilised in this study are discussed in detail, including the issues associated with research quality and the practices utilised in this study to address the quality of the methods employed. This is followed by a discussion of ethical considerations relevant to methodical approaches. The final section of Chapter 3 discusses the methodological limitations of this study.

3.1 Introduction

This study adopted a mixed methods research design, purposefully utilising qualitative and quantitative methodologies to address the research questions. The strength of the mixed methods approach combines the detailed contextualised information from a small number of participants using qualitative techniques, with the population representation possible through large sample size methodology from quantitative techniques (Greene, 2007; Teddlie & Tashakkori, 2009).

A two-phase sequential exploratory design was adopted for this study. This research design typically collects and analyses qualitative data (Phase 1), which is then used to explicitly inform the quantitative phase (Phase 2) of data collection and analysis (Creswell, Plano Clark, Gutmann, & Hanson, 2003; Tashakkori & Teddlie, 2009). Such a design is appropriate when the intent of the research is to first explore the problem under study and then investigate the problem with a large sample size (Creswell et al., 2003). As discussed in Chapter 2, utilisation of information sources is contextually
bound to the activity and the professional group. This study first used qualitative methods to collect detailed contextualised data from a small sample (N=28). This detailed data was then used to explicitly inform the second, quantitative, phase of data collection and analysis. Quantitative methods supported studying a larger sample of MRS professionals (N=362) and testing the hypotheses in terms of the factors influencing knowledge updating activity.

A diagrammatic representation of the two-phase sequential exploratory design utilised in this study is shown in Figure 3.1. A detailed description of methodology for Phase 1 and Phase 2 is provided in later sections.

![Diagram](image)

**Figure 3.1: Diagrammatic representation of two-phase sequential exploratory design adopted for this study and associated data sources.**

The approach utilised in this study of collecting data from different sources and drawing on different research methods enhances the research by providing a more detailed understanding of a complex phenomenon (Greene, 2007; Plano Clark & Creswell, 2008), in this case, professional knowledge updating practice. This study acknowledged and incorporated complexity by
examining concurrently the use of multiple mediating tools (e.g., Internet, journals, conferences), utilised multiple measures of accessibility of information sources and examined the influence of multiple factors (e.g., characteristics of the workplace, such as health sector, geographic location, workplace type) on accessibility of these mediating tools to MRS professionals. The examined research questions, hypotheses and data sources used to address each question are presented in Table. 3.1.
<table>
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<tr>
<th>Research questions</th>
<th>Operationalised research questions and null hypotheses</th>
<th>Data sources</th>
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| 1. What information sources do MRS professionals use as tools to update their professional knowledge? And why are they used? | 1a What information sources are utilised as mediating tools in professional knowledge updating activity?  
1b How frequently are these tools used?  
1c What value is attributed to these tools? | Semi-structured interviews (N=28)  
Survey (N=362)  
Review of government health information portals (N=3) |
| 2. What areas of knowledge do MRS professionals update? | 2 What areas of knowledge are updated? | Semi-structured interviews (N=28)  
Survey (N=362) |
| 3. What factors associated with professions influence level of use of mediating tools? | H1 Level of use of mediating tools in professional knowledge updating activity will be no different for membership of a professional society.  
H2 Level of use of mediating tools in professional knowledge updating activity will be no different for enrolment in a CPD program. | Survey (N=362) |
| 4. Does workplace accessibility of mediating tools influence their use in updating professional knowledge? | H3 Level of use of mediating tools in professional knowledge updating activity will be no different for physical access to these tools in the workplace.  
H4 Level of use of mediating tools in professional knowledge updating activity will be no different for effective access to these tools in the workplace. | Survey (N=362) |
| 5. What factors influence workplace access to mediating tools in professional knowledge updating activity? And do hierarchies of access to these tools exist across workplaces? | H5 Workplace accessibility of mediating tools will be no different for workplace profile, work context (university, clinical).  
H6 Workplace accessibility of mediating tools will be no different for clinical workplace profile, health sector (public, private).  
H7 Workplace accessibility of mediating tools will be no different for clinical workplace profile, geographic location (metropolitan, regional and rural and remote).  
H8 Workplace accessibility of mediating tools will be no different for clinical workplace profile, workplace type (teaching hospital, non-teaching hospital, clinic).  
H9 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, area of specialisation (nuclear medicine, radiation therapy, radiography, sonography).  
H10 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, employment role (manager, senior practitioner, practitioner, clinical educator).  
H11 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, employment fraction (full time, part time). | Survey (N=362) |
Research Question 1 – What information sources do MRS professionals use as tools to update their professional knowledge? And why are they used?

This question sought to provide a descriptive analysis of information sources adopted by MRS professionals to update their professional knowledge. The collected data was then used to construct the tools component of the descriptive model of professional knowledge updating within the MRS profession.

Research Question 2 – What areas of knowledge do MRS professionals update?

This question sought to provide a descriptive analysis of areas of knowledge that are updated by MRS professionals. The collected data was then used to construct the object component of the descriptive model of professional knowledge updating within the MRS profession.

Together Research Questions 1 and 2 provide an initial dataset to the Australian and international MRS profession on professional knowledge updating practice. The collected data is then used to construct the upper sub-triangle of mediated learning in Engeström’s (2001) Activity System model, in this case professional knowledge updating.

Research Question 3 – What factors associated with professions influence level of use of mediating tools?

This question sought to determine factors influencing professional knowledge updating activity system. The factors examined were derived from Engeström’s Activity System model (2001), which hypothesises that rules influence activity. Two voluntary professional activities, namely membership of a professional society (H1) and enrolment in a CPD program (H2) were hypothesised as rules that influence professional knowledge updating activity system.
Research Question 4 – **Does workplace accessibility of mediating tools influence their use in updating professional knowledge?**

This question sought to determine if workplace accessibility of mediating tools influences level of use of these tools in professional knowledge updating activity. Workplace accessibility was selected for study as the workplace is recognised both as an important learning community (Billett, 1999; Boud & Garrick, 1999; Bruce, 1999; Eraut, 1994; Lave & Wenger, 1991; Schön, 1991; Senge, 1990) and one that may afford or constrain learning activity by the access it provides to learning tools and supports (Eraut, 1994; Lave & Wenger, 1991; Senge, 1990).

Research Question 5 – **What factors influence workplace access to mediating tools in professional knowledge updating activity?**

This question builds from Research Question 4 by investigating factors that may influence workplace accessibility of mediating tools in professional knowledge updating activity system. The factors examined were derived from Engeström’s Activity System model (2001) – *community* and *division of labour*. The factors of community and division of labour were focused at the workplace. Community was represented by four physical profile characteristics of workplaces that were hypothesised to influence workplace accessibility of mediating tools: work context (H5), health sector (H6), geographic location (H7) and workplace type (H8). Division of labour was represented by three professional profile characteristics of employees hypothesised to influence workplace accessibility of mediating tools: area of specialisation (H9), employment role (H10) and employment fraction (H11).

The following section addresses the specific methodologies utilised in this study to address the operationalised research questions.

Together Research Questions 3 through to 5 provide an initial dataset to the Australian and international MRS profession on factors influencing professional knowledge updating practice. The collected data was then used to construct the lower section of Engeström’s (2001) Activity System model, in this case factors influencing professional knowledge updating practice.
3.2 Methods

This section begins with a discussion of issues influencing the quality of research. The second and third sections describe the methods utilised in this study for data collection and data analysis in Phase 1 and Phase 2, respectively. Incorporated within each method section is a detailed description of practices utilised in this study to enhance the quality of the research. The final section discusses the ethical considerations for research involving humans.

3.2.1 Enhancing quality of research study data

Careful consideration to the design of the study can enhance the quality of the research so that confidence can be placed in the findings. In mixed method studies, the researcher must consider and evaluate data quality for both quantitative and qualitative approaches utilised (Creswell & Plano Clark, 2007; Teddlie & Tashakkori, 2009). Standards can be broadly categorised under reliability, validity and generalisability of research study data (Creswell, 2009b; Mertens, 1998). This section outlines how each standard – reliability, validity and generalisability – was addressed in this study to ensure quality and maximise confidence in the research findings.

Reliability

Reliability is concerned with consistency or dependability of the data (Hunter & Brewer, 2003; Mertens, 1998) and considers whether results vary because of the measurement process or measurement instrument (Neuman, 2003).

Stability reliability considers the consistency or dependability of the data across time (Neuman, 2003). The use of an interview guide is recommended to reduce variation in interview technique over time (Mertens, 1998; Neuman,
2003), thereby enhancing stability reliability of the study (Neuman, 2003). An interview guide was utilised in Phase 1 semi-structured interviews to enhance reliability in this study.

*Equivalence reliability* is concerned with reliability across indicators. Pilot testing of survey instruments should be undertaken to reduce ambiguity with questions and response categories (de Leeuw, Hox, & Dillman, 2008; Fowler & Cosenza, 2008; Neuman, 2003) to improve their reliability. The survey instrument utilised in Phase 2 of this study was piloted. Coding error is a recognised issue influencing equivalence reliability in qualitative method (Creswell, 2009b; Creswell & Plano Clark, 2007). Two sources of error that may diminish the reliability of coding utilised in qualitative data analysis are intra-coder and inter-coder error (Creswell, 2009b). Hence, an assessment of intra-coder and inter-coder reliability of Phase 1 semi-structured interview data was undertaken to ensure the quality of the coding data.

**Validity**

Validity examines the extent to which you have measured what you intended to measure (Mertens, 1998; Singleton & Straits, 2005). There are multiple measures of validity, including construct, face, descriptive and external validity (Cohen, Manion, & Morrison, 2000; Neuman, 2003; Teddlie & Tashakkori, 2009).

*Construct validity* is concerned with how well the data collection instruments measure the intended concepts for the study (Cohen et al., 2000; de Leeuw et al., 2008; Singleton & Straits, 2005). Contextual relevance is an important component of construct validity and it is strengthened when the content of a survey instrument is developed from interview data with members of the population under study (Mertens, 1998). This approach was adopted in this study. The survey instrument utilised in Phase 2 of this study was explicitly informed by Phase 1 semi-structured interviews. Contextual relevance of the instrument was enhanced. As an example, Phase 1 interview data identified
a broader range of journals, including discipline specific journals, as being read by MRS professionals, than had previously been identified in the published literature. This is discussed in Section 4.2.1.

*Face validity* is a judgement made by others of whether ‘on the face of it’ a survey instrument measures the underpinning content areas (Neuman, 2003; Warner, 2008). Validity of the survey instrument should be assessed by members of the population for whom the questionnaire is intended (Campanelli, 2008). Pilot testing of the survey instrument used in this study (Phase 2) was undertaken with MRS professionals and the feedback obtained used to improve content coverage.

*Descriptive validity* refers to the factual accuracy of the account (Maxwell, 2002). Descriptive validity in qualitative method is enhanced by checking the accuracy of the transcription records against the original recording of the interview (Creswell, 2009b; Mertens, 1998). Allowing respondent quotations to be easily traced to their original source enables them to be reviewed in context for meaning (Guba & Lincoln, 1989). Descriptive validity of quantitative data may be assessed by checking the level of accuracy of data entry into computer programs and correcting any errors (Neuman, 2003; Warner, 2008). These conventions for enhancing descriptive validity of qualitative and quantitative data were also adopted in this study.

**Generalisability**

Generalisability, or external validity, refers to the extent to which findings from the sample in the study can be applied to the broader population (Henry, 2009; Mertens, 1998). Probability sampling must be utilised in a study when the goal of the research is to make inferences to the broader population under study (Henry, 2009; Neuman, 2003). This study implemented a random sampling method for selection of survey participants. Two important components of sampling must be considered when assessing
whether it is reasonable to generalise results from a sample to the larger population – sample size and sample coverage (Creswell, 2009a; de Leeuw et al., 2008). The survey sampling frame and data regarding representativeness of the Australian population of MRS professionals are presented in Phase 2 data collection (3.2.3.2) section.

3.2.2 Phase 1

3.2.2.1 Overview
As previously noted, this study adopted a two-phase sequential exploratory design with qualitative data collected in Phase 1 being utilised to inform Phase 2 data collection (Creswell et al., 2003; Greene & Caracelli, 1997; Tashakkori & Teddlie, 2009). This section provides the rationale and data collection and analysis methods utilised in Phase 1 of this study.

3.2.2.2 Data collection

Purposeful sampling

This study utilised a purposeful sampling technique for Phase 1. Purposeful sampling allows the researcher to “learn a great deal about issues of central importance to the purpose of the research” (Patton, 2002, p. 46). In this study, stratified purposive sampling was used to include participants from multiple sub-groups of interest as reflected in the selection criteria (Mertens, 1998; Patton, 2002).

The selection criteria used in the recruitment of Phase1 participants was:

1. Expert knowledge: As little was known in this topic area in relation to the MRS profession, academics and senior/managerial clinical MRS professionals were purposefully selected as having expert knowledge relating to the practices of the profession (Mertens, 1998; Miles & Huberman, 1994).
2. *Area of specialisation*: The reviewed literature suggested that there were issues of relevance of information sources related to the area of sub-specialisation within a profession. To examine the potential for major variation across the MRS profession, participants were purposefully selected from each of the four recognised areas of sub-specialisation, namely nuclear medicine, radiation therapy, radiography and sonography (Australian Institute of Health and Welfare, 2003, 2009).

3. *Public/private sectors*: Australian governments are making electronic information sources available to health professionals employed in the public health sector through electronic information portals. Participants employed in clinical workplaces from both the public and private health sectors were selected to examine for variation across the MRS profession.

These selection criteria allowed the researcher to capture the diversity that exists across the MRS profession.

**Participant recruitment**

A letter of invitation to participate in the study (Appendix A), an Information Statement (Appendix B) and an Informed Consent Form (Appendix C) were sent to 16 academics with an MRS qualification listed on the eight university web sites that offer MRS programs of study. Academics interested in participating in the research were asked to return their signed Informed Consent Form. A total of 14 academics (response rate 88%) agreed to participate in the study.

At the end of the interview, academics were asked to identify MRS professionals who were employed in clinical practice and would meet the established selection criteria. This approach of utilising the knowledge of key informants to nominate other participants for inclusion in research is a well-recognised form of purposive sampling (Patton, 2002). The letter of invitation
to participate in the study (Appendix A), the Information Statement (Appendix B) and an Informed Consent Form (Appendix C) were sent to a further 14 identified expert clinical practitioners. All contacted clinical practitioners agreed to participate in the study (response rate 100%).

Key characteristics of participants are presented in Appendix D. Clinical practitioners were evenly distributed between the public (7) and private sectors (7). In addition, three academics (RA4, SA1, SA2) were also concurrently engaged in part-time clinical practice. Participants were located in a range of Australian states – Victoria (14), New South Wales (8), South Australia (3), Queensland (2) and Western Australia (1). Based on the professional profiles of participants (Appendix D), it was reasonable to assume that these participants would have a sound understanding of the issues of relevance in their area of specialisation and also, more generally, across the MRS profession. This sampling approach, therefore, allowed for contextually relevant and diverse experiences to be captured, which is a recognised strength of purposive sampling (Mertens, 1998; Patton, 2002).

**Semi-structured interviews**

A semi-structured interview guide (Appendix E) was used as a data collection tool during interviews. The interview guide questions were derived by the researcher from the literature. Such a tool is used when the topic is pre-specified and allows for a systematic coverage of topic areas across multiple participants (Patton, 2002). Furthermore, as Phase 1 data collection involved interviews with 28 MRS professionals, the use of an interview guide provided the researcher with a framework for systematically collecting data on each research question from each of the participants. The use of the interview guide reduces variation in interview technique over time, thereby enhancing stability reliability of the data collection method (Neuman, 2003).
Missing important topics can also be a limitation associated with the use of interview guides (Patton, 2002). To minimise this potential, prompts were listed for each question. In addition, the final question of the semi-structured interview was open response. Participants were asked if they thought something important concerning professional knowledge updating and accessing information sources in the workplace had not yet been covered and needed to be included in the interview. This adopted approach enhances the construct validity of this study as it allows both known (from the literature) and unknown (from the study participants) topics to emerge.

The semi-structured interviews in this study were conducted by telephone. The telephone is recognised as a cost-effective method of covering issues with a diverse group who, due to geographic distance, may not otherwise be able to contribute (Neuman, 2003). The use of telephone interviews provided flexibility as to when (e.g., at lunch time or at a non-scheduled teaching time) the interview with busy professionals would occur. Appendix F provides a detailed comparison of interview techniques. The average interview time was 40 minutes (see Appendix G for a list of the interview time per participant). Each interview was audio-recorded to capture all discussion for later transcription and review. The researcher concurrently took brief notes to allow for further probing and clarification of statements during the interview.

Verbatim transcriptions of interviews were developed from each audio recording. As the participants were busy health professionals and the content of the interviews was non-sensitive and had been recorded, the interview transcripts were not returned to participants for them to check. Each transcription was cross-checked by the researcher against the original audio recording of the interview to ensure accuracy of the transcription (Gillham, 2000) before the data was entered into NVivo 7 qualitative analysis software.
3.2.2.3 Data analysis

Prior to the codification of data, the transcripts from the semi-structured interviews were read and reread by the researcher to enhance familiarity with the content (Creswell & Plano Clark, 2007; Mertens, 1998). An analysis framework was developed through both a deductive approach (based on the literature and interview questions) and inductive technique (based on reading of the interview transcripts).

After the researcher was familiar with the content of the interviews and the analysis framework was established, the transcripts were entered into NVivo 7 to assist in the management of the raw data. Programs such as NVivo afford the researcher with the opportunity to store, analyse and retrieve qualitative data conveniently and efficiently (Bazeley, 2003). The use of a software program such as NVivo provides rapid and flexible access to respondent quotations and to easily align to their original source and to be reviewed in context. In short, programs such as NVivo offer the researcher a tool that facilitates the management, analysis and retrieval of qualitative data, enhancing factual accuracy and thus descriptive validity of the study (Maxwell, 2002).

Within NVivo, the analysis framework was structured around the primary tools for updating professional knowledge (Research Question 1). Each identified tool was established as a parent node with the relevant codes of the analysis framework linked. In order to address the potential of coding error as an issue influencing reliability of data in qualitative method, intra-coder and inter-coder reliability checks were undertaken (Creswell, 2009b). Seven randomly selected interview transcripts were processed by a second coder for consistency within the coding scheme of the analysis framework. There was 100% intra- and inter-coder agreement across the parent node of information sources (Appendix H). The level of intra- and inter-coder agreement suggests that equivalence reliability is high for the qualitative phase of the study.
Once coding reliability was established, each node was analysed to define its properties and dimensions. A questioning process was used to establish the characteristics or properties of each node category. The properties and dimensions identified from the interview analysis and the literature review were used to develop the questions and response categories for the questionnaire utilised in Phase 2.

3.2.3 Phase 2

3.2.3.1 Overview

The purpose of Phase 2 was twofold:

1. To provide a descriptive account of the use of information sources as mediating tools utilised by MRS professionals for the purpose of updating professional knowledge (Research Questions 1 and 2)

2. To investigate factors that may influence professional knowledge updating utilising Engeström’s Activity System model as a framework for analysis (Research Questions 3 through 5 and related 11 hypotheses).

The survey method was used during Phase 2. Surveys are considered an appropriate research method for collecting descriptive data and for testing differences between groups (Alreck & Settle, 2004; Creswell, 2009b; Mertens, 1998; Neuman, 2003; Steeh, 2008).

3.2.3.2 Data collection

Survey design

It was necessary to develop a purpose-fit survey instrument to account for the contextually bound mediating tools and professional updating activities of the specialist health professionals of focus in this study (Bawden & Robinson,
The instrument was developed from the reviewed literature and Phase 1 analysis. This approach was adopted to ensure a high level of contextual relevance, strengthening the construct validity of the instrument (Plano Clark & Creswell, 2008; Williams, 1997). Appendix I maps Phase 1 parent nodes against survey instrument questions.

The first 14 questions of the survey instrument (Appendix J) were designed to collect demographic information about the respondents. The demographic information included questions relating to the respondent, their professional profile and physical profile of their workplace. The response options are shown in Appendix J. The demographic data was used in two ways. First, the characteristics of the respondents were compared to the Australian population of MRS professionals for indicators of representativeness. Second, the collected demographic data allowed hypotheses associated with Research Questions 3–5 (see Table 3.1) to be tested, so that factors influencing MRS professionals’ access to and level of use of mediating tools, in this study information sources, for professional knowledge updating could be identified.

The next section of the survey instrument asked respondents to rate the relative importance of information sources for professional knowledge updating using a five-point Likert scale. The listed information sources were those nominated as used by participants in Phase 1 to update their professional knowledge (seminars, conferences, journals, books, health and medical databases, Internet). Tele- or video-conferencing and journal clubs were added to the instrument as although these were not nominated as used by Phase 1 participants, they were utilised (Bloomfield, Chan, Smith, Watson, & Soong, 2002) or being promoted within the literature as useful tools (Milinkovic et al., 2004) for MRS professionals. The data extracted in this section was used to explore Research Question 1. Ranked importance of the nominated information sources provided contemporaneous discipline-specific consideration of these tools for professional knowledge updating. Respondents were also invited to add comments in response to ‘These
are not important to me because'. This allowed additional data to be collected, providing context to the numerical score (Creswell, 2009a). For example, survey respondent 82, an MRS professional from a rural or remote location, rated the importance of seminars at the second lowest available rating of 4 and added ‘no access’.

The remainder of the survey instrument addressed workplace access to and use of information sources for professional knowledge updating (Research Questions 1–5). Physical and effective measures were utilised to examine workplace access of information sources to MRS professionals. As noted previously (Section 2.6) Selwyn et al. (2006) identified that studies examining access to electronic information sources are limited, as they utilise a single measure of physical access. The authors argued that it is the individual’s effective access in practice that is more important to measure. To address this identified limitation of other research, this study utilised both physical and effective measures of access to information sources. Most measures of physical access utilised in this study were dichotomous (Yes, No) unless multi-cohotomous, such as computers in the workplace with Internet access. The measure utilised in this study for effective access to information sources in the workplace was ease of access (Fidel & Green, 2004), with a five-point Likert scale implemented.

Measures of access to information sources generally do not lend themselves to internal consistency reliability testing. As this study utilised physical and ease of access measurements for access to the Internet in the workplace, this presented an opportunity to examine the internal reliability of these item measures. The internal consistency reliability, as measured by Cronbach alpha, between computers with Internet access in the workplace and ease of access to the Internet in the workplace, was 0.76, thus demonstrating that the two items on the instrument do provide an acceptable measure of accessibility of the Internet in the workplace.
Four questions on the survey instrument (Q31, Q35, Q36, Q37) were designed as open response. The use of open questions allows for unanticipated findings to emerge (Creswell, 2009a; Neuman, 2003). For example, in response to Q35 ‘Please comment on any issues you have with access to journals’ a range of access issues that had not been identified in Phase 1 semi-structured interviews were reported. This included: “abstract access but not full journals” (survey respondent 82), “these [journals] are in a library that is accessible one day a week” (survey respondent 128) and “rural hospital – no budget for journals” (survey respondent 200).

To provide comprehensive data multiple measures of frequency of use of information sources were utilised. These questions address Research Question 1 and provide a descriptive overview of professional knowledge updating. Data relating to frequency of use of information sources were also used to test the hypothesis related to Research Questions 3–5. In addition, Question 25 listed twelve broad categories of topic areas for knowledge updating. These listed areas were derived from Phase 1 semi-structured interviews and the literature. Question 25 sought to collect descriptive statistical data from MRS professionals, regarding the areas of knowledge that are being updated, addressing Research Question 2.

Pilot testing the survey instrument

The survey instrument was piloted with seven MRS professionals in senior or managerial roles, four of whom were Fellows of the Australian Institute of Radiography. Fellowship is the highest membership category of the Australian Institute of Radiography and demonstrates that the member has expert knowledge in their field (Australian Institute of Radiography, 2004). The initial pilot test of the survey instrument with experts ensured a high level of face validity and measurement reliability of the data collection tool (Mertens, 1998; Warner, 2008). During the pilot test, these experts were asked to comment on the clarity of the wording of questions and response items and to identify any other issues they encountered while completing the
questionnaire. Responses from the experts indicated that the instrument had a clear layout and the questions were clearly written and easily understood, suggesting that the survey would have a high level of measurement reliability (de Leeuw et al., 2008; Fowler & Cosenza, 2008; Neuman, 2003).

The seven MRS professionals involved in pilot testing the survey instrument were not involved in the Phase 1, semi-structured interviews. This approach provided another opportunity to enhance content coverage of the instrument. The experts identified a further five journals that they use to update their professional knowledge (British Journal of Oncology, Health Physics, Journal of Clinical Oncology, Pediatric Radiology, Radiation Therapist). These journal titles were added to Question 34. The confirmation of content coverage by experts involved in pilot testing the survey instrument suggests that the purposefully designed survey instrument has face validity for professional knowledge updating within the MRS profession (Neuman, 2003; Warner, 2008).

**Survey Administration**

The survey was conducted via Australia Post, as this was considered the most efficient and effective way to obtain data from the geographically dispersed professional community of interest. See Appendix F for a summary of survey administration techniques compiled by the researcher. The postal technique supported the necessary probability sampling (de Leeuw et al., 2008), as registration boards were to be drawn upon to compile the accurate and comprehensive contact list for participants necessary for probability sampling. These organisations hold accurate postal address information for the MRS professionals listed. Conversely, telephone numbers and email addresses were not consistently available through these lists.

While the option to potentially increase sample size by combining postal and Internet administration techniques was considered, there was a concern of
potential bias in results toward users familiar with and having easy access to the online environment (Alreck & Settle, 2004; Manfreda & Vehovar, 2008). Consequently, the approach of using both postal and Internet survey was not adopted in this study.

**Probability sampling**

Sample size and sample coverage are two important components of probability sampling that must be considered when assessing whether it is reasonable to generalise results from a sample to the larger population (Creswell, 2009a; de Leeuw et al., 2008; Neuman, 2003).

Yamane (1967) provides a simplified formula for determining sample size for data collection as shown in Equation 1.

\[
(n) = \frac{N}{1 + Ne^2}
\]

where 
- \(n\) is the required response sample size
- \(N\) is the total population under study
- \(e\) is the probability of error

The error (e) in the formula recognises that random sampling of a population may not represent the true characteristics of that population. An error set at, for example, 5% (e=0.05) means that on probability only 5% of the time the sample mean will differ from the true population mean (Creswell, 2009a; Mertens, 1998; Warner, 2008). Researchers typically set a small error of 4 – 6% for data collection using survey methodology (Creswell, 2009a). Applying the formula where the latest available data sets the population of Australian MRS professionals (\(N\) = 10,477 (Australian Institute of Health and Welfare, 2009) with the error set ranging from 4% (0.04) to 6% (0.06) results in a required response sample ranging from 271 to 590 as shown in Table 3.2.
TABLE 3.2

REQUIRED SAMPLE SIZE (N) AGAINST THREE LEVELS OF ERROR (E) WHEN THE TOTAL POPULATION UNDER STUDY IS 10,477

<table>
<thead>
<tr>
<th></th>
<th>e=0.04</th>
<th>e=0.05</th>
<th>e=0.06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required sample size</td>
<td>590</td>
<td>385</td>
<td>271</td>
</tr>
</tbody>
</table>

For this study, a response number or sample size from the postal questionnaire between 271 and 590 would provide a rigorous confidence level ≥ 94%. This was achieved in Phase 2 data collection, with 362 useable questionnaires returned. It is therefore reasonable to conclude that adequate sample size exists in this study to generalise results to the larger population of Australian MRS professionals.

An accurate and comprehensive list or sampling frame of the population under study is required to generalise results (de Leeuw et al., 2008; Lohr, 2008; Neuman, 2003). There were two sampling frame options to use for postal survey in this study. The first was to use lists from professional societies that represent MRS professionals. However, there is no single society representing all MRS professionals in Australia (a difficulty encountered by Sim (2000) in an investigation of lifelong learning within the MRS profession). In addition, as membership of a professional society is optional, utilising lists from professional societies was likely to introduce coverage error into the study population.

The second sampling frame, which was adopted in this study, was to draw upon the Australian state and territory Medical Radiation Technologist Boards (MRTBs) to obtain lists of MRS professionals. As registration is a legal requirement, it is reasonable to suggest that the MRTB registers would have a high degree of accuracy. The number of questionnaires returned due to incorrect mailing address was 39, representing 3.4% of the total number of questionnaires mailed. It is reasonable to suggest that the MRTB registers provided an accurate sampling frame.
**Probability sampling technique**

A systematic sampling technique was utilised in this study for the survey. Systematic sampling is a type of random sampling that is commonly used when a written list forms the sampling frame (Alreck & Settle, 2004; Mertens, 1998). In systematic sampling, researchers use a sampling interval to select cases for inclusion in the study (Mertens, 1998; Neuman, 2003). Two MRTB registration lists were utilised in this study, namely the MRTB registers from Victoria and Queensland. Registrants on the MRTB registers provide a mailing address, typically that of their workplace, which is made publicly available. In addition, to explore whether work context (academic or clinical) influenced access to mediating tools such as journals, all academics listed on the relevant university web sites were also invited to participate in the study. Financial constraints limited the total number of MRS professionals invited to participate in the Phase 2 data collected by postal survey to approximately 1100 invitations. As such, the aim of the sampling process was to select approximately 530 registrants from each MRTB register. The sampling method is shown in Table 3.3.

**Table 3.3**

**Sampling method adopted to select MRS professionals to be invited to participate in Phase 2 survey**

<table>
<thead>
<tr>
<th>Sampling frame</th>
<th>Sampling interval method</th>
<th>Number invited to participate in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRTB register of Victoria</td>
<td>Every 5\textsuperscript{th} name on the register</td>
<td>537</td>
</tr>
<tr>
<td>MRTB register of Queensland</td>
<td>Every 2\textsuperscript{nd} name on the register</td>
<td>530</td>
</tr>
<tr>
<td>Faculty web sites of the eight universities that offer MRS programmes</td>
<td>100% sample of academics listed with an MRS qualification</td>
<td>75</td>
</tr>
</tbody>
</table>
Systematic sampling may result in an unrepresentative sample. Neuman (2003) states that “in most cases, a simple random sample and a systematic sample yield virtually equivalent results” (p. 221), although he warns that if a pattern exists in the sampling frame then using systematic sampling would result in an unrepresentative sample being selected. The Victorian MRTB register listed registrants in the order they first registered with the Board and the Queensland register listed registrants alphabetically and so there appeared to be no apparent pattern to suggest that systematic sampling was an inappropriate method for this study.

**Maximising the response rate**

Multiple strategies were utilised in this study to maximise the response rate for the survey. Low response rate is a well-recognised issue with the postal survey method (Creswell, 2009a; de Leeuw, 2008), with Alreck and Settle (2004) advising that response return rates between 5% and 10% are common for postal surveys, whilst rates over 30% are rare. Sim (2000), investigating lifelong learning within the Australian MRS profession, conducted a national survey and reported a response rate of 14.5%. Given the low response rate reported in other large-scale research in this area, it was anticipated that a low response rate was likely to be of concern for this study. To address concerns regarding low response rates, several strategies are commonly adopted to encourage high return rates. Table 3.4 presents some recommended strategies to maximise response rate of postal surveys that were utilised within this study.
### Table 3.4

**ADOPTED STRATEGIES TO IMPROVE RESPONSE RATE OF POSTAL SURVEY AND UTILISATION IN THIS STUDY**

<table>
<thead>
<tr>
<th>Recommended strategy</th>
<th>Utilised in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaire sent in a hand-written envelope addressed to the individual</td>
<td>Yes</td>
</tr>
<tr>
<td>Envelope containing cover letter, questionnaire and postage paid addressed return envelope</td>
<td>Yes, envelope package also contained Information Statement (Appendix B).</td>
</tr>
<tr>
<td>Cover letter on official letterhead with signature, explaining purpose of the study and including contact details of the researcher</td>
<td>Yes (Appendix K). In addition, each cover letter included the hand-written first name of the recipient and was hand signed by the researcher</td>
</tr>
<tr>
<td>Short questionnaire of 3–4 pages</td>
<td>Yes, 4 A4 pages in length</td>
</tr>
<tr>
<td>Use a booklet format</td>
<td>Yes, questionnaire printed double sided on one sheet of A3 paper, thus ensuring individual pages could not become loose or be lost</td>
</tr>
<tr>
<td>At the bottom of questionnaire include thank you</td>
<td>Yes</td>
</tr>
<tr>
<td>Send preliminary notification and two follow-up reminder letters</td>
<td>Not employed</td>
</tr>
<tr>
<td>Include a small inducement</td>
<td>Not employed</td>
</tr>
</tbody>
</table>

It is evident from Table 3.4 that a range of recommended strategies were employed in this study to maximise the postal survey response rate. In this study, each envelope was hand written, each letter of invitation to participate in the research through postal survey included the hand-written first name of the recipient and was hand signed by the researcher. These packages were distributed between mid-April and mid-May, 2007. Financial constraints prevented the researcher from sending a follow-up notification or small inducement to participate in the survey, strategies recommended in the literature. The strategies utilised in this study (Table 3.4), while time consuming, yielded a response rate of 31.7%. The strategies adopted in this study to improve postal survey response rates resulted in a sufficiently large
sample size (N=362) with a previously noted small error (e) between 5% and 6%.

MRTBs register professionals from three of the four areas of specialisation (Australian Institute of Health and Welfare, 2003, 2009): radiation therapy, radiography and nuclear medicine. Whilst MRTBs do not register sonographers, two recognised pathways for entry into sonography postgraduate programs are undergraduate qualifications in radiography or nuclear medicine (Australian Sonographers Association, 2013). The assumption that the MRTB register would provide a representative sample of the MRS profession, including sonography, was tested by comparing demographic characteristics of survey respondents to latest available national demographic data for MRS professionals (Australian Institute of Health and Welfare, 2009). Comparison of survey respondents against national data was required as MRTBs do not register sonographers and so direct comparison of participants against MRTB registration data would not provide a valid assessment of whether the characteristics of the respondents were representative of the four areas of specialisation within medical radiations. Three indicators of the representativeness of the sample were examined – area of specialisation, gender and employment fraction. Demographic analysis for area of specialisation is displayed in Figure 3.2.
As shown in Figure 3.2, demographic data shows that each of the four areas of specialisation within the MRS profession are represented. It is also evident that the percentage of respondents from each area of specialisation in the survey are similar to national data (Australian Institute of Health and Welfare, 2009). In relation to gender, the survey response (Female 68.5%) closely approximates the Australian MRS profession of 68.4% (Australian Institute of Health and Welfare, 2009). Furthermore 70.1% (n=253) of survey respondents indicated that they were employed full time and this is in accord with national data, where 70.5% of MRS professionals reported that they worked 35 hours or more per week (Australian Institute of Health and Welfare, 2009). Demographic analysis, therefore, has provided multiple indicators that the study sample is representative of the Australian MRS population.
In conclusion, an adequately large survey sample size selected by random sampling method together with multiple indicators of population representativeness suggest that the findings from the survey (Phase 2) can be generalised to the broader population of MRS professionals.

Survey of web sites

Web site selection

As noted in the literature review (Section 2.5.2), Australian state and territory governments have developed electronic information portals for health professionals so that they can access a range of high-quality information sources to improve patient care. Three health information portals (Figure 3.1) were selected to determine which professionally relevant journals (Question 34 on the survey instrument) were listed as available through the sites. The selected portals were Clinicians Health Channel (CHC), Victorian Government, Clinicians Information Access Program (CIAP), New South Wales Government, and Clinicians Knowledge Network (CKN), Queensland Government. The CHC and CIAP provided open access to the list of journals available through the site, whereas CKN required a user login to determine the content of the resources. A one-week login for access to CKN for the purposes of the research was authorised by the Manager, Library Health Statistics Centre Queensland Health. The review of the web sites was conducted over a two-week period in July 2008 and provided a snapshot of which of the professionally relevant journals were listed as available through each site.

3.2.3.3 Data analysis

Survey data was entered and analysed using SPSS 17.0®. Prior to analysing quantitative data, the level of accuracy of data entry into SPSS 17.0® was assessed for coding error (Neuman, 2003; Tabachnick & Fidell, 2007). Warner (2008) describes two types of coding errors associated with
computer data entry – ‘impossible’ or ‘unlikely’ codes. An ‘impossible’ code is one that does not respond to any alternatives provided in a given question. Each survey instrument question was analysed for ‘impossible’ codes by obtaining a frequency distribution, which identified the number of responses against each code. If a code error was detected, the researcher reviewed the appropriate column in SPSS to identify the cell or cells with observed error(s). As each returned survey instrument was assigned a unique code number at the time of data entry into SPSS, it was possible to locate and review the original survey instrument for correct information. The data was then corrected within SPSS. Box plots on interval data were used to assess for ‘unlikely’ codes. Outliers and extreme outliers on box plots were checked to ascertain if the entered data matched the information on the returned surveys. Appendix L provides an example of such a box plot. In this case, each outlier and extreme outlier was cross-checked against the original questionnaire to confirm accuracy. These adopted processes serve to enhance the reliability of the quantitative data (Neuman, 2003; Warner, 2008). Having checked accuracy of quantitative data entry, statistical analyses may be applied.

Descriptive and inferential statistics were utilised in this study to address Research Questions 1–5.

**Descriptive statistics**

Descriptive statistics were adopted to summarise data and provide a descriptive account of professional knowledge updating, addressing Research Questions 1 and 2. Descriptive statistics typically include information on distributions, measures of central tendency and measures of variability (Alreck & Settle, 2004; Warner, 2008).

Frequency and per cent distributions were utilised in relation to Research Questions 1 and 2 (Table 3.1) to summarise MRS professionals’ use of information sources and the areas of knowledge that they update. These
distributions are the most common form of data description of individual survey items (Alreck & Settle, 2004; Orr, 1995). In addition, for Research Questions 3–5, when two variables were examined together contingency tables or cross tabulations were used to analyse the data (Johnson & Christensen, 2004; Neuman, 2003).

Central tendency and variability of the data were measures also employed to summarise quantitative data. Measures of central tendency are a one-number summary of a frequency distribution giving its centre value. Measures of central tendency represent the most typical value of the data distribution (Alreck & Settle, 2004; Johnson & Christensen, 2004).

Measurement of variability represents the spread of data around the ‘central value’ (Alreck & Settle, 2004; Mertens, 1998). The following conventions were applied to the data in this study. The mean ± SD (standard deviation) was used when the data was ratio level (Alreck & Settle, 2004), had a normal distribution and did not contain extreme outliers (Neuman, 2003). When these conditions were not met, the recommended alternate measures, the median and interquartile range (IQR) were adopted (Alreck & Settle, 2004; Warner, 2008).

**Inferential statistics**

Inferential statistics were utilised to test the hypotheses associated with Research Questions 3–5. Inferential statistics are used to compare differences between groups in the sample population so that inferences may be drawn to the total population under study (Neuman, 2003; Warner, 2008). This section begins with an overview of principles for utilising parametric and nonparametric statistical tests and is followed by the rationale for the statistical tests employed in this study.
Parametric and nonparametric statistical tests

Statistical tests are described as parametric or nonparametric (Nachmias & Nachmias, 1976; Pett, 1997; Warner, 2008). Parametric and nonparametric statistics have underlying assumptions concerning the empirical data being analysed. Table 3.5 contains a list of the assumptions, compiled from Mertens (1998), Nachmias and Nachmias (1976), Pett (1997), Tabachnick and Fidell (2007) and Warner (2008).

### Table 3.5
**UNDERLYING ASSUMPTIONS FOR PARAMETRIC AND NONPARAMETRIC STATISTICS**

<table>
<thead>
<tr>
<th>Assumptions for parametric statistics</th>
<th>Assumptions for nonparametric statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample population is randomly drawn</td>
<td>Sample population is randomly drawn</td>
</tr>
<tr>
<td>Dependent variables are interval(^{ab}) or ratio level measurements only</td>
<td>Dependent variables can be nominal, ordinal, interval or ratio level measurements</td>
</tr>
<tr>
<td>Data has a normal distribution</td>
<td>Data does not necessarily have a normal distribution</td>
</tr>
<tr>
<td>Data does not contain extreme outlier values</td>
<td>Data can contain extreme outlier values</td>
</tr>
<tr>
<td>Variance across sub-groups must be similar</td>
<td>Homogeneity of variance not necessarily equal across sub-groups</td>
</tr>
</tbody>
</table>

\(^{a}\) Warner (2008, p.24) advises that Likert scales may not meet the true test for equal interval.

\(^{b}\) Tabachnick and Fidell (2007) argue that it is more important to consider the distribution shape of data, asserting that if the data is normally distributed then parametric statistics may be utilised for Likert scales when the number of categories is large (≥7) even though the level of measurement may not meet the strict equal interval requirement.

Quantitative data in this study was examined against these assumptions. As discussed previously, a random sampling technique was utilised in this study to select the sample MRS professionals from MRTB registers for survey, thus the first assumption has been met.

The second assumption concerns the level of measurement of the dependent variable. The dependent variables in this study included measures of frequency of use of mediating tools and accessibility of information sources. These measures comprised nominal, ordinal and ratio level data. From
Table 3.5, nonparametric statistics should be utilised when the dependent variables are nominal or ordinal and this principle was utilised for selection of the statistical test in this study. Cross tabulations were performed to examine nominal and ordinal data. The nonparametric chi-square test of independence is most commonly utilised with cross tabulations (Neuman, 2003; Pett, 1997). The chi-square statistic has a basic requirement that the expected cell frequency in all cells of the contingency table (or cross tabulation) is five or greater. If this minimum cell frequency is not met then the generated chi-square statistic will not be valid (Alreck & Settle, 2004; Pett, 1997). The Fisher exact test should be applied when expected cell frequencies are below five (Pett, 1997; Warner, 2008). This condition for use of chi-square and Fisher’s exact test was implemented in this study.

The data in this study also comprised Likert-type scales. The Likert scales in this study did not have seven or more categories and so should not be considered interval data (Tabachnick & Fidell, 2007). For statistical testing Likert scales utilised in this study were, therefore, treated as ordinal level measurements and examined using chi-square or Fisher’s exact test, as described above.

Parametric or nonparametric statistics may be employed when the dependent variables are ratio level measurements, depending on the characteristics of the empirical data (Table 3.3). The Kolmogorov-Smirnov test determines if ratio level data has a normal distribution (Pett, 1997). This test was used in this study to determine if parametric or non-parametric assumptions should be applied.

Another important assumption of parametric tests comparing differences between two or more groups is that variances amongst the sub-groups must be similar (Assumption 5, Table 3.5). The Levene test is used to determine if the assumption of homogeneity of variance is met when the dependent variable is ratio level (Pett, 1997). The Levene test was employed for research questions that compared ratio level measurements across sub-
groups in this study. If the result of the Levene test indicated that the homogeneity of variance had not been violated, an appropriate parametric test was employed. Where the result of the Levene test indicated that the homogeneity of variance had been violated, an appropriate nonparametric test was employed.

The number of sub-groups within the tested independent variables determines the choice of the parametric and nonparametric test (Mertens, 1998; Warner, 2008). When there are two groups in the independent variable – in this study, for example, health sector public, private – the independent t test or its nonparametric counterpart, the Mann-Whitney U test, should be performed (Pett, 1997; Warner, 2008). When there are three or more groups in the independent variable – for example in this study, geographic location of workplace as metropolitan, regional, rural or remote – the one-way ANOVA or its nonparametric counterpart, the Kruskal-Wallis test, are performed (Mertens, 1998; Warner, 2008). These conditions for selection of the appropriate parametric or non-parametric test were implemented in this study.

To address Research Question 1 (Table 3.1), data was collected on the value MRS professionals attribute to mediating tools for updating professional knowledge using a five-point Likert scale (1 very important – 5 not important). As previously noted, Likert scales with only five categories should be treated as ordinal data (Tabachnick & Fidell, 2007) and, from Table 3.5, require analysis with a nonparametric test. There are two commonly utilised nonparametric tests to examine the ranks of ordinal data, namely the Friedman test and Kendall’s W (Pett, 1997). The Friedman test examines difference in median value of rankings, whereas Kendall’s W is primarily an assessment of the agreement of rankings (Pett, 1997). As an overall ranking of importance of mediating tools was sought in this study, the Friedman test was employed to address Research Question 1c.
**Statistical significance**

A significance level or alpha level, is a probability level that the relationship between two variables tested in the sample population are actually related to one another in the total population. The significance level in educational and health research is typically set at 0.05 (Johnson & Christensen, 2004; Pett, 1997). A probability (p) value of 0.05 indicates that the researcher accepts there is a 5% chance that the observed relationship between variables would result purely from chance, for example, sampling error, and so not reflect the population accurately (Alreck & Settle, 2004; Neuman, 2003; Pett, 1997). This study adopted the statistical significance level of .05 to reject the null hypotheses, listed in Table 3.1.

A second criterion for establishing rejection of the research hypothesis is whether the hypothesis is non-directional or directional. For the null hypothesis, which is non-directional, alpha is two-tailed (Pett, 1997). The parametric and non-parametric tests performed in this study adopted this condition of making alpha two-tailed.

**Survey of web sites**

**Data analysis**

Three government health information portals were examined to determine the number of journals available through each site. A simple checklist based on survey instrument Question 34 (Appendix J) was utilised, so that all listed journals were recorded as available or not available through each examined site. Stated access restrictions were also noted.

**3.3 Ethical considerations**

Prior to the conduct of this study, an ethics application was submitted to the University of Wollongong, Human Research Ethics Committee (HREC). The
research project was granted ethical approval (Appendix M) with annual renewal. Primary ethical issues relevant to this study were informed consent and confidentiality.

Informed consent was gained for all components in this study. For Phase 1, each individual was provided with the Information Statement (Appendix B) and Consent Form (Appendix C) relating to the study. Participants involved in Phase 1 were required to sign and return to the researcher the Consent Form prior to the semi-structured interview occurring. The Consent Form clearly states that the semi-structured interviews were to be tape recorded for analysis purposes. At the start of each interview participants were again advised the interview would be audio-recorded and were asked if they were happy to proceed with the interview. All participants agreed both in writing and verbally to their interview being audio-recorded. Participants were also asked during the interview if they were willing to continue with the interview. This process of ensuring ongoing consent to participate in the interview was recorded and also documented by the researcher on the interview guide. Phase 2 survey participants were provided with the Information Statement (Appendix B) providing an explanation of the purpose and voluntary nature of the study. Participants were provided with an addressed pre-paid envelope to return their questionnaire. Return of their anonymous questionnaire was considered as consenting to participate in the study (Boud, 2000).

Confidentiality was guaranteed to all Phase 1 participants. For Phase 1 participants, confidentiality was maintained through the use of a code rather than names. The researcher allocated the codes and the identities were maintained in a secure location. The return of the postal survey with no identification marks provided anonymity to Phase 2 participants. The following structure of coding was used to de-identify research participants: area of specialisation (nuclear medicine, NM; radiation therapy, RT; radiography, R; sonography, S), work context (academic, A; clinical practice, P), number and data collection method (interview or questionnaire). For example a code, NMA3 interview, indicated the MRS professional specialised
in nuclear medicine (NM), had an academic work context (A), was identified with the number 3 and the presented data was collected by interview.

### 3.4 Limitations of this study

The investigation of professional updating activity is a complex system influenced by numerous factors. Consequently, the research design has several limitations that may impact on the broader derived conclusions. This study adopted Engeström’s (2001) Activity System model as a framework to concurrently examine the contemporaneous value and use of electronic and non-electronic information sources for updating professional knowledge, as well as the factors that afford or constrain use of and workplace access to these tools. First, it is important to acknowledge that not all relevant information sources, either electronic or non-electronic, that MRS professionals utilise as mediating tools in professional updating activity were identified in Phase 1 of this study. This was evidenced by the inclusion of five additional journal titles during the pilot testing of the survey instrument. This study does provide an initial dataset on the use of a broad range of information sources as mediating tools utilised by MRS professionals in professional updating activity. The study offers comprehensive coverage both in terms of the sample population and the range and number of mediating tools investigated.

This study adopted Engeström’s (2001) Activity System model, which suggests that *rules, community* and *division of labour* influence level of activity. As professional knowledge updating is a complex system it is also reasonable to assume that the operationalised variables, adopted in this study, have not identified all variables that influence level of professional knowledge updating activity. For instance, individual attitudes or characteristics not examined in this study may also influence professional knowledge updating. This study does provide an initial dataset on factors that influence level of knowledge updating activity. Statistically significant
positive relationships were observed between use of information sources to update professional knowledge and enrolment in a CPD program, membership of a professional society, greater physical access and greater effective access in the workplace to the information source.

It is also reasonable to presume that not all factors that influence accessibility of these mediating tools within workplaces have been examined during data analysis. This study does provide an initial dataset on the workplace accessibility of a broad range of information sources to MRS professionals. This study did identify that hierarchies of access to mediating tools are widespread across the MRS profession and involved all examined information sources.

It is also acknowledged that it is unlikely that the listed areas in which MRS professional update their knowledge is fully inclusive. As noted in Section 3.2.3.2 the listed areas on the survey were identified from the literature and Phase 1 interviews. This approach supported development of the survey instrument where the content was contextually relevant to the respondents. This study does provide an initial dataset on the areas in which MRS professional update their knowledge.

It is recognised that in Phase 1 semi-structured interviews and Phase 2 survey the use of self-reporting behaviours carries with it limitations of bias and socially desirable responses (Alreck & Settle, 2004). MRS professionals may want to ‘look good’ and so self-report higher levels of use of mediating tools for professional updating activity than may be reported in an observational study (Warner, 2008). However, the data did show that, across all mediating tools examined, all categories of response concerning use were utilised (e.g., from never use to several times daily), suggesting that if bias exists it was not systemic. Similarly, it may be argued that asking people if they are aware of nominated information sources such as health and medical databases may influence their response. Again the data did show low level
of awareness of multiple health and medical databases, a finding consistent with other published studies (Section 4.2.1).

The survey response rate of 31.7% obtained within the study is a potential limitation for broader generalisation. The relatively large survey sample size (N=362) together with multiple indicators that survey participants were representative of the Australian population of MRS professionals suggests that the study findings can be generalised. It should also be acknowledged that the sample population for the survey was not national but rather limited to two states. Some caution must, therefore, be exercised when interpreting the findings in relation to the broader Australian population of MRS professionals.
CHAPTER 4 – RESULTS AND DISCUSSION – PART 1

This chapter reports on the findings derived from both the qualitative and quantitative approaches used in this study to address Research Questions 1 and 2. Chapter 5 reports on the findings that address Research Questions 3 through to 5.

Research Question 1 was: **What information sources do MRS professionals use as tools to update their professional knowledge and why are they used?**

Research Question 1 was operationalised as:

1a **What information sources are utilised as mediating tools in professional knowledge updating activity?**

1b **How frequently are these tools used?**

1c **What value is attributed to these tools?**

Research Question 2 was: **What areas of knowledge do MRS professionals update?**

These questions relate to the primary information sources (*tools*) that health professionals adopt and the areas of knowledge that they perceive to be central for updating their professional knowledge. Section 4.1 presents the demographic profile of survey respondents. A comparison is made to national data to ascertain that the sample is representative of the Australian population of MRS professionals (i.e., the health professionals who participated in this study). Section 4.2 presents the findings addressing Research Question 1. This initial question relates to the value and use of the multiple information sources available to today’s health professionals to update their professional knowledge. Section 4.3 expands upon this data relating to information sources by investigating the areas of knowledge that
are updated by MRS professionals. The final section interprets the findings in the context of current literature related to learning mediated by information sources.

4.1 Demographic profile of participants

4.1.1 Descriptive data for sample and its generalisability

The response rate for the survey was 31.7% (N=362) of all MRS professionals sampled. A summary of key demographic characteristics of survey respondents is presented in Table 4.1. Comparing the valid per cent response, that is comparing those that responded to a given survey question, there are multiple indicators to suggest that the demographic profile of the respondents is representative of the broader Australian population of MRS professionals. For instance:

- All four areas of specialisation were represented in survey respondents: nuclear medicine (11.9%, n=43), radiation therapy (21.3%, n=77), radiography (50.8%, n=184) and sonography (16%, n=58), with distribution similar to national data – nuclear Medicine (5%), radiation therapy (13%), radiography (60%) and sonography (22%) (Australian Institute of Health and Welfare, 2009).

- The percentage of females of the sampled population (68.5%, n=246) closely approximates national data where females account for 68.4% of MRS professionals (Australian Institute of Health and Welfare, 2009).

- The percentage of survey respondents employed full time (70.1%, n=253) was in accord with national data where 70.5% of MRS professionals report working 35 hours or more per week (Australian Institute of Health and Welfare, 2009).
### TABLE 4.1

**DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS (N=362)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency</th>
<th>Per cent</th>
<th>Valid Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area of specialisation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear medicine</td>
<td>43</td>
<td>11.9</td>
<td>11.9</td>
</tr>
<tr>
<td>Radiation therapy</td>
<td>77</td>
<td>21.3</td>
<td>21.3</td>
</tr>
<tr>
<td>Radiography</td>
<td>184</td>
<td>50.8</td>
<td>50.8</td>
</tr>
<tr>
<td>Sonography</td>
<td>58</td>
<td>16.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Geographic location</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metropolitan</td>
<td>208</td>
<td>57.5</td>
<td>58.3</td>
</tr>
<tr>
<td>Regional</td>
<td>95</td>
<td>26.2</td>
<td>26.6</td>
</tr>
<tr>
<td>Rural or remote</td>
<td>54</td>
<td>14.9</td>
<td>15.1</td>
</tr>
<tr>
<td>Total valid</td>
<td>357</td>
<td>98.6</td>
<td>100.0</td>
</tr>
<tr>
<td>No response</td>
<td>5</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td><strong>Primary role</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practitioner</td>
<td>151</td>
<td>41.7</td>
<td>43.1</td>
</tr>
<tr>
<td>Senior practitioner</td>
<td>84</td>
<td>23.2</td>
<td>24.0</td>
</tr>
<tr>
<td>Manager</td>
<td>57</td>
<td>15.7</td>
<td>16.3</td>
</tr>
<tr>
<td>Clinical educator</td>
<td>19</td>
<td>5.2</td>
<td>5.4</td>
</tr>
<tr>
<td>Academic</td>
<td>28</td>
<td>7.7</td>
<td>8.0</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>3.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Total valid</td>
<td>350</td>
<td>96.5</td>
<td>99.9</td>
</tr>
<tr>
<td>Identified multiple roles</td>
<td>10</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>99.9</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>246</td>
<td>68.0</td>
<td>68.5</td>
</tr>
<tr>
<td>Male</td>
<td>113</td>
<td>31.2</td>
<td>31.5</td>
</tr>
<tr>
<td>Total valid</td>
<td>359</td>
<td>99.2</td>
<td>100.0</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–29</td>
<td>83</td>
<td>22.9</td>
<td>22.9</td>
</tr>
<tr>
<td>30–39</td>
<td>92</td>
<td>25.4</td>
<td>25.4</td>
</tr>
<tr>
<td>40–49</td>
<td>94</td>
<td>26.0</td>
<td>26.0</td>
</tr>
<tr>
<td>50–60</td>
<td>75</td>
<td>20.7</td>
<td>20.7</td>
</tr>
<tr>
<td>&gt;60</td>
<td>18</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Professional experience (years)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>64</td>
<td>17.7</td>
<td>17.7</td>
</tr>
<tr>
<td>5–10</td>
<td>64</td>
<td>17.7</td>
<td>17.7</td>
</tr>
<tr>
<td>11–15</td>
<td>51</td>
<td>14.1</td>
<td>14.1</td>
</tr>
<tr>
<td>&gt;15</td>
<td>183</td>
<td>50.6</td>
<td>50.6</td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Survey participants were asked to identify their highest level of academic qualification. Over 40% (42.7%, n=153) of MRS professionals held postgraduate-level qualifications. Bachelor level qualifications were held by 35.4% (n=127) of respondents. Diploma, associate diploma and certificates were the highest qualification level of the remaining 22% (n=79) of
practitioners. Sixty-three respondents were undertaking further study. The percentage of nuclear medicine technologists (NMTs) with postgraduate qualifications in this study (35%) is consistent with the only available comparative data on postgraduate qualification by area of specialisation. In their national survey of NMTs, Cowell and Parkinson (2006) reported 33.5% of NMTs held postgraduate qualifications.

Survey participants were asked if they were enrolled in a continuing professional development (CPD) program. Seventy-three per cent (n=265) of all MRS respondents reported that they were. Ninety-six MRS professionals identified that they were not enrolled in a CPD program and one participant did not answer this question. On a specialisation basis, enrolment in CPD was as follows:

- 93% of sonographers (54 of 58)
- 82% of radiation therapists (63 of 77)
- 67% of nuclear medicine technologists (29 of 43)
- 65% of radiographers (119 of 183).

Respondents were asked about their membership in professional societies. Seventy-nine per cent (n=275) of MRS professionals held membership with one or more of the nominated professional societies (Table 4.2).

Table 4.2

MEMBERSHIP ACROSS PROFESSIONAL SOCIETIES

<table>
<thead>
<tr>
<th>Professional society</th>
<th>Number (n=275²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Institute of Radiography (AIR)</td>
<td>213</td>
</tr>
<tr>
<td>Australian &amp; New Zealand Society of Nuclear Medicine (ANZSNM)</td>
<td>37</td>
</tr>
<tr>
<td>Australian Sonographers Association (ASA)</td>
<td>53</td>
</tr>
<tr>
<td>Australian Society of Ultrasound in Medicine (ASUM)</td>
<td>30</td>
</tr>
</tbody>
</table>

² Total greater than 275, as respondents could hold membership with more than one professional society
When asked about their membership of overseas professional societies (Q12, Appendix J), 15% (n=53) of respondents identified that they also held these types of professional memberships.

Survey respondents represented academic and clinical workplaces. In relation to clinical workplaces, respondents span the public (n=169) and private (n=149) sector, teaching (n=173), non-teaching hospitals (n=46) and stand-alone clinics (n=93).

Summary of findings

Demographic analysis demonstrates there are multiple indicators suggesting that the survey sample is representative of the Australian population of MRS professionals. This indicates that findings from this study are generalisable to the wide population of Australian MRS professionals.

The following sections address Research Questions One and Two of this study. That is, an examination of the mediational tools (Research Question 1) and the object of activity (Research Question 2) for updating professional knowledge.

4.2 Research Question 1

Research Question 1 focused on mediating tools utilised by MRS professionals to update their professional knowledge. Specifically the question was:

What information sources do MRS professionals use as tools to update their professional knowledge and why are they used?

Research Question 1 was operationalised into three sub-questions:
1a What information sources do MRS professionals use as tools to update their professional knowledge?
1b How frequently are these mediating tools used?
1c What value is attributed to these tools?

Figure 4.1 portrays the relationship of these research questions to the activity system model.

4.2.1 Mediating tools for updating professional knowledge

Research Question 1a examined the primary tools for updating professional knowledge. Specifically the question was:

1a What information sources do MRS professionals use as tools to update their professional knowledge?

To respond to Research Question 1a, descriptive statistics from survey data (N=362) were generated to determine the percentage and number of MRS professionals that employ the nominated information sources as mediating.
tools in professional knowledge updating activity. The percentage of MRS professionals who purposefully use information sources to update their professional knowledge are displayed in Table 4.3.

**Table 4.3**  
**PERCENTAGE OF MRS PROFESSIONALS USING MEDIATING TOOLS FOR PROFESSIONAL KNOWLEDGE UPDATING**

<table>
<thead>
<tr>
<th>Mediating tool</th>
<th>Percentage (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text and reference books</td>
<td>90.0 (325)</td>
</tr>
<tr>
<td>Journals</td>
<td>88.1 (317)</td>
</tr>
<tr>
<td>Internet search engines</td>
<td>86.8 (308)</td>
</tr>
<tr>
<td>Web pages</td>
<td>86.0 (306)</td>
</tr>
<tr>
<td>Email</td>
<td>81.7 (295)</td>
</tr>
<tr>
<td>National conference</td>
<td>75.3 (271)</td>
</tr>
<tr>
<td>Health and medical databases</td>
<td>73.9 (263)</td>
</tr>
<tr>
<td>Seminars</td>
<td>61.4 (208)</td>
</tr>
<tr>
<td>Workshops</td>
<td>54.3 (184)</td>
</tr>
<tr>
<td>Listserv</td>
<td>39.4 (140)</td>
</tr>
<tr>
<td>Tele- or video-conferencing</td>
<td>30.9 (110)</td>
</tr>
<tr>
<td>International conference</td>
<td>17.0 (57)</td>
</tr>
</tbody>
</table>

*Percentages are based upon number of respondents answering each question, that is, the valid percentage is reported.

As detailed in Table 4.3, the primary tools for updating professional knowledge include books, journals and web pages. Information search tools, such as Internet search engines and health and medical databases, were also employed by a majority of respondents to obtain information needed to construct their knowledge. In addition to the aforementioned tools, conferences, seminars and workshops were also widely employed for updating professional knowledge. An overview of individual tools utilised by MRS professionals to update their professional knowledge is provided below. Section 4.2.2 analyses and discusses frequency of use of these nominated primary tools for updating professional knowledge. A detailed analysis of the value MRS professionals attribute to each nominated tool is then presented in Section 4.2.3.
A broad range of journal titles were read by MRS professionals. Details on particular journals research participants report reading is provided in Appendix N. These titles include discipline-specific journals for nuclear medicine, radiation therapy, radiography and sonography as well as the broad categories of cardiology, education, general medicine, oncology and physics. In comparison to other studies investigating the key journals for the MRS profession (Burnham, 1997; Hill et al., 1998), this study identified a broader range of discipline-specific journals. These newly identified titles that are relevant to areas of specialisation within the MRS profession include:

- **Nuclear medicine**: *European Journal of Nuclear Medicine and Molecular Imaging*, *Journal of Nuclear Cardiology*, *Nuclear Medicine and Biology* and *Nuclear Medicine Communications*
- **Radiation therapy**: *Journal of Radiotherapy in Practice*, *Radiotherapy & Oncology*, *Seminars in Radiation Oncology*
- **Sonography**: *Journal of Clinical Ultrasound*, *Journal of Vascular Ultrasound*, *Journal of Ultrasound in Medicine*, *Ultrasound in Medicine and Biology* and *Ultrasound in Obstetrics and Gynecology*
- **Radiography**, which includes the sub-specialisations of CT and MRI: *Magnetic Resonance Imaging Clinics of North America*, *Magnetic Resonance in Medicine* and *Seminars in Ultrasound, CT & MRI*.

Of the 84 journals identified in this study as read by Australian MRS professionals, 68 were not identified by Burnham (1997) or others (Chew, 1986; Hill et al., 1998; Hill et al., 2001) as journals of relevance to MRS or radiology professions (Appendix N). This study, therefore, provides new detailed information on core journals that span disciplinary areas shared by the MRS and radiology professions. In addition, as the primary journal read by health professionals are those from professional societies (Turner & Mjolne, 2001; Turner & Whitfield, 1997), this study extends the list of titles from professional societies relevant to the MRS profession. Previous studies by Hill et al. (1998, 2001) had identified four journals from professional societies in North America: *Radiologic Technology*, *Nuclear Medicine Technology*, *Journal of Diagnostic Medical Sonography*, and *Canadian*
Journal of Medical Radiation Technology. This current study extends this list by identifying titles not previously recognised from professional societies of Australia and internationally (Appendix O). These newly identified journals cross the four areas of specialisation within the MRS profession and include *ANZ Nuclear Medicine, Radiographer, Sound Effects and Ultrasound Bulletin, Medical Dosimetry, Radiography,* and *Radiation Therapist.*

The vast majority of respondents (91%, n=295) indicated that they had access to one (18%, n=58) or more (73%, n=237) of the listed journals. The median number of journals respondents could access was four (IQR =11). Nine per cent of respondents (n=30) reported they had access to none of the journals listed. No comparable data exists for the MRS profession and so the findings from this study present baseline data to the profession. As 27% (n=88) of respondents have access to just one or no journals, this study establishes that for many MRS professionals journals are not readily available to support them to update their professional knowledge.

State government-provided electronic information portals make health and medical databases and journals available to Australian health professionals (Section 2.5.2). However, there appears to be a disconnect between the available journals and those currently preferred by health professionals. For example, Gosling and Westbrook (2002b) previously identified that the New South Wales state-based electronic portal did not contain the preferred journals for many health professions. To explore this in relation to the MRS profession, the web sites of three Australian portals were accessed and data collected on the inclusion of nominated journals relevant to MRS professionals. Table 4.4 presents a summary of the results.
Table 4.4

Number of Journals Available through Three Electronic Portals

<table>
<thead>
<tr>
<th>Journals included in this study (N=94)</th>
<th>Clinicians Health Channel</th>
<th>Clinical Information Access Program</th>
<th>Clinician Knowledge Network</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17</td>
<td>35&lt;sup&gt;b&lt;/sup&gt;</td>
<td>51&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Journals read by MRS professionals (n=84)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>14</td>
<td>30&lt;sup&gt;b&lt;/sup&gt;</td>
<td>46&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Journals from MRS professional societies (n=9)</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

As displayed in Table 4.4, the three examined electronic information portals vary in the number of journals that were available. Overall, there was little standardisation of journals made available through these portals, with only the following eight journals having unrestricted access (i.e., no embargo period, or access limited to certain hospitals) in all three electronic portals:

- American Journal of Obstetrics and Gynecology
- British Medical Journal
- Clinical Nuclear Medicine
- Journal of Bone and Joint Surgery
- Lancet
- Medical Journal of Australia
- Nuclear Medicine Communications

These eight journals were read by only 7% (n=2) or less of MRS professionals (see Appendix N). Thus, the core journals available across government portals do not reflect the preferred reading of MRS professionals. For example, the two most commonly read journals by MRS professionals are:

- American Journal of Obstetrics and Gynecology
- British Medical Journal
professionals were *Radiographer* and *Radiography* (Appendix N). These journals stem from professional societies from Australia and England, respectively (Appendix O). None of the listed journals from MRS professional societies were available in all three government-provided portals. As health professionals favour journals from professional societies (Turner & Mjolne, 2001; Turner & Whitfield, 1997), there is an apparent mismatch between what the portals offer and what health professionals prefer to read. This mismatch may also contribute to the observed low level of use of these portals by MRS professionals. For instance, the examined portals were utilised by only 15.6%, (n=50) of respondents in this study. In Australia, access to these electronic information portals is restricted to health professionals employed in the public health sector (Gosling & Westbrook, 2002a; Hall, 2008; Keppell et al., 2001). This is reflected in the increased access level (25%, n=38) and awareness (45%, n=80) by MRS professionals employed within the public sector in contrast to their private sector colleagues (5%, n=7; 19%, n=26, respectively). Given that the state-based electronic information portals do contain a number of journals (14–46, Table 4.4) that are read by MRS professionals, lack of awareness, underutilisation, restrictive access and, as previously noted, lack of key journals from MRS professional societies, currently limit the use of these portals in professional knowledge updating.

In addition, there was very little standardisation of included journals across the examined portals. As each portal has been developed at the state government level (Hall, 2008), the observed low level of standardisation of journals may indicate that different approaches were used to determine which journals or suites of journals to include within a given state-based portal. Given the low level of awareness of these portals and the observed variability in journals available through them, education activities to promote awareness of the portals and their content, would facilitate knowledge updating of health professionals within a given state and also for those who now, through national registration (Australian Health Workforce Ministerial Council, 2009), can more easily work in different states where different health information portals operate.
Conferences, seminars and workshops were also widely utilised mediating tools for updating professional knowledge by MRS professionals. Three-quarters (75.3%, n=271) of respondents reported that they attend the national conference of their associated professional society (Table 4.3). In relation to international conferences, attendance by MRS professionals was lower (17.1%, n=57) with more radiation therapists (31.4%, n=22) attending international conferences than their colleagues from other areas of specialisation such as radiography (15.9%, n=27), nuclear medicine (5%, n=2) and sonography (10.9%, n=6). The Australian Federal Government Strengthening Cancer Care Initiative (Australian Federal Government, May 2005) may contribute to the higher rate of attendance at International conferences by radiation therapists. As noted in Section 2.4.4.2 this initiative provided funding to improve professional development for cancer health workers such as those specialising in radiation therapy. The influence of area of specialisation on time and financial support to attend conferences is examined in Section 5.3.

Survey participants were asked about their attendance at short-duration conferences (one or two days) to update their professional knowledge. The results are presented in Table 4.5.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Percentage a (%)</th>
<th>(No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional society</td>
<td>32</td>
<td>(107)</td>
</tr>
<tr>
<td>Workplace</td>
<td>24</td>
<td>(80)</td>
</tr>
<tr>
<td>Vendor</td>
<td>9</td>
<td>(31)</td>
</tr>
<tr>
<td>University</td>
<td>5</td>
<td>(18)</td>
</tr>
</tbody>
</table>

a Percentages are based upon number of respondents answering each question, that is, the valid percentage is reported.

Almost one-third of respondents attended one (21%, n=72) or more (11%, n=35) short conferences organised by a professional society in the previous year. In relation to professional updating organised by the workplace, 24%
(n=80) respondents went to one (9%, n=29) or more (15%, n=51) short conferences. Less than 10% of respondents attended short-conferences organised by vendors or universities. These findings illustrate the important role that professional societies and workplaces, and to a much lesser extent vendors and universities, play in supporting professional updating through their provision of short-duration conferences to MRS professionals.

Professionals update their knowledge at local, national and international conferences. This updating practice can simultaneously support individual and shared learning that occurs in a community of practice. For instance, as an individual, attending a conference allows the person to keep abreast of new knowledge, techniques and tools in their practice area. This new knowledge can be shared back to members in their workplace, that is, their local CoP, who were unable to attend (Wenger et al., 2002). If members of a workplace attend different conferences then the range of content and perspectives, in this case local, national and international, discussed, exchanged, adapted or implemented within a local CoP or workplace can increase. Wenger et al. (2002) identifies that this shared approach to updating knowledge is required within local CoPs, due to the rapid rate at which discipline knowledge is changing.

The high number of MRS professionals attending conferences outside of their workplace, also represents their participation in non-local CoPs. The terms “constellations of practices” (Wenger, 1998, p. 126) and “distributed communities” (Wenger et al., 2002, p. 115) have been used to represent the broader interconnected configuration of local CoPs, that contribute to an overall larger establishment such as a profession, an organisation or a government. By attending national and international conferences, MRS professionals can interact and share professional knowledge and practice beyond their workplace, that is beyond their local CoP (Wenger, 1998; Wenger et al., 2002). This sharing of new knowledge, that cuts across workplaces, is akin to using external resources or expertise, which Wenger et al. (2002) identified as necessary for developing best workplace practice.
Over 60% (61.4%, n=208) of survey respondents attended seminars to update their professional knowledge (Table 4.3). Respondents reported attending 312 seminars in total for the preceding year. Thirty-five per cent (n=119) of respondents went to one (14%, n=46) or more (21%, n=73) seminars organised by a professional society in the previous year. This finding is consistent with a recent study conducted in Western Australia that reported 40.1% of radiographers attended seminars organised by their relevant professional society (Sholer et al., 2011). With regard to seminars organised by the workplace, 30% (n=99) of respondents attended one (9%, n=29) or more (21%, n=70) within the previous 12 months. Fewer MRS professionals attend seminars organised by vendors (17%, n=57) and universities (10%, n=35). Professional societies and workplaces were thus the primary providers of seminars attended by MRS survey respondents. Despite this finding, the current level of provision of seminars within the workplace is not perceived to be meeting the needs of MRS professionals, as Sholer et al. (2011) reported that participation in CPD would be improved by an increase in workplace seminars.

Almost half of MRS professionals (54.3%, n=184) reported that they attended workshops to update their professional knowledge (Table 4.3). The reported attendance at workshops in the previous year was:

- 35% (n=118) attended workshops organised by their workplace
- 20% (n=69) attended workshops organised by vendors
- 11% (n=39) attended workshops organised by professional societies
- 9% (n=32) attended workshops organised by universities.

Workplaces and vendors were the principal providers of workshops undertaken by MRS professionals to update their professional knowledge. Vendors were recognised as having an important role in supporting learning associated with the rapid rate of technological change for MRS professionals in the United Kingdom (Society of Radiographers, 2007). The findings from this study identify that, in Australia, vendors support MRS professionals
update of their knowledge through the provision of workshops and, to a lesser extent, seminars and short-duration conferences.

More generally, whilst workplaces are recognised as supporting learning as the local primary CoP (Lave & Wenger, 1991; Wenger, 1998; Wenger et al., 2002) and through their provision of resources (Eraut, 1994; Senge, 1990), the findings from this study exemplify the important contribution workplaces make as key providers of workshops, seminars and short-duration conferences to support MRS professionals update their professional knowledge. Albeit, the level of provision within the workplace is not perceived to meet the current learning needs of MRS professionals (Sholer et al., 2011).

Internet-based information and communication tools were employed by MRS professionals to update knowledge. Eighty-seven per cent (n=308) of survey respondents made use of search engines such as Google to update their professional knowledge (Table 4.3), with 86% (n=308) accessing websites for this purpose. Communication tools available through the Internet such as email (81.7%, n=295) and to a lesser extent listservs (39.4%, n=140) were also utilised by survey respondents to update their knowledge. The findings from this study are consistent with the reported use of Internet-based tools within health and education professions, where email, search engines and listservs were the three most commonly utilised tools for professional learning (Herrington & Herrington, 2006).

Examination of the full-text and bibliographic health and medical databases indicates that 73.9% (n=263) of respondents (Table 4.3) use these resources to update their knowledge. Table 4.6 presents the databases used by MRS professionals.
**TABLE 4.6**

*HEALTH AND MEDICAL DATABASE USAGE BY MRS PROFESSIONALS*

<table>
<thead>
<tr>
<th>Database</th>
<th>Percentage</th>
<th>(No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDLINE</td>
<td>60</td>
<td>(206)</td>
</tr>
<tr>
<td>PubMed</td>
<td>55</td>
<td>(182)</td>
</tr>
<tr>
<td>CINAHL (Cumulative Index of Nursing and Allied Health)</td>
<td>20</td>
<td>(65)</td>
</tr>
<tr>
<td>Cochrane Libraries</td>
<td>20</td>
<td>(65)</td>
</tr>
<tr>
<td>ProQuest</td>
<td>15</td>
<td>(48)</td>
</tr>
<tr>
<td>Informit</td>
<td>14</td>
<td>(42)</td>
</tr>
<tr>
<td>PsycINFO</td>
<td>10</td>
<td>(32)</td>
</tr>
<tr>
<td>EMBASE</td>
<td>7</td>
<td>(22)</td>
</tr>
</tbody>
</table>

* Percentages are based upon number of respondents answering each question, that is the valid percentage is reported.

MEDLINE and PubMed were the two most commonly used health and medical databases with 60% and 55% of respondents respectively, indicating that they employ these tools to update professional knowledge. The remaining databases were utilised by 20% or less of respondents. Within the health professions generally (Conn et al., 2003; Lefebvre & Clarke, 2003; Snowball, 2005) and also for MRS professionals (Brettle & Gambling, 2003) it is recognised that searching must occur across multiple databases to obtain good coverage of the topic area of interest. However, across health professions a low level of awareness limits utilisation of these tools for learning and improving professional practice (Cole & Kelsey, 2004; Gosling, Westbrook, & Coiera, 2003; Griffiths & Riddington, 2001; Guo et al., 2008; McClusky, 2003; Mills et al., 2011). To ascertain if lack of awareness of health and medical databases also existed within the MRS profession, respondents were asked if they were aware of a number of health and medical databases that are recommended for use by health professionals (Brettle & Grant, 2004; Conn et al., 2003; Lefebvre & Clarke, 2003; Snowball, 2005). The results are displayed in Table 4.7.
TABLE 4.7
AWARENESS OF HEALTH AND MEDICAL DATABASES

<table>
<thead>
<tr>
<th>Database</th>
<th>Percentage a (No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDLINE</td>
<td>82 (281)</td>
</tr>
<tr>
<td>PubMed</td>
<td>69 (230)</td>
</tr>
<tr>
<td>Cochrane Libraries</td>
<td>33 (106)</td>
</tr>
<tr>
<td>CINAHL (Cumulative Index of Nursing and Allied Health)</td>
<td>29 (95)</td>
</tr>
<tr>
<td>ProQuest</td>
<td>27 (85)</td>
</tr>
<tr>
<td>Informit</td>
<td>26 (79)</td>
</tr>
<tr>
<td>PsycINFO</td>
<td>20 (63)</td>
</tr>
<tr>
<td>EMBASE</td>
<td>15 (45)</td>
</tr>
</tbody>
</table>

a Percentages are based upon number of respondents answering each question, that is, the valid percentage is reported

Apart from MEDLINE (82%) and PubMed (69%), there was a low level of awareness of other relevant health and medical databases. Low level of awareness of health and medical databases has been reported across health professions (Cole & Kelsey, 2004; Gosling et al., 2003; Griffiths & Riddington, 2001; McClusky, 2003) and also amongst their undergraduate students (Callinan, 2005; Griffiths & Brophy, 2005; Shanahan, 2009; Urquhart et al., 2005). Purposefully designed learning activities have been shown to produce long-term positive changes to the level of use of health and medical databases as tools for learning by undergraduate MRS students (Shanahan, 2009; Shanahan, 2008). While such programs will help support future MRS professionals more fully engage with specialised electronic information tools, it is evident that there is also an immediate need for education activities for graduate professionals in this area. Lack of access within the workplace may also contribute to the observed low level of use of many nominated databases. The influence of workplace access to tools such as databases on frequency of use is examined in Section 5.3.

The use of electronic alerts such as journal table of content was not common amongst survey respondents with 9% (n=32) of survey respondents having one or more electronic alerts for journals and 3% (n=11) alerts within health
and medical databases. This may indicate that the majority of MRS professionals are not aware of functions such as these that can support knowledge updating activity by providing effective mechanisms for receiving current contents across multiple journals and databases.

Studies examining utilisation of information sources typically present data as a dichotomous scale, such as percentage of respondents who use or do not use the nominated tools (Gosling & Westbrook, 2004; Keppell et al., 2001; Taylor & Lee, 2005; Wong & Veness, 2005). As this study sought to examine if workplace access influences level of use of mediational tools for updating professional knowledge, a more refined level of use, namely frequency of use of tools, was required. The following section addresses Research Question 1b, which investigated frequency of use of these tools in professional knowledge updating activity.

4.2.2 Frequency of use of mediating tools

Research Question 1b examined the frequency of utilisation of primary mediating tools for updating professional knowledge identified from Research Question 1a. Specifically the question was:

1b How frequently are these mediating tools used?

As noted in Section 3.2.3.2 survey respondents were requested to indicate their frequency of use of listed tools for updating their professional knowledge. A summary of the frequency results is presented in Figure 4.2.

A large variation in frequency of use, both across and within mediating tools was observed. Whilst variation in frequency of use of Internet search engines and email has been noted by others (Herrington & Herrington, 2006; Lyall & Surjan, 2008), the findings from this study demonstrate that observed variations also include all nominated mediating tools. This is an important finding for this study as frequency of use of mediating tools is the dependent
FIGURE 4.2: FREQUENCY OF USE OF MEDIATING TOOLS BY MRS PROFESSIONALS FOR THE PURPOSE OF UPDATING PROFESSIONAL KNOWLEDGE.
variable for testing hypotheses associated with Research Questions 3 through to 5 (Section 3.2.3.3).

On a daily basis, email and Internet search engines were the most frequently used tools by respondents to update professional knowledge, with 46% (n=167) and 30% (n=106) respectively. This finding is in accord with reported use of Internet-based tools by rural health and education professionals, who similarly reported that their most frequently used tools for professional learning were email and Internet search engines (Herrington & Herrington, 2006; Lyall & Surjan, 2008). The observed higher level of use for electronic communication, email, over other Internet-based tools exists more broadly. Email was recently attributed as the single most important reason businesses in Australia utilise the Internet (Sensis, 2011). Apart from email, Australian organisations have adopted the Internet to primarily perform financial transactions (84.8%) (Australian Bureau of Statistics, 2011a). Thus, although the Internet is recognised as an important tool to facilitate learning, Australian organisations are using the Internet to support business operations, with online learning (23.8%) implemented to a much lesser extent (Australian Bureau of Statistics, 2011a). The high frequency of use of email over other Internet-based tools may be attributed to the previously noted organisational support for this tool and also MRS professionals’ preference for email over other communication tools, such as telephone and letters (Lyall & Surjan, 2008).

Internet search engines were widely adopted (71%, n=252), with books (58%, n=210), journals (50%, n=181) and health and medical databases (43%, n=153) also utilised by respondents at least several times per month to update their professional knowledge. This finding indicates that across the MRS profession a variety of mediating tools are utilised on a regular basis to update professional knowledge. The higher level of adoption of Internet search engines may reflect higher skills using this tool over other search tools, such as health and medical databases (Shanahan, 2008; Taylor & Lee, 2005). To investigate if skill level was associated with frequency of use of
the Internet and health and medical databases, cross tabulations were performed. The results are displayed in Table 4.8.

### Table 4.8

**RELATIONSHIP BETWEEN MRS PROFESSIONALS’ SKILL LEVEL AND FREQUENCY OF USE OF MEDIATING TOOLS**

<table>
<thead>
<tr>
<th>Mediating tool</th>
<th>Test of difference</th>
<th>P value</th>
<th>Difference in experience of MRS professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet search engines</td>
<td>119.252† a</td>
<td>p &lt; .001</td>
<td>43% of MRS professionals who rated their skill for searching the Internet as <em>very high or high</em> (n=226) use Internet search engines daily to update professional knowledge compared to 0% who rated their skill level as <em>very low or low</em> (n=37).</td>
</tr>
<tr>
<td>Health and medical databases</td>
<td>107.627† a</td>
<td>p &lt; .001</td>
<td>38% of MRS professionals who rated their skill for searching health and medical databases as <em>very high or high</em> (n=118) use these tools at least several times per week to update their professional knowledge compared to 5% who rated their skill level as <em>very low or low</em> (n=81).</td>
</tr>
</tbody>
</table>

* Monte Carlo Method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 1993510611
† Fisher’s exact test,

A statistically significant relationship was observed between skill level in using Internet search engines and health and medical databases and frequency of use of these tools to update professional knowledge. That is, MRS professionals who rate their skill level in using these tools higher, use the tools more frequently to update their professional knowledge than their colleagues who have a lower self-rating of skill level.

MRS professionals rated their skill level in searching the Internet higher than for database searching. For example, 65.1% (n=226) of respondents described their Internet skill level as *very high* or *high* compared to 33.1% (n=118) for database searching. This variance in skill level may also contribute to the higher level of use of the Internet in comparison to health and medical databases by MRS professionals. Almost one-quarter (22.8%, n=81) of survey respondents rated their database searching skill level as *low* or *very low* with a further 12.6% (n=45) reporting that they have never
searched a health or medical database. With over one-third (35.4%, n=126) of MRS professionals having very limited skills in searching databases and just 27% (n=96) having attended any database training program (Appendix J, Q22) there is an immediate need for education and skill development so that these tools can be fully harnessed by MRS professionals to update their professional knowledge. While low level of use of health and medical databases has been reported across health professions (Cole & Kelsey, 2004; Gosling et al., 2003; Griffiths & Riddington, 2001; Guo et al., 2008; McClusky, 2003; O'Leary & Mhaolrunaigh, 2011), the findings from this study demonstrate a relationship between skill level and frequency of use of health and medical databases. Education activities aimed at developing skill level in health and medical database searching would support health professionals to more fully engage with these specialised electronic information tools that are available and can support professional knowledge updating activity.

Thirty eight per cent of respondents (n=136) read journals several times per year. While this appears to be a low level of journal reading for a large number of respondents, lack of access to journals in the workplace and journal publishing patterns may contribute to this finding. As noted in Section 4.2.1 9% (n=30) of respondents reported that they had no access to any of the 96 listed journals. A further 18% (n=58) had access to just one journal. Radiographer, the journal that the majority of survey respondents (63%, n=180) reported they could access, and the journal read by 46% (n=13) of Phase 1 participants, published just three issues per year at the time of data collection. Hence, while the rate of frequency for using journals in this study may be considered low, this may be indicative of lack of access and the publishing patterns of professional journals, in comparison to the Internet, which makes a broad range of current information available to users.

Listservs and tele- or video-conferencing were not widely adopted by the MRS profession to update professional knowledge. Seventeen per cent (n=60) of participants reported using listservs several times per year to update their professional knowledge. In relation to tele- and video-
conferencing, 19% (n=68) of respondents identified that they used these tools several times per year to update their professional knowledge. A low overall level of use of tele- and video-conferencing was also reported by Taylor and Lee (2005) in their investigation of information and communication tools usage by Western Australian occupational therapists. However, Taylor and Lee noted that these tools were used to a greater degree by rural professionals to overcome professional and social isolation, to update professional knowledge and for management and meetings. To investigate if geographic location was associated with frequency of use of listservs and tele- or video-conferencing within the MRS profession, cross tabulations were performed. No statistically significant relationship was shown to exist between geographic location and frequency of use of listservs (Fishers exact test = 12.715, p=0.120) or frequency of use of tele- or video-conferencing (Fishers exact test = 3.664, p=0.923) for updating professional knowledge. Many survey respondents reported that these tools were not available to them in their workplace – listservs 27%, n=56; tele- and video-conferencing 24%, n=83. Lack of access within the workplace may, therefore, contribute to the low level of adoption of tools by MRS professionals that have been identified as useful for overcoming professional isolation and to update professional knowledge.

In sum, this study provides baseline data on the frequency of use of primary mediating tools for updating professional knowledge by MRS professionals. Frequency of use was observed to vary across all examined information sources. This finding was important for this study, as frequency of usage is the dependent variable utilised for hypothesis testing associated with Research Questions 3–5.

While difference in frequency of use across mediating tools was demonstrated in this study, it does not necessarily mean that tools with higher adoption rates are perceived by users as more valuable. Studies investigating usage of multiple information sources have not included a quantitative assessment of the value attributed to the tools (Forrest & Robb,
2000; Gosling & Westbrook, 2004; Guo et al., 2008; O'Leary & Mhaolrunaigh, 2011; Rappolt & Tassone, 2002). This study sought to address this empirical deficit. The following section addresses Research Question 1c, which investigated value attributed to mediating tools for updating professional knowledge.

4.2.3 Value of mediating tools

Research Question 1c examined the value attributed to primary mediating tools for updating professional knowledge identified from Research Question 1a. Specifically the question was:

1c What value is attributed to these tools?

As described in Section 3.2.3.2 survey respondents were asked to rate on a scale from 1 (very important) to 5 (not important) each listed primary mediating tool. A Friedman test was conducted on this data to obtain an overall ranking of the importance MRS professionals attribute to these tools for professional updating activity. Qualitative comments from semi-structured interviews (N=28) serve to illuminate the rankings. The ordered ranking is presented in Table 4.9.
Difference in ranking was observed across the examined mediating tools. The observed difference in ranking for all participants was statistically significant ($\chi^2 = 509.994, df = 8, p < .001$). This indicates that the value attributed to the examined tools for mediating professional knowledge updating activity was not homogenous. For example, seminars and conferences were ranked as having the highest importance for professional knowledge updating activity. This finding is in agreement with Keppel et al. (2001), who similarly reported seminars and conferences were the two preferred information sources for refreshing professional knowledge. In a study examining how rehabilitation therapists integrate new knowledge into professional practice, Rappolt and Tassone (2002) reported that there was an overall preference for interactive education experiences. In a recent study investigating continuing education amongst Australian nurses (Newman et al., 2009), conference workshops were ranked as the second preferred method. The high ranking of seminars and conferences observed in this current study, and in other studies, may reflect both the opportunity they
provide to participants to interact and share knowledge with others outside of the local CoP of their workplace (Wenger, 1998; Wenger et al., 2002), as well as being the traditional initial routes for dissemination of new knowledge within professions (Candy, 1991; Garvey & Griffith, 1972; Garvey et al., 1972).

The Internet was ranked third in overall importance as a mediating tool for professional knowledge updating activity (Table 4.8). While health professionals consider the Internet to be an important tool for learning (Gilmore et al., 2012; Guo et al., 2008; Masters, 2008; Steel & Adams, 2011), its value as a tool for professional knowledge was lower than seminars and conferences. For rural health professionals, attendance at conferences and seminars is problematic due to lack of availability and difficulty attending those held in metropolitan locations (Hegney et al., 2010; Keane, Lincoln, & Smith, 2012). The Internet has been promoted as an important tool for combating the professional isolation of rural health professionals (Herrington & Herrington, 2006; Taylor & Lee, 2005). To ascertain if value attributed to tools by rural MRS professionals would parallel this heightened role for the Internet, an ordered ranking of importance of mediating tools for updating professional knowledge was conducted on data limited to MRS professionals who identified that they were employed in a rural or remote location. Within this group (Table 4.9) the observed difference in ranking was statistically significant \( \chi^2 = 67.522, df = 8, p < .001 \). Again, it was observed that the highest ranked information source for updating professional knowledge was seminars. The value of the Internet as a mediating tool for updating professional knowledge did increase in importance for rural and remote MRS professionals. This signifies the importance this tool has for learning when other preferred tools, such as conferences, are not readily accessible. Despite geographic distance, seminars remained the preferred primary tool for updating professional knowledge. Greater use of the Internet to make seminars and conferences more accessible to rural and remote MRS professionals would facilitate professional knowledge updating.
The Internet was perceived as filling a gap between the information in textbooks that was commonly viewed as out of date, and newer knowledge. This viewpoint was explained by one interview participant when discussing their use of the Internet:

I suppose just bridging the gap between textbook information and new Internet information. A lot of the textbooks by the time they are printed even, the images are fairly old. (SP2 interview)

So while usage of textbooks was high (90%, n=325, Table 4.4), the importance attributed to this tool for updating professional knowledge was ranked lower by survey respondents. Seminars, conferences and the Internet were perceived to offer access to the most current information. The ranking of electronic journals higher than print journals (Table 4.8) also highlights the perceived importance of early access to current information. One interview participant explained this preference when discussing the reading of overseas journals

You know it takes them a month to send a journal from the US … So I actually read it all online a month before I actually get the hard copy. (NMP4 interview)

The preference shown by MRS professionals for electronic journals over their print counterpart contrasts the preference of print over electronic information sources reported by health professionals in earlier studies (Davies, 2007; Forrest & Robb, 2000; Liaw et al., 2004). This difference in preference may reflect an increased availability and hence acceptance of electronic information by health professionals since these earlier studies.

Seminars, conferences and the Internet afford opportunities for communication, such as face-to-face discussion at conferences and seminars and electronic discussion through email and listservs. Knowledge construction is supported through articulation of understanding (Jonassen,
The high value attributed to seminars, conferences and the Internet may also reflect the opportunities for discussion, networking and unpacking the application of new knowledge into daily practice that these tools afford. Utilisation of these tools for updating professional knowledge enables the sharing and construction of professional knowledge and professional practice beyond the workplace, that is, the local CoP, to include broader distributed learning communities that exist within and across professional groups (Wenger et al., 2002). Incorporation of new knowledge from sources external to the local CoP is essential to developing best practice within organisations generally (Wenger, 1998; Wenger et al., 2002) and within healthcare (Meagher-Stewart et al., 2012; Tolson et al., 2005; Westbrook et al., 2004). For example, Meagher-Stewart et al. (2012) investigated the link between evidence-based practice and CoPs and concluded that CoPs act as facilitators enhancing the integration of discipline knowledge, which is external to the local CoP, and tacit knowledge that is context specific to the local workplace. Context sensitivity supports the translation of new discipline knowledge, made available through information sources, into the complex world of local professional practice.

It was also observed (Table 4.9) that journal clubs, which also afford opportunities for discussion, had the lowest importance ranking for updating professional knowledge by participants in this study. This finding may reflect the low level of participation in journal clubs across participants in this study (17.1%, n=58). An ordered ranking of importance of mediating tools for updating professional knowledge was conducted on data limited to MRS professionals who had experience of participating in a journal club. The results are displayed in Table 4.10.
Table 4.10

**Ordered ranking of importance of a range of tools for professional knowledge updating for survey participants who participated in a journal club**

<table>
<thead>
<tr>
<th>Mediating tool</th>
<th>Mean rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminars</td>
<td>3.64</td>
</tr>
<tr>
<td>Conferences</td>
<td>4.04</td>
</tr>
<tr>
<td>Electronic journals</td>
<td>4.46</td>
</tr>
<tr>
<td>Health and medical databases</td>
<td>4.48</td>
</tr>
<tr>
<td>Internet</td>
<td>4.86</td>
</tr>
<tr>
<td>Journal club</td>
<td>5.44</td>
</tr>
<tr>
<td>Formal study</td>
<td>5.92</td>
</tr>
<tr>
<td>Text and reference books</td>
<td>5.97</td>
</tr>
<tr>
<td>Print journals</td>
<td>6.20</td>
</tr>
</tbody>
</table>

The observed difference in ranking of information sources for updating professional knowledge for MRS professionals who had participated in a journal club (Table 4.10) was statistically significant ($\chi^2 = 56.059, df = 8, p < .001$). It was again observed that the two highest ranked information sources for updating professional knowledge were seminars and conferences respectively. Whilst the ranking of importance attributed to journal club did increase, it was not as highly valued as electronic information sources, such as e-journals or health and medical databases, that are purposefully searched to find journal articles for journal club activities.

Despite seminars and conferences having lower usage than other mediating tools such as books and journals (Table 4.4, Section 4.2.1) they were ranked higher in importance by respondents for updating their professional knowledge. Being removed from workplace practice for the duration of the seminar or conference presents professionals with the opportunity for dedicated time where learning is the primary aim. This contrasts with the
experience of busy professionals trying to read a journal article at work, typified by one interviewee:

Just having the time to actually sit down and read through that information, cause normally you have other tasks you need to carry through. It’s always the last thing you might do at the end of the day or during a quiet period or when there are not many patients. That might be something that you do but when there are patients to be scanned or work to be done then reading journals is probably the last thing that happens. (NMP2 interview)

When asked if their workplace provided time during work hours for professional reading (Appendix J, Q30), only 25% (n=78) of survey respondents from clinical workplaces were afforded this form of learning support. Whilst MRS professionals consider that the workplace should allow time during the workday to engage in learning (Henwood, Yelder, & Flinton, 2010) the findings from this study identify that this practice is not widespread in Australia. In essence, for busy professionals reading journals in the workplace competes directly against and is relinquished for other work requirements. This contested environment is not conducive for effective learning and this may negatively impact on MRS professionals’ ranking of journals in terms of their importance as tools to update professional knowledge.

Formal study was ranked 8th (Table 4.8) in terms of importance as a mediating tool for updating professional knowledge. Sixty per cent of respondents either held postgraduate-level qualifications (42.7%, n=153) or were currently undertaking further formal study (17.4%, n=63). The sample population thus had considerable experience with formal study at the postgraduate level. The low ranking of importance of formal study in professional updating activity may be indicative of formal study being undertaken primarily for a different purpose, such as career development. For instance, data from the Australian Bureau of Statistics (2007) identified
that the two most common reasons adults undertake formal study was to get a better job or promotion (28%) and to get extra skills for the job (21%). This suggests that professional knowledge updating is not a primary reason for enrolment in formal education. In essence professional knowledge updating is an activity occurring outside of formal education institutions.

### 4.2.4 Professional knowledge updating model with tools

The findings from this study provide baseline data on the mediating tools utilised by MRS professionals to update their professional knowledge. Usage and a ranked importance of these tools were determined. Figure 4.3 incorporates these identified tools into the professional knowledge updating model.

**FIGURE 4.3:** PROFESSIONAL KNOWLEDGE UPDATING MODEL FOR MRS PROFESSIONALS (ADAPTED FROM ENGESTRÖM, 2001) DISPLAYING MEDIATING TOOLS.

MRS professionals (subjects) update their knowledge (object) utilising multiple mediating tools. While books and journals were used to update professional knowledge by the highest number of survey participants (90%, n=325; 88.1%, n=317 respectively), they were not ranked as the most
important tools for this activity. The top three information sources, in terms of importance for updating professional knowledge were, in ranked order: seminars, conferences and the Internet. The overall ranking of seminars and conferences as the two most highly valued information sources for updating professional knowledge highlights the importance that these non-electronic information sources continue to play in professional learning, offering access to both the most recent research and opportunities for knowledge sharing. The Internet was ranked 3rd in terms of importance for updating professional knowledge, a higher ranking than observed in the earlier study by Keppell et al. (2001). Respondents perceived the Internet as filling the gap between discipline knowledge available in books and new discipline knowledge. The higher ranking of the Internet in this study is indicative of its increased importance as a mediating tool for updating professional knowledge.

In addition, a low level of awareness and low skill level in using specialised electronic health and medical databases was shown to exist across the MRS profession, a finding that has similarly been reported across health professions (Cole & Kelsey, 2004; Gosling et al., 2003; Griffiths & Riddington, 2001; Guo et al., 2008; McClusky, 2003). As this study established that there is a positive relationship between skill level and frequency of use of specialised health and medical databases, educational activities aimed at developing skill level in health and medical database searching would support health professionals more fully engage with these specialised electronic information tools that are available and can support professional knowledge updating activity.

Having established the primary mediating tools, the next research question in this study sought to further develop the professional knowledge updating model by investigating the object of activity.
4.3 Research Question 2

As previously discussed the rapid rate of change of discipline knowledge and advances in technology underpin the imperative for health professionals to update their knowledge. While ‘update knowledge’ provides a generic descriptor of the object of activity (Figure 4.4), Research Question 2 sought to provide a more detailed account by examining the areas of professional knowledge that are updated by MRS professionals.

Specifically the research question was:

What areas of knowledge are updated?

Figure 4.4 portrays the relationship of Research Question 2 to the activity system model.

*Figure 4.4: Professional Knowledge Updating Activity Model (Adapted from Engeström, 2001) Displaying Research Question 2.*
Research Question 2 examined knowledge areas updated by MRS professionals. Descriptive statistics were generated from survey data (N=362) to determine the number of MRS professionals who update knowledge in each listed area. The results are displayed in Table 4.11.

Table 4.11

<table>
<thead>
<tr>
<th>Knowledge area</th>
<th>Percentage * (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical diseases/pathology</td>
<td>79.2 (282)</td>
</tr>
<tr>
<td>Anatomy</td>
<td>65.4 (233)</td>
</tr>
<tr>
<td>New technologies</td>
<td>63.2 (225)</td>
</tr>
<tr>
<td>Procedure or treatment techniques</td>
<td>62.6 (223)</td>
</tr>
<tr>
<td>Professional issues, e.g., role development, CPD</td>
<td>52.5 (187)</td>
</tr>
<tr>
<td>New applications of technologies</td>
<td>49.4 (176)</td>
</tr>
<tr>
<td>Guidelines</td>
<td>47.2 (168)</td>
</tr>
<tr>
<td>Physiology</td>
<td>43.8 (156)</td>
</tr>
<tr>
<td>Procedure or treatment effectiveness</td>
<td>39.9 (142)</td>
</tr>
<tr>
<td>Product information, e.g., implant type, contrast medium</td>
<td>32.6 (116)</td>
</tr>
<tr>
<td>Medical equipment or supplies</td>
<td>32.0 (114)</td>
</tr>
<tr>
<td>Procedure or treatment comparison across workplaces</td>
<td>22.5 (80)</td>
</tr>
<tr>
<td>Resources for patients</td>
<td>15.7 (56)</td>
</tr>
</tbody>
</table>

* Percentages are based upon number of respondents answering each question, that is, the valid percentage is reported

MRS professionals update their professional knowledge across a range of areas. The top four areas in which knowledge is updated are all core components of undergraduate MRS programs (Australian Institute of Radiography, 2004, 2010). This suggests that the principal activity of updating professional knowledge is constantly adding new information to the foundational knowledge developed as undergraduate students. This reinforces the contention that professional knowledge updating is an activity mediated by information sources. In particular, it is indicative of the additive approach to learning with information sources described in Section 2.3.
The majority of respondents (79.2%) reported that they seek current information on medical diseases or pathology. This finding parallels a recent study of Australian health professionals. In this study, Usher (2011) examined the information seeking behaviour of five health professions. Across all examined professions, the medical or health conditions of patients was the primary area of information sought. Similarly, earlier work by Bryant (2004) examined the information needs of medical practitioners and reported that information was sought primarily in relation to patient care. Within the MRS profession, knowledge needed on the presenting medical disease provides a catalyst for learning mediated by tools to occur. One interviewee helped exemplify the immediacy of this workplace learning activity:

Very often in daily scanning pathology comes through that we are not familiar with and I find I sit down at the computer and look it up. (SP1 interview)

In this example, a MRS professional (subject) identifies that they need to learn about a particular medical condition so they use the Internet (tool) to expand their knowledge of medical disease (object) specific to the clinical case. Without this new knowledge the examination performed may comprise the diagnosis of the patient's medical condition. It is reasonable to suggest that this needed new information to extend the individual's professional knowledge must be readily accessible within the workplace. As noted in Section 4.2.1, the workplace was a primary provider of short conferences, seminars and workshops, which are all tools, utilised by MRS professionals to update their professional knowledge. It is also apparent that other tools, such as the Internet and the time to search for needed information, must also be readily available within the workplace so MRS professionals can respond to their immediate need for information required to perform the presenting clinical procedure. The accessibility of information sources and protected learning time within the workplace is the focus for Research Question 5 (Section 5.3).
Although the emphasis underpinning the need for CPD for MRS professionals is on technological change (Australian Institute of Radiography, 2007; Society of Radiographers, 2007), the findings from this study illustrate that it is neither the new technologies nor their direct application that are the areas in which new knowledge is most commonly sought. The important role that vendors play in supporting learning encompassing technological advances has been identified within the United Kingdom (Society of Radiographers, 2007) and, as previously identified in this study (Section 4.2.1), they are providers of workshops and seminars attended by approximately 20% of MRS professionals to update their knowledge. Rather, the findings from this study highlight that the primary reason for updating professional knowledge relates to the medical condition of presenting patients, a finding consistent with other studies examining information-seeking behaviour of health professionals (Bryant, 2004; Gilmore et al., 2012; Jones & Lambros, 2003; Usher, 2011). As the need to update knowledge can arise during the conduct of daily professional practice, the important role that workplaces must play in supporting professional knowledge updating is highlighted. However, as previously noted (Section 2.4.4.2), CPD documentation in Australia does not include a specific role for workplaces in supporting professional learning. Rather, the current approach of portraying CPD as the responsibility of the individual health professional (Australian Health Workforce Ministerial Council, 2010; Australian Institute of Radiography, 2007; Chiropractic Board of Australia, 2010; Medical Radiation Technologists Registration Board of Western Australia, 2009) ignores the essential link this learning has to the daily provision of high-quality healthcare.

Despite the acknowledged importance of evidence based practice (EBP) for MRS professionals for over a decade (Bentzen, 1998; Brealey, 2001; Hafslund, Clare, Graverholt, & Wammen Nortvedt, 2008; Howson, Scutter, & Hillier, 2010; Langmack & Routsis, 2006; Pickersgill, 2007; Smith, 2008), investigation of the effectiveness of procedures or examinations was not widely adopted (39.9%, n=142). Survey respondents specialising in radiation
therapy reported higher level of knowledge updating directed toward
effectiveness of procedures or examinations (35%, n=27) than other
specialisations: nuclear medicine (9%, n=4); radiography (12%, n=22); and
sonography (5%, n=3). This may be due to EBP and support for involvement
in research being at the implementation phase within radiation therapy
(ACORRN Research Radiographer Working Party, 2007; Bolderston,
Harnett, Palmer, Wenz, & Catton, 2008; Pacitti, 2005), whereas this does not
yet appear to be the case in other areas of specialisation (Fauber & Legg,
2003, 2004; Gambling, Brown, & Hogg, 2003). To test this assertion, further
interrogation of survey data analysing level of use of Cochrane Library, a key
resource for implementing EBP (Snowball, 2005; Veness et al., 2003),
against area of specialisation was undertaken. Forty-four per cent (n=30) of
survey respondents specialising in radiation therapy reported that they
utilised Cochrane Library, a level of use similar to that reported by
Australasian radiation oncology registrars: 49% (Wong & Veness, 2005).
This finding suggests there may be a similarity of support for using EBP tools
within radiation therapy and radiation oncology practice in Australia. In
contrast, a lower level of use of Cochrane Library across other areas of
specialisation within MRS (nuclear medicine 17%, n=7; radiography 11%
sonography 20%, n=11) suggests use of EBP tools may not yet be as
developed or supported within these three areas of specialisation within the
MRS profession.

The least common area of knowledge updating by survey respondents
related to resources for patients. This area in which MRS professionals
update their knowledge was more common amongst respondents
specialising in radiation therapy (36%, n=27) than for other areas of
specialisation (nuclear medicine 9%, n=4; radiography 12%, n=22;
sonography 5%, n=3). This finding is indicative of radiation therapists having
a recognised role in patient education and management, as identified in the
recent study by Halkett, Short and Kristjanson (2009). Within the nursing
profession, Gilmour et al. (2012) have identified that nurses have an
important role in helping patients understand and evaluate information they
are reading from the Internet about their health condition. This is because almost two-thirds of the nurses who assessed patients' use of online information were aware that patients had misconceptions of their clinical condition because of what they had read on the Internet. Consequently, Gilmore et al. advocate nurses take a proactive new role in supporting patients to find and understand good quality online health information related to their clinical condition. Across the MRS profession in general, and in particular within radiation therapy, this proactive approach may similarly transform the role from one of information resource provider to supporting patients to develop the knowledge and skills needed to find and understand information relevant to their health condition.

4.3.1 Professional knowledge updating model with object

The findings from this study provide baseline data on the areas of professional knowledge updated by MRS professionals. Figure 4.5 incorporates these identified knowledge areas into the professional knowledge updating model within object of activity.

**Figure 4.5: Professional knowledge updating model for MRS professionals** (adapted from Engeström, 2001) displaying areas of knowledge updated.
MRS professionals (subjects) update their knowledge (object) using multiple information sources (tools). The primary areas that are updated encompass general medical knowledge of pathology, anatomy and physiology, discipline-specific knowledge of procedures and professional issues, as well as technological advances and discipline-specific applications. These areas of knowledge updating are reflected in the range of journal titles read by MRS professionals (Section 4.2.1) and are supportive of the assertion that the MRS knowledge base has been strongly informed by medicine, nursing and physics (Decker & Iphofen, 2005; Larkin, 1978).

Past president of the Australian Institute of Radiography described the MRS professional as synthesising science and professional expertise into service “for and to our patients, who are the very reason for our professional existence” (Harvey, 2012, p. 3). If Harvey’s assertion is correct, it may appear reasonable to suggest that professional knowledge updating within the MRS profession can influence patient outcomes. The following section addresses outcomes of professional knowledge updating activity.

### 4.4 Additional insights gained from this study

As represented in Engeström’s Activity System model (2001), there are outcomes for mediated learning activity. The outcomes of professional learning were previously identified in Section 2.5.3 as occurring for patients, organisations and individuals. Semi-structured interviews (N=28) provided data to investigate the perceived outcomes of professional knowledge updating activity for the MRS profession.

Twenty-seven of the 28 interview participants identified that when the MRS professionals possess updated or current knowledge (object), there are benefits or improved outcomes to patients, organisations and the individual professional. Twenty-seven participants identified that updated knowledge has benefits for the patient. This is well noted by one interview participant:
If they miss something or their knowledge is poor and they don’t understand what they are looking at and they don’t take the image in 99.9% of the time that is then totally missed … and that’s why if they are not kept up to date … and if they don’t know what’s abnormal well then they’re not going to, unlikely to extend the examination and so other pathology can be missed and we see that regularly within our practice where we have second referrals from other areas where people obviously haven’t had the understanding in their everyday scanning and they have missed pathologies. (SP1 interview)

This comment suggests that when MRS professionals have current knowledge the examination they perform is more comprehensive, demonstrating the full extent of the medical condition and thereby improving the accuracy of diagnosis of the patient’s medical condition. This supports the inclusion of improved patient outcomes within the professional knowledge updating Activity System model portrayed in Figure 4.5.

As previously noted, the most common reason health professionals use information sources is to find information related to the medical condition of their patients. A large number of health professionals also link learning with information sources to improved patient care. For example, 90% of allied health professionals (Gosling & Westbrook, 2004) and 85% of nurses (Gosling, Westbrook, & Spencer, 2004) believe that information they access from electronic evidence resources has the potential to improve patient care. In relation to health professionals’ clinical practice, 65% of radiation oncologists reported that information searches and professional reading had changed their clinical practice in the last month (Veness et al., 2003). Amongst nurses, those that used the Internet at work reported that more of their practice was based on the latest research findings (O’Leary & Mhaolruneigh, 2011). Health professionals also had evidence that accessing information improved patient care. Sixty-nine per cent of pharmacists and 53% of physiotherapists reported that they had direct experience that
accessing information improved patient care (Gosling & Westbrook, 2004). Across health professions, the inclusion of improved patient outcomes within the professional knowledge updating Activity System model appears, therefore, to be supported.

Employing organisations were also identified as beneficiaries when MRS professionals have current updated professional knowledge. They gain through improved service provided to patients, as noted above, and also through improved service to the referring physicians, enhancing the organisation’s viability. For example:

> It’s also important to us I guess, especially in private practice, that we produce the best possible results so that we stay in business. We have to be seen also to be up to date and have number one, state-of-the-art equipment but also to be seen to, if suddenly we get a call from a referrer saying ‘can we do this’ or ‘can we do that’ it’s important that we can demonstrate that we are entirely up to date and if they’ve heard something we should have heard about it before. (NMP2 interview)

Staff with current knowledge is perceived as benefiting organisations, as referring physicians will have confidence that this particular organisation has current knowledge of new procedures and techniques. The inclusion of improved organisational outcomes within the professional knowledge updating Activity System model for the MRS profession (Figure 4.5), therefore, appears reasonable.

Two interviewees in Phase 1 (RTA1, NMA2) identified that the individual MRS professional benefited as a consequence of engaging in knowledge updating activity. Both participants portrayed this as the individual MRS’s professional learning. Learning at the level of the individual thus supports the inclusion of improved individual outcome within the professional knowledge updating Activity System model as portrayed in Figure 4.5. More broadly,
health professionals purposefully seek information to ‘fill knowledge gaps’ (Bryant, 2004; Gosling & Westbrook, 2004; Gosling et al., 2004; Westbrook et al., 2004). This finding supports the inclusion of improved individual outcomes within the professional knowledge updating Activity System model across health professions.

A further insight into Activity System models was derived from this study. In Activity System models the arrow from the object of activity to the outcome is represented as a one-way arrow, object → outcome (Barab et al., 2004; Engeström, 1999, 2001; Kaptelinin & Nardi, 2006). The findings from this present study suggest that there is a two-way relationship between object ↔ and outcome. As discussed previously, 27 of the 28 interview participants described the patient as benefiting (outcome) when MRS professionals engage in professional updating activity (object). This finding does support the traditional one-way relationship object → outcome (Figure 4.5).

However, it was also apparent from interview participants that improving patient outcome was their primary consideration. This was illustrated across interview participants and is exemplified by one interviewee:

I think the reason we’re in this sort of field is that we want to see the best possible outcomes for our patients so I think that’s the, it’s always the bottom line that we want to do things better. (NMP2 interview)

From analysis of interview data, it appears that MRS professionals’ desire to improve patient outcome is also a driver for updating knowledge. Thus, the desire to improve patient outcomes results in the purposeful updating of knowledge (object), that is, outcome → object by health professionals. One interviewee articulates this contention:

You look to the evidence base to what’s the best way you can do what you’re doing. What’s the best service you can provide for your patients with the best possible outcome? (RTP1 interview)
In order to provide the best outcome for their patients, MRS professionals purposefully utilise information sources to access the evidence base and update their knowledge, outcome → object. A double-ended arrow, object ↔ outcome, therefore, is introduced into the professional knowledge updating activity system (Figure 4.6).

### 4.4.1 Professional knowledge updating model introducing two-way relationship between object and outcome

The professional knowledge updating model was modified to demonstrate that the outcome of activity, in this case, for example, improving patient outcomes, can drive MRS professionals to update their knowledge (object).

![Figure 4.6: Professional knowledge updating model (adapted from Engeström, 2001) introducing two-way relationship between object and outcome.](image)

Figure 4.6 displays the professional knowledge updating model, introducing a double-ended arrow, object ↔ outcome. The introduction of the double-ended arrow, object ↔ outcome, within an activity system may have broader...
applicability than this current study. Consider, for example, Verenikina’s (2010) activity system for a teacher’s activity mediated by ICT in a classroom. This activity system has the one-way arrow pointing from the object of “effective learning using computer technologies” (p. 21) toward the outcome of “enhanced (or not enhanced) learning” (p. 21). It may be reasonable to suggest that if ‘not enhanced learning’ was the outcome, then if the teacher or others reviewed and reflected upon the outcome in relation to the object then the outcome could act to drive the activity of teachers developing effective learning activities with new computer-based technologies. Thus, a double-ended arrow between outcome and object can exist in other activity systems.

4.5 Addressing Research Questions 1 and 2

The following section discusses the importance and implications of the findings associated with Research Questions 1 and 2. This study aimed to investigate learning mediated by information sources within the context of professional knowledge updating within a health profession. A summary of findings in relation to Research Question 1 and 2 is displayed in Table 4.12.
In relation to Research Question 1, this study provides baseline data to the MRS profession on the value and use of information sources to update professional knowledge. It has been established in this study that the majority of MRS professionals use books, journals, Internet web pages and search engines, conferences, health and medical databases, seminars and workshops for the purpose of updating their professional knowledge. This finding is consistent with other studies that demonstrate that health professionals use information sources to support their own learning. For example, the primary reason health professionals use information sources such as journals, Internet and health and medical databases is for personal learning (Bryant, 2004; Gosling & Westbrook, 2004; Gosling et al., 2004).

The detailed investigation in this study of journals utilised by MRS professionals to update their professional knowledge has identified a number of discipline-specific journals for nuclear medicine, radiation therapy,
radiography and sonography as well as journals within the broad categories of cardiology, education, general medicine, oncology and physics that have not previously been identified as key journals for the MRS profession. The findings from this study extend the body of knowledge on core journals within the MRS profession.

The contemporaneous use of multiple information sources indicates that professional knowledge updating operates concurrently as an individual and a shared learning activity. On an individual basis, MRS professionals read books (90%) and journals (88.1%) and search for information using the Internet (86.8%) and health and medical databases (73.9%) to construct their professional knowledge. MRS professionals also engage in activities that provide opportunities to access new information as well as learn with others. For example, three-quarters of MRS professionals reported that they attend the national conference of their professional society (75.3%) and seminars (61.4%) to update their professional knowledge. Conferences and seminars provide participants with the latest knowledge in their discipline area as well as present opportunities for participants to discuss findings and their implementation into daily practice. In such cases, knowledge construction can expand beyond the individual and become an active shared process amongst those who share a common language and practice (Billett, 1995; Lave & Wenger, 1991), in this case MRS professionals.

When information sources and search engines are purposefully used for learning they become cognitive tools supporting active intentional knowledge construction (Hill et al., 2004; Jonassen et al., 2008; Jonassen, 2000). The new information, obtained from tools such as seminars, conferences and journals, and web pages and books, can be used both to expand knowledge by adding factual information (Kegan, 2009; Todd, 1999, 2006) and also to reconstruct knowledge by, for example, linking previously unconnected concepts and deleting previously held understandings and accepting something that is new or different (Illeris, 2009; Todd, 1999, 2006). Kegan (2009) distinguishes these two forms of learning with information as in-form-
ative and trans-form-ative. Informative learning brings valuable new content to expand an already existing knowledge framework, whilst transformative learning changes the framework itself, through greater linkage and coherence of understanding. Professional knowledge updating can involve both informative and transformative learning, both of which are necessary for developing and maintaining expert knowledge in the learner’s discipline area (Barba & Rubba, 1992; Bryce & Blown, 2012; Kegan, 2009).

In relation to providers of information sources utilised by MRS professionals to update their knowledge, major contributors have been identified. The workplace has been identified as a major provider, organising workshops, seminars and short-duration conferences for their employees. Professional societies support knowledge updating through their provision of journals, conferences, seminars and, to a lesser extent, workshops. Vendors and universities were identified as having a more limited role as providers of these types of information sources. The high number of MRS professionals attending conferences, seminars and workshops outside of their workplace is indicative of their participation in multiple communities that share local professional practices – that is professional knowledge updating extends beyond the local CoP of the workplace, encompassing multiple CoPs that operate within the broader MRS profession. Through participation in these distributed learning communities (Wenger et al., 2002) MRS professionals can update and share new knowledge, techniques and tools beyond their workplace. This integration of new knowledge from outside the local CoP is an essential aspect for developing best practice within organisations (Wenger, 1998; Wenger et al., 2002) and within and across professions (Meagher-Stewart et al., 2012; Rolls et al., 2008; Tolson et al., 2005).

The professional knowledge updating Activity System model (Figure 4.6) is inclusive of both individual and shared learning, that occurs within and external to the workplace. For instance, as an individual learning activity it includes the individual MRS professional (subject), purposefully reading a journal (tool) or undertaking an Internet search (tool) to update their
knowledge (object). This learning activity can occur within the workplace, such as when an MRS professional uses the Internet to respond to an immediate need to update knowledge on a presenting pathology (Section 4.3), or at home when the MRS professional reads their professional journal. Access to professional journals for health professionals is typically obtained through personal subscription (Turner & Mjolne, 2001; Turner & Whitfield, 1997). As a shared learning activity, professional knowledge updating extends to include opportunities for communication and discussion with others within and external to the workplace at, for example, workshops and seminars held in the workplace or externally provided by professional societies and vendors, conferences, listservs and journal clubs. Professional knowledge updating can then encompass both the local CoP, which exists in a given workplace, and the broader distributed communities that operate within and across workplaces and professional groups (Lathlean & le May, 2002; Price & Felix, 2008; Rolls et al., 2008; Tolson et al., 2005; Wenger et al., 2002).

The continued importance of non-electronic information sources in professional learning is also evident in this study. The overall ranking of seminars and conferences as the two most highly valued information sources for updating professional knowledge in this study is in accord with the earlier finding by Keppell et al. (2001). However, attention continues to focus on electronic information sources to support learning (Frandsen, 2009; Gilmore et al., 2012; Gilmore et al., 2008; Jonassen et al., 2008; Usher, 2011; Younger, 2010). It is, therefore, important that research of information sources as mediation tools in learning are inclusive of the range of information sources that are currently used for a particular purpose. It is also evident that for rural and remote professionals the Internet does assume a higher level of importance as a mediation tool, albeit behind that of seminars. For these professionals, effective access to seminars and the Internet would facilitate their knowledge updating activity.
In relation to Research Question 2, this study established that the principal area in which MRS professionals seek information was medical or health conditions of patients. Similarly, it has been recognised across multiple health professions that information is primarily sought in relation to the patient’s medical condition (Bryant, 2004; Usher, 2011). Furthermore, health professionals report that the information they obtain from the Internet and health and medical databases is used to modify and improve patient care (Bennett et al., 2007; Gosling & Westbrook, 2004; Gosling et al., 2004; Jones & Lambros, 2003; O’Leary & Mhaolrunaigh, 2011; Usher, 2011; Veness et al., 2003; Westbrook et al., 2004). Across health professions learning with information sources is an important activity used to improve patient care. Information sources that provide current relevant health information must, therefore, be readily accessible in the workplace so that care of the patient is not compromised (Gosling et al., 2003; Hall, 2008; Scott, Heyworth, & Fairweather, 2000). Accessibility of information sources in the workplace is addressed in Chapter 5.

As noted in Section 2.5.4, learning in professional knowledge updating activity system is situated within the context of professions and workplaces. Learning activity may be influenced by factors within these contexts, affording or constraining level of activity. Factors influencing level of knowledge updating activity are addressed in Chapter 5.
Chapter 4 identified the primary mediating tools for professional knowledge updating. Chapter 5 investigates factors influencing both individuals’ intensity of use of these mediating tools and also their access to these tools within the workplace environment. Specifically, this chapter reports on the findings derived from the quantitative data to address Research Questions 3 through to 5 and their associated hypotheses.

Research Question 3 was: **What factors associated with professions influence the use of mediating tools in updating professional knowledge?**

Research Question 3 was operationalised as two null hypotheses:

**H1** Level of use of mediating tools in professional knowledge updating activity will be no different for membership of a professional society.

**H2** Level of use of mediating tools in professional knowledge updating activity will be no different for enrolment in a CPD program.

Research Question 4 was: **Does workplace accessibility of mediating tools influence their use in updating professional knowledge?**

Research Question 4 was operationalised as two null hypotheses:
H3 Level of use of mediating tools in professional knowledge updating activity will be no different for physical access to these tools in the workplace.

H4 Level of use of mediating tools in professional knowledge updating activity will be no different for effective access to these tools in the workplace.

Research Question 5 was: What factors influence workplace accessibility of mediating tools to MRS professionals and do hierarchies of access to these tools exist across workplaces?

Research Question 5 was operationalised as seven null hypotheses:

H5 Workplace accessibility of mediating tools will be no different for workplace profile, work context (university, clinical).

H6 Workplace accessibility of mediating tools will be no different for workplace profile, health sector (public, private).

H7 Workplace accessibility of mediating tools will be no different for workplace profile, geographic location (metropolitan, regional and rural and remote).

H8 Workplace accessibility of mediating tools will be no different for workplace profile, workplace type (teaching hospital, non-teaching hospital, clinic).

H9 Workplace accessibility of mediating tools will be no different for workplace professional profile, area of specialisation (nuclear medicine, radiation therapy, radiography, sonography).

H10 Workplace accessibility of mediating tools will be no different for workplace professional profile, employment role (manager, senior practitioner, practitioner, clinical educator).
H11 Workplace accessibility of mediating tools will be no different for workplace professional profile, employment fraction (full time, part time)

Section 5.1 presents the findings addressing Research Question 3 and its related two hypotheses. This question relates to professional factors (rules) that may influence level of knowledge updating activity. Section 5.2 addresses a second set of factors related to workplace access to tools that may influence level of knowledge updating activity. The third section expands upon this data by investigating the factors that influence individuals’ access within the workplace to primary tools for updating professional knowledge. The final section interprets the findings in the context of current literature related to professional and workplace factors influencing knowledge updating activity.

5.1 Research Question 3

Engeström’s (2001) Activity System model posits that rules influence activity. Rules refer to given or negotiated guidelines, directives or regulations that influence the activity system (Engeström, 2001). In relation to professions, voluntary membership of a professional society and enrolment in CPD program were identified from the reviewed literature as factors that may influence the level of professional knowledge updating activity. Research Question 3 sought to establish if voluntary membership of a professional society and enrolment in a CPD program (viewed in this research as a rule in Engeström’s (2001) Activity System model) influences the level of use of information sources in professional knowledge updating activity.

Specifically, the research question was:

What factors associated with professions influence the use of mediating tools in updating professional knowledge?
To respond to this question, data from the survey (N=362) was analysed in the context of two null hypotheses:

**H1** Level of use of mediating tools in professional knowledge updating activity will be no different for membership of a professional society.

**H2** Level of use of mediating tools in professional knowledge updating activity will be no different for enrolment in a CPD program.

Figure 5.1 displays the relationship of these hypotheses the activity system model.

*Figure 5.1: Professional knowledge updating model for MRS professionals (adapted from Engeström, 2001) portraying the two hypotheses, H1 and H2, associated with research question 3.*

Figure 5.1 portrays two factors under *rules* that may influence level of professional knowledge updating activity – membership of a professional society and enrolment in a CPD, represented as Hypothesis 1 and Hypothesis 2, respectively.
5.1.1 H1 Membership of a professional society

The first rule identified in the Engeström 2001 model that potentially influences the level of professional updating activity relates to an individual’s membership in a professional society. Hypothesis 1, stated in the null, predicts no relationship between professional membership and knowledge updating activity. Specifically, hypothesis 1 was:

**H1 Level of use of mediating tools in professional knowledge updating activity will be no different for membership of a professional society.**

Survey data (N=362) was analysed for those who held and did not hold membership of an Australian professional society (Table 5.1).

---

**Table 5.1**

<table>
<thead>
<tr>
<th>Influencing factor in Engeström’s Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Characteristic</td>
<td>Frequency</td>
</tr>
<tr>
<td><strong>Rule</strong></td>
<td>Membership of professional society</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>285</td>
<td>79.0</td>
</tr>
<tr>
<td>No</td>
<td>77</td>
<td>21.0</td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>100.0</td>
</tr>
</tbody>
</table>

To test Hypothesis 1, cross tabulations were performed for a range of professional knowledge updating activities for those holding and not holding membership of an Australian professional society. Table 5.2 displays the results for both groups.
### Table 5.2

*Activities undertaken to update professional knowledge for members and non-members of an Australian professional society*

<table>
<thead>
<tr>
<th>Activities undertaken</th>
<th>Member Per cent&lt;sup&gt;a&lt;/sup&gt; (No.)</th>
<th>Non-member Per cent&lt;sup&gt;a&lt;/sup&gt; (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attend annual conference of professional society**</td>
<td>83 (235)</td>
<td>47 (36)</td>
</tr>
<tr>
<td>Read journals**</td>
<td>92 (261)</td>
<td>73 (56)</td>
</tr>
<tr>
<td>Read books</td>
<td>92 (261)</td>
<td>84 (64)</td>
</tr>
<tr>
<td>Internet search</td>
<td>88 (244)</td>
<td>83 (64)</td>
</tr>
<tr>
<td>Health and medical database search</td>
<td>76 (213)</td>
<td>66 (50)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Percentages are based upon number of respondents answering each question, that is, the valid percentage is reported

<sup>**</sup> Difference significant at p<.01 level

Difference was observed across all activities, with more respondents holding membership with a professional society engaging in professional updating activity. Chi-square test of independence and Fisher’s exact test were employed as statistical tests of difference between groups, with selection of test determined by cell size (see Section 3.2.3.3). The observed difference in frequency of use of two mediating tools in professional updating activity was statistically significant for frequency of attendance at annual conference of the professional society ($\chi^2 = 44.510 (df = 3), p < .001$) and reading journals (Fisher’s exact test = 18.879, $p \leq .001$) between those who hold and elect not to hold membership with a professional society. Sixty-two per cent (n=177) of research participants who held membership of a professional society reported that they attend at least one conference every two years. In comparison, 28% (n=21) of non-members of professional societies reported the same frequency of conference attendance. The finding that membership of a professional society is positively associated with attendance at professional conferences is supportive of previous findings by Landers et al. (2005). The authors reported that membership of professional societies
positively influenced level of engagement in formal learning activities. Whilst Landers et al. did not provide a definition of formal learning activities, CPD programs typically classify conferences as formal learning activities (Australian Institute of Radiography, 2007; Chiropractic Board of Australia, 2010; General Medical Council, 2013; Health Professions Council, nd). Members of a professional society may be adopting a norm or rule, by regular attendance at professional conferences. That is, professional societies expect their members to regularly attend conferences to update their knowledge and they encourage their attendance by offering discount registration fees. For example, the Australian Institute of Radiography offered their members a significant discount in registration to their 2012 national conference (50–67%) compared to registration fees for non-members (Australian Institute of Radiography, 2012).

A statistically significant positive association was also shown to exist between membership of a professional society and reported frequency of reading of journals. Ninety-two per cent of MRS professional holding membership with a professional society read journals to update their professional knowledge, compared to 73% who do not elect to belong to a professional society. The finding that a higher percentage of members of professional societies read journals may be attributed to members of professional societies reading at least the journal associated with the society. Twenty seven per cent (n=21) of research participants who were not a member of a professional society reported that they never read journals. In contrast, 8% (n=21) of participants who held membership reported that they never read journals. Membership of a professional society, such as the Australian Institute of Radiographers or Australian Sonographers Association, provides access to their professional journal. Participants who do not hold membership of a professional society may not have easy access to journals. This finding may not be surprising, as the primary journal read by health professionals is the journal of their professional society and this is typically accessed through personal subscription (Turner & Mjolne, 2001; Turner & Whitfield, 1997), involving an associated cost to the individual.
The difference in participation level for the other examined activities, such as reading books and searching the Internet or health and medical databases, was not statistically significant ($p > .05$). This finding indicates that there is no relationship between membership of a professional society and level of use of the Internet, health and medical databases and books for updating their knowledge. It would appear that the influence of professional societies on use of tools for updating knowledge is limited to tools over which professional societies exert some control. For example, professional societies produce journals and organise conferences and seminars to support the continued learning of their members.

The relationship between membership with a professional society and attendance at seminars organised by professional societies and workplaces attended was also examined. As number of seminars attended was not normally distributed the Mann-Whitney U test was employed. The difference in attendance at seminars organised by a professional society was significant ($Z = -2.581$, $p = .01$) between those holding membership with a professional society (median = 0, IQR = 1) and those who do not (median = 0, IQR = 0). The difference in number of seminars attended organised by workplace was not significant ($p > .05$) between respondents holding (median = 0, IQR = 1) or not holding (median = 0, IQR = 1) membership with a professional society. Given that attendance at workplace seminars was not statistically significant across those holding or not holding professional society membership, the finding that a statistically significant relationship exists between membership of a professional society and attendance at seminars organised by professional societies supports the earlier assertion that the relationship between membership of a professional society and use of tools in knowledge updating is limited to the tools over which the professional society exerts control.

This study has shown that membership of a professional society was consistently associated with an observed increase in use of mediating tools.
in professional updating activity. Difference between groups was shown to be statistically significant for attendance at conferences and seminars organised by a professional society and frequency of reading journals.

Based on these results H1 was rejected: there is a positive relationship between membership of a professional society and level of use of mediating tools in professional knowledge updating.

Consequently, membership of a professional society was included as an influencing rule in the professional knowledge updating activity system, as shown in Figure 5.2. The association between membership of professional societies and use of tools in knowledge updating was observed to be limited to the tools over which the professional society exerts control.

### 5.1.2 H2 Enrolment in continuing professional development program

The second rule identified in the Engeström (2001) model that may influence level of professional updating activity is enrolment in a CPD program. Hypothesis 2, stated in the null, predicts no relationship between enrolment in a CPD program and knowledge updating activity. Specifically Hypothesis 2 was:

H2 Level of use of mediating tools in professional knowledge updating activity will be no different for enrolment in a CPD program.

Survey data was analysed for those who were enrolled and those not enrolled (Table 5.3) in a CPD program.
To test Hypothesis 2, cross tabulations were performed on a range of professional knowledge updating activities for those enrolled (n=265) and those not enrolled (n=96) in a CPD program. Table 5.4 displays the results for both groups.

Differences were observed across all activities, with more respondents enrolled in a CPD program engaging in the examined professional updating activity. Chi-square test demonstrated that the observed difference in frequency of attendance at annual conference of the professional society was
statistically significant ($\chi^2 = 46.075 (df = 3), p < .001$) between those enrolled and not enrolled in a CPD program. At the time of this study, CPD requirements were introduced by professional societies, such as the Australian Institute of Radiography. Ninety-two per cent (n=243) of participants enrolled in a CPD program did hold membership with one or more professional societies. As previously established, a positive relationship was shown to exist between membership of a professional society and attendance at conferences. The finding that enrolment in a CPD program is positively associated with attendance at conferences may reflect the high number of participants who are enrolled in a CPD program and hold membership of a professional society and, thus, receive discount registration to attend their annual conference. The allocation of points awarded to activities within CPD programs may also contribute to this finding. For example, organised events such as conferences and seminars approved by the professional society for their CPD program are allocated higher points than self-directed reading and information searching (Australian Institute of Radiography, 2007). This differential points weighting across learning activities may, therefore, also influence the tools that are used by MRS professionals to update their knowledge.

The observed difference in participation level for the other examined activities was not statistically significant ($p > .05$) between respondents enrolled and not enrolled in a CPD program. This finding indicates that there is no relationship between enrolment in a CPD program and an individual’s level of use of the Internet, health and medical databases and books for updating their professional knowledge. It would appear that the influence of CPD programs on use of tools for updating knowledge does not extend to these non-formal information sources.

In addition, the relationship between enrolment in a CPD program and attendance at seminars organised by professional societies and workplaces was examined. After testing for the assumption of equal variance (Levene’s statistic), Mann-Whitney U test demonstrated that difference in number of
seminars attended organised by a professional society was statistically significant \((Z = -3.320, p = .001)\) between those enrolled (median = 0, IQR = 1) and not enrolled (median = 0, IQR = 0) in a CPD program. The difference in number of seminars attended organised by the workplace was not significant \((p>.05)\) between respondents enrolled (median = 0, IQR = 1) and not enrolled (median = 0, IQR = 1) in a CPD program. Seminars that run in the workplace are likely to be equally accessible to those enrolled or not enrolled in a CPD program. In contrast, seminars organised by professional societies may have differential registration rates for members and non-members of the society. This may contribute to the observed difference in attendance at seminars organised by a professional society between those holding and not holding society membership.

The findings from this study have shown that enrolment in a CPD program was consistently associated with an observed increase in use of mediating tools in professional updating activity. Difference between groups was statistically significant for attendance at conferences and seminars organised by a professional society for enrolment in CPD program.

**Based on these results H2 was rejected: there is a positive relationship between enrolment in a CPD program and level of use of mediating tools in professional knowledge updating.**

Consequently, enrolment in a CPD program was included as an influencing rule in the professional knowledge updating activity system as shown in Figure 5.2. The association between enrolment in a CPD program and use of tools in knowledge updating was observed to be limited to formal CPD learning activities of attendance at conferences and seminars organised by a professional society.

**5.1.3 Professional knowledge updating model with rules**

The findings from this study confirm that both membership of a professional society and enrolment in a CPD program are positively associated with level
of professional knowledge updating activity. Figure 5.2 incorporates these findings into the professional knowledge updating activity model, under rules.

**Figure 5.2: Professional Knowledge Updating Model for MRS Professionals**

(Adapted from Engeström, 2001), displaying two rules, membership of professional society (PS) and enrolment in CPD program (CPD) and their association with level of use of mediating tools.

Observed difference ** significant at .01 level.

It was observed across all examined mediating tools that a higher percentage of respondents engage in professional updating activity when they hold membership with a professional society or are enrolled in a CPD program. The observed difference was statistically significant only for attendance at conferences and seminars organised by professional societies and reading of journals. Thus, influence of membership of professional society and enrolment in CPD program appeared to be limited to tools associated with professional societies. This finding may assist with interpreting the results by Landers et al. (2005) who reported, in their study of physical therapists, that membership of professional societies and enrolment in a CPD program positively influenced level of engagement in formal learning activities. The findings from this current study examining professional knowledge updating suggest that the influence may be limited to formal learning activities associated with professional societies. In addition, the findings from this
The current study indicates that membership of professional societies and enrolment in a CPD program did not influence non-formal learning activities. The only exception noted was membership of a professional society on reading journals. Professional societies, such as the Australian Institute of Radiography and Australian Sonographers Association, provide their journal to members as part of their membership fee. Hence, it may not be surprising that members of a professional society who receive a journal as part of their membership fee report a higher level of journal reading than their colleagues who are not members. This suggests that the provision of journals by a professional society to their membership can influence the type of professional knowledge updating activity that is undertaken.

It is also apparent that when MRS professionals hold membership of a professional society or are enrolled in a CPD program there is a greater tendency to participate in activities such as seminars and conferences that run external to the workplace. That is, more MRS professionals who hold membership of a professional society or are enrolled in a CPD program engage in learning not only in the local CoP of their workplace, but also in broader distributed communities that operate within and across workplaces and professional groups (Wenger, 1998; Wenger et al., 2002). Sharing of knowledge and practice across workplaces is considered essential for developing best practice within organisations generally (Wenger, 1998; Wenger et al., 2002) and for developing best patient outcomes within healthcare (Rolls et al., 2008; Tolson et al., 2005). Membership of a professional society and enrolment in a CPD program, can therefore, not only support improved personal outcome for the individual MRS professional within the professional knowledge updating model, through increasing level of learning activity, but it can also support improving organisational and patient outcomes through the introduction of external knowledge and practices into the local CoP or workplace.

As noted in Section 1.1, mandatory CPD requirements are increasingly being utilised across professions as a mechanism to promote the continual
updating of professional knowledge. The findings from this study demonstrate that enrolment in a CPD program had limited influence on level of professional knowledge updating activity. This supports the viewpoint, noted in Section 2.4.3, that professionals would update their knowledge regardless of whether or not they are compelled to do so. This perspective is further supported by a recent study, that demonstrated that the introduction of mandatory CPD requirements for MRS professionals in the United Kingdom did not influence level of CPD activity (Henwood & Flinton, 2012). However, the study by Henwood and Flinton did not identify the CPD activities examined, presenting only a median score for level of CPD activity. While Henwood and Flinton’s pooled data did not demonstrate CPD influencing level of learning activity, in the United Kingdom’s outcome-based CPD system, the findings from the current study examining professional knowledge updating establishes that there is a positive relationship between enrolment in CPD and attendance at conferences and seminars associated with professional societies. As previously identified (Section 1.1), professional societies have cancelled membership for those who fail to meet mandated CPD requirements (Australian and New Zealand Society of Nuclear Medicine, 2008; Australian Institute of Radiography, 2009). In the Australian context, professional societies such as Australian Institute of Radiography (2007) introduced mandatory CPD requirements for their membership prior to mandatory CPD requirements being introduced by the national regulatory body. As 92% (n=243) of survey participants in this study who were enrolled in a CPD program (n=265) were also members of a professional society, the positive association demonstrated between enrolment in CPD and attendance at professional society conferences and seminars may not extend to other occupational groups where membership of a professional society is low. Henwood and Flinton also reported that recording of CPD activity was the only area significantly influenced by the introduction of mandatory CPD requirements. In essence, the introduction of mandatory CPD primarily influences compliance requirements, namely the recording of engagement in CPD activities and, at best, its influence on level of CPD activity is limited to information sources associated with professional
societies. However, as Lee, Reed and Poulos (2010) noted, compliance was not a strong motivator for engaging in CPD amongst radiographers in New South Wales, Australia. The increase in recording of CPD activity observed amongst radiographers in the United Kingdom may not, therefore, translate to the Australian context. However, care in interpreting results across time and countries must be adopted given that mandatory CPD associated with national registration of MRS professionals has been in place in the United Kingdom for years (Henwood & Flinton, 2012) but enacted in Australia much later – 1 July 2012 (Australian Health Workforce Ministerial Council, 2009).

It was observed in data relating to Research Question 1, an apparent mismatch between the ranked value of information sources and frequency of use of information sources. Books, for example, were the most frequently utilised information source but were ranked fourth in terms of their value as a mediating tool in professional updating activity. It was also observed that frequency of use of information sources (Research Question 1b) was variable across the profession. In the Activity System model, focused on adult learning, the workplace operates as an important learning community (Engeström, 2001). The workplace is recognised as the primary local CoP (Wenger, 1998; Wenger et al., 2002) as a structure that can afford or constrain the learning activity of its members (Eraut, 1994; Lave & Wenger, 1991; Senge, 1990). Through the provision of on-site tools such as information sources, time and financial support, workplaces play an important role in supporting professional knowledge updating (Chartered Society of Physiotherapists, 2007; Eraut, 1994; General Medical Council, 2013; Lave & Wenger, 1991; Senge, 1990; Society of Radiographers, 2007).

5.2 Research Question 4

Research Question 4 tests the proposition that workplace accessibility of mediating tools is associated with their level of use within the professional knowledge updating activity system. Fidel and Green (2004) and Selwyn et al. (2006) differentiate between physical access to an information source and
an individual’s perceived access to the information source. Consequently, this study utilised two measurements for accessibility: physical access to mediating tools within the workplace; and ease of access (Fidel and Green, 2004) to information sources in the workplace, which provides a measurement of the individuals’ perception of their effective workplace access (Selwyn et al., 2006) to mediating tools.

Specifically, the research question was:

**Does workplace accessibility of mediating tools influence their use in updating professional knowledge?**

To respond to this question, data from the survey (N=362) was analysed in the context of two null hypotheses:

**H3** Level of use of mediating tools in professional knowledge updating activity will be no different for physical access to these tools in the workplace.

**H4** Level of use of mediating tools in professional knowledge updating activity will be no different for effective access to these tools in the workplace.

Figure 5.3 displays the relationship of these hypotheses in the professional knowledge updating model.
5.2.1 H3 Physical access to mediating tools

Physical access to tools in the workplace may influence level of professional updating activity. Hypothesis 3, stated in the null, predicts no relationship between physical access to mediating tools in the workplace and knowledge updating activity. Specifically, Hypothesis 3 was:

H3 Level of use of mediating tools in professional knowledge updating activity will be no different for physical access to these tools in the workplace.
To test Hypothesis 3, data from the survey (N=362) was analysed. Two measures of physical access to mediating tools were analysed: computers with Internet access within the workplace; and whether the workplace provided employees with paid leave to attend conferences. Cross tabulations were performed to determine whether workplace accessibility to mediating tools was associated with frequency of use of these mediating tools in professional knowledge updating. Difference between groups was examined descriptively and Fisher’s exact test was utilised to determine level of statistical significance, as minimum cell size for use of chi-square statistic was not met (see Section 3.2.3.3).

Descriptive analysis of survey data demonstrated that workplace configuration of computers with Internet access varied across the profession. Results are as follows:

- Internet access on all workplace computers (44%, n=159)
- Internet access on most workplace computers (14%, n=52)
- Internet access on some workplace computers (17%, n=63)
- Internet access only on computers in offices (20%, n=71)
- Internet access on no workplace computers (4%, n=13)
- Other (1%, n=4)

Cross tabulation was performed to determine if workplace configuration of computers with Internet access was associated with frequency of use of a range of electronic information sources previously identified (Section 2.4.2) as tools used by health professionals to support their professional learning. The tools examined were Internet search engines, web pages, email, listservs, health and medical databases and journals. These tools were shown to be used by MRS professionals (Research Question 1, Section 4.2.1) for updating professional knowledge. The results are summarised in Table 5.5. The n value reported under mediating tools represents the number of survey respondents who had valid responses for both computers.
with internal access (Appendix J, Q18) and frequency of use of the listed tool (Appendix J, Q24).

**Table 5.5**  
**Relationship between workplace configuration of computers with internet access and frequency of use of a range of primary electronic mediating tools**

<table>
<thead>
<tr>
<th>Mediating tool</th>
<th>Test of difference</th>
<th>P value</th>
<th>Difference in experience of MRS professionals at least several times a week (month ¥)</th>
<th>Internet access on all workplace computers</th>
<th>Internet access on all restricted to offices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Internet search engines (n=351)</td>
<td>60.196† a</td>
<td>p &lt; .001</td>
<td></td>
<td>68</td>
<td>155</td>
</tr>
<tr>
<td>Web pages (n=352)</td>
<td>36.991† a</td>
<td>p &lt; .001</td>
<td></td>
<td>34</td>
<td>157</td>
</tr>
<tr>
<td>Email (n=357)</td>
<td>65.994† a</td>
<td>p &lt; .001</td>
<td></td>
<td>77</td>
<td>158</td>
</tr>
<tr>
<td>Listservs ¥ (n=352)</td>
<td>26.383† a</td>
<td>p&lt;0.05</td>
<td></td>
<td>31</td>
<td>159</td>
</tr>
<tr>
<td>Health and medical databases ¥ (n=352)</td>
<td>63.421† a</td>
<td>p &lt; .001</td>
<td></td>
<td>58</td>
<td>156</td>
</tr>
<tr>
<td>Journals (n=356)</td>
<td>45.641† a</td>
<td>p &lt; .001</td>
<td></td>
<td>26</td>
<td>159</td>
</tr>
</tbody>
</table>

*Monte Carlo method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 2000000
† Fisher’s exact test
¥ Updates at least several times a month

As displayed in Table 5.5, a consistent and statistically significant relationship exists between workplace configuration of computers with Internet access across information sources. Workplace configuration of Internet access on all workplace computers was associated with increased frequency of use of mediating tools for professional updating activity, compared to more-restrictive workplace practices, such as limiting Internet access to offices.
only. For example, 68% of MRS professionals who have Internet access on all computers in their workplace (n=155) use Internet search engines to update professional knowledge at least several times a week compared to 29% of MRS professionals where Internet access is restricted to offices only (n=69). A similar finding exists when comparing use of specialised tools. For instance, 58% of MRS professionals who have Internet access on all computers in their workplace (n=156) use health and medical databases to update professional knowledge at least several times a month compared to 20% of MRS professionals where Internet access is restricted to offices only (n=71).

In addition to the provision of computers, workplaces can also support learning through the provision of time to attend formal learning activities such as conferences (Chartered Society of Physiotherapists, 2007; General Medical Council, 2013; Society of Radiographers, 2007). Cross tabulation was performed to determine if frequency of attendance at professional conferences was associated with the provision of paid leave from the employer to attend conferences. The difference in attendance was significant \( \chi^2 = 38.495, df = 3, p < 0.001 \) with 63% of MRS professionals who report that they have paid leave provision (n=276) attending a national conference at least every second year, compared to 28% of MRS professionals who are not granted this type of leave (n=69). Forty-nine per cent (n=34) of MRS professionals whose employers did not provide paid leave to attend conferences never or rarely attend the annual conference.

The findings from this study confirm that a relationship exists between physical access to computers in the workplace and level of use of mediating tools for updating professional knowledge. This study has identified that the universal inclusion of Internet access onto all workplace computers is associated with increased frequency of use of health and medical databases, journals, web pages, Internet search engines, listservs and email to update professional knowledge. This finding would be of interest across professions.
where updating knowledge is recognised as a fundamental aspect of professional practice.

In addition, there is growing emphasis on evidence-based practice across health professions. Use of health and medical databases and journals is fundamental to basing professional practice on best available evidence (Gray, 2003; Hall, 2008; Khan & Coomarasamy, 2004; Snowball, 2005). This study has identified that the universal inclusion of the Internet onto all workplace computers is associated with the increased use of health and medical databases and journals. This finding would be applicable to the many health professions where practitioners are being urged to increase their use of evidence-based information sources (Guo et al., 2008; Howson et al., 2010; McClusky, 2003; Runciman et al., 2012).

Conferences are recognised as an initial stage in disseminating new knowledge to professionals (Garvey & Griffith, 1972; Garvey et al., 1972). This study has shown that conferences continue to be highly valued as mediating tools for updating professional knowledge (Research Question 1c) and that a positive relationship exists between frequency of attendance at conferences and the workplace decision to provide leave to their employees to attend (Research Question 3). This finding would be applicable to employers who want to support their staff to update their knowledge using tools that are highly valued within their profession.

Based on these results H3 was rejected: there is a positive relationship between physical access in the workplace to mediating tools and level of use of these tools to update professional knowledge.

Consequently, physical access in the workplace was included as a broken line surrounding tools in the professional knowledge updating activity system, as shown in Figure 5.4.
5.2.2 H4 Effective access to mediating tools

Effective access to tools in the workplace may influence level of professional updating activity. Hypothesis 4, stated in the null, predicts no relationship between effective access to mediating tools in the workplace and knowledge updating activity. Specifically, Hypothesis 4 was:

H3 Level of use of mediating tools in professional knowledge updating activity will be no different for effective access to these tools in the workplace.

To test hypothesis 4, data from the survey (N=362) was analysed. To examine the relationship between effective workplace access to mediating tools and frequency of use, survey respondents were asked to rate, on a scale from 1 (very easy) to 5 (not easy), their perceived ease of access (Section 2.6) to multiple information sources in their workplace (Appendix J, Q16). Cross tabulations were performed to determine if workplace ease of access to information sources is associated with frequency of use of these tools (Appendix J, Q24) for updating professional knowledge. The results are summarised in Table 5.6. The n value reported under mediating tools represents the number of survey respondents who had valid responses for both ease of access (Appendix J, Q16) and frequency of use of the listed tool (Appendix J, Q24).
### Table 5.6

**Relationship between effective workplace access of tools and frequency of use**

<table>
<thead>
<tr>
<th>Mediating tool</th>
<th>Test of difference</th>
<th>P value</th>
<th>Difference in experience of MRS professionals at least several times a week (month *)</th>
<th>Effective access to resources “very easy”</th>
<th>Effective access to resources “not easy”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Books (n=353)</td>
<td>62.452† a</td>
<td>p &lt; .001</td>
<td></td>
<td>46</td>
<td>92</td>
</tr>
<tr>
<td>Electronic journals (n=346)</td>
<td>62.574 †b</td>
<td>p &lt; .001</td>
<td></td>
<td>33</td>
<td>92</td>
</tr>
<tr>
<td>Print journals (n=347)</td>
<td>67.618 †b</td>
<td>p &lt; .001</td>
<td></td>
<td>34</td>
<td>53</td>
</tr>
<tr>
<td>Web pages (n=348)</td>
<td>64.361 †c</td>
<td>p &lt; .001</td>
<td></td>
<td>38</td>
<td>173</td>
</tr>
<tr>
<td>Internet search engines (n=347)</td>
<td>116.212 †c</td>
<td>p &lt; .001</td>
<td></td>
<td>75</td>
<td>172</td>
</tr>
<tr>
<td>Health and medical databases (n=337)</td>
<td>145.205 †d</td>
<td>p &lt; .001</td>
<td></td>
<td>43</td>
<td>104</td>
</tr>
<tr>
<td>Seminars (n=330) b</td>
<td>18.141 †</td>
<td>p &lt; .005</td>
<td></td>
<td>78</td>
<td>27</td>
</tr>
</tbody>
</table>

*Monte Carlo method used for Fisher’s exact test (95% CI) 10000 sampled tables with starting seed.*

† Fisher’s exact test, ‡ Chi-square

Consistent and statistically significant results were observed across all examined information sources, demonstrating that individuals’ effective access to mediating tools in the workplace is positively associated with frequency of use of these tools in professional updating. For example, 75% of MRS professionals who rate their workplace access to the Internet as very
easy (n=172) use internet search engines to update professional knowledge at least several times a week compared to 19% of MRS professionals who rate their access to the Internet as not easy (n=31). A similar finding exists when comparing use of specialised tools. For instance, 43% of MRS professionals who rate their workplace access to the Internet as very easy (n=104) use databases to update professional knowledge at least several times a week compared to 4% of MRS professionals who rate their access to databases as not easy (n=50). This finding is new. Although Selwyn et al. (2006) identified that when investigating access to information sources the individual’s effective access was the most important measure, as previously noted (Section 2.5) effective access does not appear to have been used in studies that examined health professionals’ workplace access to information sources. The relationship between ease of access, a measure of an individual’s effective access to information sources (Fidel and Green, 2004), and the level of use of these tools by health professionals to update knowledge does not appear to have been previously tested. As statistically significant relationships were shown to exist for all examined information sources, the findings from this study demonstrate that ease of access is a useful quantitative measure to adopt for studies examining workplace access to, and level of use of, single or multiple information sources. The use of this measure would allow other studies to similarly test the relationship between effective access to information sources in the workplace and their level of use.

Ease of access represents an individual’s perceived effective access to mediating tools. Workplace culture and heavy work pressures may contribute significantly to lack of effective access to mediating tools within the workplace. For example, issues relating to Internet access were a constant theme amongst written comments on questionnaires. Even when Internet access was available on computers in the workplace, MRS professionals identified that organisational restrictions – such as lack of time, use of passwords to limit Internet access to certain staff only and limited access to external web sites – prevented them using the Internet to update their
professional knowledge. Thus, whilst the technology was physically present in the workplace, MRS professionals were not able to fully harness its benefits due to heavy workload pressures and organisational access restrictions. These forms of restriction on access to the Internet are similar to those identified by Herrington and Herrington (2006) and Klotz and Reis (2005) in their studies examining access to the Internet by rural and remote health professionals in Australia. This current study demonstrates that such workplace access restrictions to Internet-based tools also exist within the MRS profession.

Workplace access restrictions that lower an individual's perceived effective access to information sources in the workplace negatively impact on level of use of these tools to update professional knowledge. Whilst this and other studies (Eley et al., 2009; Herrington & Herrington, 2006; Klotz & Reis, 2005; Soar, 2010) have identified workplace access restrictions that limit use of Internet-based tools, the findings from this current study indicate that workplace access restrictions also inhibit use of print-based information sources, such as journals and books, and attendance at seminars (Table 5.6) to update professional knowledge. Lack of time is commonly cited as a reason for reduced engagement in professional learning (Gilmore et al., 2008; Jackowski & Akroyd, 2001; Keane et al., 2012). As previously identified (Section 4.2.3), just 25% of MRS professionals were afforded time during work hours for professional learning activities. This lack of workplace support for learning through the provision of time may be a contributing factor that lowers the individuals’ perceived effective workplace access to electronic and print-based information sources and seminars.

Based on the findings in this study that a positive relationship between effective access in the workplace to mediating tools and level of use of these tools to update professional knowledge – H4 was rejected.

Consequently, effective access in the workplace was included as a broken line surrounding tools in the professional knowledge updating activity system, as shown in Figure 5.4.
The move toward electronic access creates the opportunity for workplaces to provide remote access to health and medical databases and electronic journals. In this study, the majority of MRS professionals employed in clinical workplaces reported that they were not able to remotely access electronic tools (e.g., e-journals and databases) available in their workplace, from home (81%, n=234). Survey respondents identified that professionally relevant information sources could be made available through the facility of remote access to workplace information tools:

Access from home would be desirable, e-access through work is excellent but time to sit and read only comes when at home. (RTP121, survey)

Extend to home access as time availability at work is very limited. (SP156, survey)

From analysis of survey data, and as the vast majority of respondents (90%, n=288) had Internet access at home, remote access to workplace resources would clearly be a useful feature. MRS professionals consider their workplace to be an important access conduit to the information sources they need to update their professional knowledge.

Depends on the support of the management in the workplace. If they support Internet access, database of journal then I can access the Internet and journals online and can get relevant information most conveniently. (RTP193, survey)

Workplaces can play an important role in professional knowledge updating by the level of access they provide to mediating tools such as information sources. As shown in this study, improving effective and physical access of information sources in the workplace is associated with increased frequency of use of these tools. If workplaces want their employees to base their
professional practice on the most current health and medical information and to use their updated professional knowledge to improve patient, organisational and personal outcomes then they can support this by improving the accessibility of information sources to their employees in their workplace and through the provision of remote access to workplace information sources.

Concern must remain regarding the level of support that workplaces provide their employees to support professional learning. Despite the introduction of mandatory CPD requirements for MRS professionals in the United Kingdom and the Society of Radiographers (2007) identifying the important role that employers must adopt to support CPD activity, workplace support for CPD did not increase (Henwood & Flinton, 2012). Employers, therefore, continue to maintain their preference for CPD activities that required no time or financial support (Henwood & Huggett, 1999). Lee et al. (2010) argue that this lack of support by employers for CPD demonstrates that employers see professional learning and CPD as benefiting the individual health professional and fail to acknowledge the benefits that may accrue in relation to patient care. This intransigence in relation to workplace support for professional learning compromises the ability of employees, in this case MRS professionals, to base their professional practice on the most current health and medical information and to use their updated professional knowledge to improve patient care.

5.2.3 Professional knowledge updating model introducing accessibility of tools

The findings from this study establish that a positive relationship exists between level of professional knowledge updating activity and both physical access and effective access to mediating tools in the workplace. The null hypotheses were rejected and workplace accessibility of mediating tools was
incorporated into the professional knowledge updating activity system as a broken line surrounding tools (Figure 5.4). In essence, the findings from this study establish that access to tools within the workplace mediates the use of the primary tools by MRS professionals to update their professional knowledge.

**Figure 5.4:** Professional Knowledge Updating Model for MRS Professionals (Adapted from Engeström, 2001), Introducing Workplace Accessibility as a Factor Influencing Use of Mediating Tools.

Observed difference ** significant at .01 level.

The findings from this study indicate that MRS professionals with greater physical and effective access to tools within their workplace report higher use of those tools in professional knowledge updating activity. While it has been previously determined that improved access to journals in the workplace was associated with increased level of journal reading (Bohannon & Larkin, 1986; Nagy et al., 1991), the findings from this study establish that the association between access in the workplace and use of tools extends to include books, conferences, seminars, health and medical databases, Internet searching, web pages, listservs and email. The finding that workplace access is
associated with use of health and medical databases is not in agreement with the study by Bennett et al. (2007), who examined the use of OTseeker, a specialised evidence database for occupation therapists, and reported that workplace access was not related to frequency of its use. This discrepancy in finding may be related to the particular database examined by Bennett et al., which was not one of the databases identified as used by MRS professional to update their professional knowledge. It is also possible that the demographics of participants in the Bennett et al. study may contribute to the observed discrepancy. For example, over half of the participants were academic (13.7%) or student (39.6%) occupational therapists. It is likely that their primary workplace for accessing the specialised database is the university setting rather than the clinical environment. There may be a difference in access to information sources between university and clinical workplaces that contributes to their finding, although this does not appear to have been examined by Bennett et al. Difference in access between university and clinical workplaces to primary information sources for updating professional knowledge is examined in this study (see Section 5.3.1).

The findings from this study, examining MRS professionals, highlight the important role that workplaces have in supporting professional knowledge updating through their provision of physical and effective access to primary tools. Increasing the individual MRS professional's physical and effective access to tools not only supports them to update their knowledge, a central tenet of CPD (Australian Institute of Radiography, 2007; Health Professions Council, 2009), but also provides increased opportunities for new discipline knowledge and practice made explicit through, for example, journals, seminars, conferences and listservs to be introduced into the workplace. The introduction of this new knowledge is an essential aspect of developing best practice within organisations (Wenger, 1998; Wenger et al., 2002) and for developing best patient outcomes within healthcare (Rolls et al., 2008; Tolson et al., 2005). Improving physical and effective access to information sources within the workplace can, therefore, support improving
organisational, patient and individual outcomes, within the professional knowledge updating model (Figure 5.4).

The findings from this study also identify that having Internet access on all workplace computers is associated with an increase in frequency of use of journals, health and medical databases, Internet searching, web pages, listservs and email to update professional knowledge. This finding highlights that whilst connection to the Internet exists in workplaces, organisational decisions such as limiting Internet access to computers situated in ‘offices only’ negatively impacts on use of multiple primary mediating tools to update professional knowledge, including journals, health and medical databases, Internet search engines and web pages.

The findings of this study that relate to Research Question 4 have established that a relationship exists between access to mediating tools in the workplace and level of use of these tools by MRS professionals to update their professional knowledge. Research Question 5 builds upon these findings by investigating factors that influence access of primary knowledge updating tools to MRS professionals in their workplace.

5.3 Research Question 5

Research Question 5 tests the proposition that workplace factors influence the accessibility of mediating tools to individuals within a workplace. Through the review of the literature, seven workplace profile characteristics were identified that may influence workplace accessibility of mediating tools to MRS professionals. These seven characteristics were aligned to community and division of labour within Engeström’s (2001) Activity System model (see Sections 2.5.4.2.1 and 2.5.4.2.2 respectively). As previously noted (Section 2.2), the workplace is commonly recognised as the primary local CoP. The alignment of Engeström’s (2001) influencing factors of community and division of labour to workplace characteristics, as adopted in this study, does not infer that community relates only to the workplace. Indeed, the findings
from this study demonstrate that MRS professionals engage in distributed learning communities (Wenger et al., 2002) through their participation in listservs and attendances at workshops, seminars and conferences that are external to their workplace. Rather, the alignment of workplace characteristics to Engeström’s (2001) influencing factors of community and division of labour was used conceptually to test the relationship between four physical profiles of the workplace (community), three professional profiles of the MRS employee (division of labour) and workplace access to mediating tools.

Research Question 5 sought to establish if the identified seven workplace profile characteristics are associated with individual access within the workplace to the primary mediating tools for updating professional knowledge.

Specifically, the research question was:

**What factors influence workplace accessibility of mediating tools to MRS professionals and do hierarchies of access to these tools exist across workplaces?**

To respond to this question, data from the survey (N=362) was analysed in the context of seven null hypotheses:

**H5 Workplace accessibility of mediating tools will be no different for workplace profile, work context (university, clinical).**

**H6 Workplace accessibility of mediating tools will be no different for clinical workplace profile, health sector (public, private).**

**H7 Workplace accessibility of mediating tools will be no different for clinical workplace profile, geographic location (metropolitan, regional and rural and remote).**
H8 Workplace accessibility of mediating tools will be no different for clinical workplace profile, workplace type (teaching hospital, non-teaching hospital, clinic).

H9 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, area of specialisation (nuclear medicine, radiation therapy, radiography, sonography).

H10 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, employment role (manager, senior practitioner, practitioner, clinical educator).

H11 Workplace accessibility of mediating tools will be no different for clinical workplace professional profile, employment fraction (full time, part time)

Figure 5.5 portrays the relationship of these hypotheses to Engeström’s Activity System model (2001) within community and division of labour.
**Figure 5.5:** Professional knowledge updating model for MRS professionals (adapted from Engeström, 2001), with workplace accessibility as a factor influencing use of these tools and portraying the seven hypotheses H5–H11 associated with research question 5.

Figure 5.5 displays the seven factors that may influence the individual’s access to mediating tools within the workplace, under *community* and *division of labour*. For *community* the four physical profiles of workplaces identified as potential variables were: work context (university or clinical); within clinical workplaces - workplace type (teaching hospital, non-teaching hospital or stand-alone clinic), health sector (public or private) and geographic location (metropolitan, regional or rural and remote). The three professional profiles identified as potential variables for *division of labour* within clinical workplaces were: area of specialisation (radiography, nuclear medicine, radiation therapy or sonography), workplace role (manager, educator, senior practitioner or practitioner) and employment fraction (full time or part time).
Each workplace physical profile or professional profile was adopted as the independent variable, and physical and effective measures of access to mediating tools within the workplace the dependent variables, in the generated hypothesis. The tools examined were books, journals, Internet, health and medical databases, conferences and seminars. Cross tabulation was adopted when the dependent variable was nominal or ordinal. Chi-square test or Fisher’s exact test were incorporated, dependent upon cell size assumptions being met. For continuous data, such as number of journals MRS professionals can access and level of financial support to attend conferences, the statistical test was determined by the distribution of the data and the number of groups analysed (see Section 3.2.3.3). When the assumptions for parametric test were violated, the appropriate non-parametric test was adopted.

The following sections first present the findings related to the access within the workplace of the primary mediating tools (dependent variables) for each of the seven examined independent variables. A discussion of the results in relation to the literature is then presented.

5.3.1 H5 Workplace context

The first factor listed under workplace community in the professional knowledge updating model (Figure 5.5) that may influence the individual’s access to mediating tools is work context. As discussed in Section 2.5.4.2, while research identified that clinical workplaces provided health professionals with greater access to their preferred journals than through universities (Turner & Mjolne, 2001), the influence of workplace context on access to other primary mediating tools, such as the Internet, health and medical databases and conferences, that are utilised to update their knowledge has not been determined. Hypothesis 5, stated in the null, predicts no difference between workplace context and accessibility of tools to individuals within the workplace. Specifically, Hypothesis 5 was:
H5 Workplace accessibility of mediating tools will be no different for workplace profile, work context (university, clinical).

Survey data (N=362) was analysed for those employed in clinical and university workplaces (Table 5.7).

**Table 5.7**

*Influencing factor and contextualised variable for investigating Hypothesis 5*

<table>
<thead>
<tr>
<th>Influencing factor in Engeström’s Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Workplace context</td>
<td>Characteristic</td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Clinical</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>University</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Total valid</td>
<td>348</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>362</td>
</tr>
</tbody>
</table>

For Hypothesis 5, the relationship between workplace context and both individuals’ effective access and physical access to tools were examined. The tools examined include those identified as used by health professionals to meet their professional learning needs (Section 2.4.2) and were also shown to be highly valued by MRS professionals (Research Question 1c, Section 4.2.3) for updating professional knowledge – seminars, conferences, Internet, books, journals and health and medical databases.

To test if a relationship exists between workplace context and effective access to tools, *ease of access*, a measure of the individual’s effective access (Section 2.5) to tools was used. Cross tabulations were performed on reported ease of access in the workplace (Appendix J, Q16) to a range of tools used to update professional knowledge for those employed in clinical (n=320) and university (n=28) workplaces. To test if a relationship exists between workplace context and physical access to tools, four measures of
physical access were utilised. First, the number of journals MRS professionals could access from the provided list of 94 journals (Appendix J, Q34) was analysed for academic and clinical work contexts. Second, the provision of time during work hours to engage in professional reading (Appendix J, Q30) was examined. Third, support to attend conferences, the most valued information source for updating professional knowledge (Research Question 1c), was examined. Two measures of support – the provision of paid leave by employers to attend conferences (Appendix J, Q27) and the level of funding support to attend conferences (Appendix J, Q26) – were used. The results are displayed in tables 5.8, 5.9 and 5.10. The n value reported in the discussion of results represents the number of survey respondents who had valid responses for both questions analysed, for example, work context and ease of access, work context and provision of time for reading.
### Table 5.8

**Relationship between work context and workplace accessibility of mediating tools**

<table>
<thead>
<tr>
<th>Work context</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td>Effective access in the workplace</td>
<td>Books</td>
<td>36.680 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E-journals</td>
<td>61.236 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Print journals</td>
<td>18.905 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internet</td>
<td>25.689 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminars</td>
<td>6.297 NS</td>
<td>p = .241</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health and medical databases</td>
<td>46.125 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Clinical</td>
<td>Physical access in the workplace</td>
<td>Journals</td>
<td>-6.033 c</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td>Provision of time to read information</td>
<td>Multiple, including books, journals, Internet</td>
<td>60.979 b</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td>Paid leave to attend</td>
<td>Conference</td>
<td>4.972 b</td>
<td>p = .026</td>
</tr>
</tbody>
</table>

* Fisher’s exact test, † Pearson chi-square, ‡ Mann-Whitney U test, NS Results not significant at p=.05 level
† Monte Carlo method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 957002199
As shown in Table 5.8, apart from seminars (p>0.05), effective access to primary tools for updating professional knowledge was statistically significant between MRS professionals employed in clinical workplaces and their colleagues in universities. MRS professionals employed in clinical workplaces report lower effective access to books, electronic journals, print journals, Internet and health and medical databases in their workplace. Twelve per cent (n=36) of MRS professionals employed in clinical workplaces rated their workplace access to text and reference books as *not easy* (10%) or *no access* (2%) compared to 0% (n=0) in universities. Effective access to electronic journals in the workplace was also lower amongst MRS professionals employed in clinical workplaces, with 25% (n=78) rating their workplace access to electronic journals as *not easy* (12%) or *no access* (13%) compared to 0% (n=0) in universities. Similarly, effective access to print journals in the workplace was lower for MRS professionals employed in the clinical environment, with 29% (n=90) rating their access to print journals as *not easy* (20%) or *no access* (9%) compared to 4% (n=1) in the universities. In relation to access to the Internet in the workplace, 21% (n=65) of MRS professionals employed in clinical workplaces rated their access to the Internet as *not easy* (10%) or *no access* (11%) compared to 0% (n=0) in the university sector. MRS professionals employed in clinical workplaces also rated their workplace access to health and medical databases lower. Thirty per cent (n=91) of MRS professionals employed in clinical workplaces rated their workplace access to databases as *not easy* (16%) or *no access* (14%) compared to 0% (n=0) in universities. This finding of differential access across work context supports rejection of the null hypothesis (H5).

MRS professionals employed as academics report access to a higher number of journals (median = 23, IQR = 60) than their colleagues employed as clinical professionals (median = 4, IQR = 8). Twenty-nine per cent of responding MRS professionals employed in clinical workplaces (n=284) reported having access to only one (19%, n=54) or none (10%, n=28) of the listed journals. As the assumption of equal variance for use of parametric
statistics was violated, Mann-Whitney U test was adopted to test if the observed difference was statistically significant for work context (Z=-6.033, p<0.001). The finding that there is a significant difference in the number of journals that can be accessed between academic and clinical MRS professionals supports rejection of the null hypothesis.

Prior work by Turner and Mjolne (2001) identified that physiotherapists had greater access to professional journals in their workplace than through university libraries. To examine if this was a consistent pattern for the MRS profession, clinical and university workplace respondents’ access to 12 journals that stem from professional societies were compared. The results are displayed in Table 5.9.

**TABLE 5.9**

**WORKPLACE ACCESS TO JOURNALS STEMMING FROM PROFESSIONAL SOCIETIES FOR TWO WORKPLACE CONTEXTS (UNIVERSITY AND CLINICAL)**

<table>
<thead>
<tr>
<th>Journal title</th>
<th>Those with access</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>University Valid Per cent</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>ANZ Nuclear Medicine</td>
<td>61.5</td>
<td>20.9</td>
<td>-4.428*</td>
</tr>
<tr>
<td>Canadian Journal of Medical Radiation Technology</td>
<td>45.8</td>
<td>10.0</td>
<td>-4.753*</td>
</tr>
<tr>
<td>Journal of Diagnostic Medical Sonography</td>
<td>43.5</td>
<td>9.1</td>
<td>4.638*</td>
</tr>
<tr>
<td>Journal of Nuclear Medicine</td>
<td>56.0</td>
<td>19.1</td>
<td>-4.075*</td>
</tr>
<tr>
<td>Journal of Nuclear Medicine Technology</td>
<td>56.0</td>
<td>14.1</td>
<td>-5.001*</td>
</tr>
<tr>
<td>Medical Dosimetry</td>
<td>50.0</td>
<td>13.4</td>
<td>-4.432*</td>
</tr>
<tr>
<td>Radiation Therapist</td>
<td>47.8</td>
<td>9.0</td>
<td>-5.579*</td>
</tr>
<tr>
<td>Radiography</td>
<td>63.0</td>
<td>28.0</td>
<td>-3.753*</td>
</tr>
<tr>
<td>Radiologic Technology</td>
<td>52.0</td>
<td>9.7</td>
<td>-5.579*</td>
</tr>
<tr>
<td>Radiographer</td>
<td>81.5</td>
<td>60.9</td>
<td>-2.100*</td>
</tr>
<tr>
<td>Sound Effects</td>
<td>39.1</td>
<td>16.9</td>
<td>-2.548*</td>
</tr>
<tr>
<td>Ultrasound Bulletin</td>
<td>30.4</td>
<td>16.9</td>
<td>-1.580*</td>
</tr>
</tbody>
</table>

* Mann-Whitney U test, b t-test for independent samples, NS Results not significant at p=.05 level
MRS professionals employed in universities reported greater access to journals stemming from professional societies. Apart from *Ultrasound Bulletin*, difference in workplace access was statistically significant for the journals examined. This finding does not support the earlier study by Turner and Mjolne (2001), who reported that, within the physiotherapy profession, access to professional journals was greater in clinical workplaces than in university libraries. This suggests that difference in workplace access to professional journals between clinical workplaces and university libraries may vary across health professions, or it may reflect change in access to journals between clinical and academic workplaces that has occurred over time. In this current study there was a significant difference in access to professional journals between academic and clinical MRS professionals and this result provides additional support to reject the null hypothesis.

In relation to the provision of time during work hours to engage in professional reading (Table 5.8), 78% (n=18) of MRS professionals employed by universities reported that their workplace allocates time for professional reading activities compared to 25% (n=78) employed in clinical workplaces. Difference in provision of time was significant (Fisher’s exact test \( \chi^2 = 4.972, df = 1, p = 0.026 \)), with 96% of MRS professionals employed by universities (n=28) receiving this leave compared to 79% employed in clinical workplaces (n=309). This result provides additional support to reject the null hypothesis.

Support to attend conferences, the most valued information source for updating professional knowledge (Research Question 1c), was examined. The difference in provision of paid leave to attend conferences (Table 5.8) was significant \( \chi^2 = 4.972, df = 1, p = 0.026 \), with 96% of MRS professionals employed by universities (n=28) receiving this leave compared to 79% employed in clinical workplaces (n=309). This result provides additional support to reject the null hypothesis.

The percentage of total funding MRS professionals receive from their workplace, professional society, government and self to attend conferences
was analysed for academic and clinical work contexts. The results are presented in Table 5.10.

**Table 5.10**

**Percentage of total funding to attend conferences for two workplace contexts (clinical and university)**

<table>
<thead>
<tr>
<th>Funding source</th>
<th>Clinical work context</th>
<th></th>
<th></th>
<th>Academic work context</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Median</td>
<td>Mean</td>
<td>SD</td>
<td>Median</td>
</tr>
<tr>
<td>Employer</td>
<td>44.4</td>
<td>36.6</td>
<td>50</td>
<td>56.9</td>
<td>35.5</td>
<td>55</td>
</tr>
<tr>
<td>Self</td>
<td>38.6</td>
<td>36.9</td>
<td>33</td>
<td>29.2</td>
<td>33.7</td>
<td>15</td>
</tr>
<tr>
<td>Professional society</td>
<td>3.8</td>
<td>16.7</td>
<td>0</td>
<td>5.4</td>
<td>15.8</td>
<td>0</td>
</tr>
<tr>
<td>Government CPD funding</td>
<td>10.3</td>
<td>25.0</td>
<td>0</td>
<td>4.6</td>
<td>13.9</td>
<td>0</td>
</tr>
</tbody>
</table>

The employer was the primary source of funding to attend conferences for both clinical and academic MRS professionals. Large variation in financial support from the workplace and self-funding to attend conferences was observed for both university and clinical workplaces. After testing for the assumption of equal variance (Levene’s statistic), t-test for independent samples was performed. Difference in financial support from each funding source was not significant (p >0.05) for work context.

In sum, baseline data on the relationship between work context and effective and physical access to multiple information sources that are used by MRS professionals to update their professional knowledge has been ascertained. Statistically significant difference for both effective and physical access in the workplace to the primary mediating tools for professional updating was shown to exist for the variable workplace context. MRS professionals employed by universities report greater access to books, electronic and print journals, the Internet and health and medical databases in their workplace. In addition, more university-employed MRS professionals are allocated time during work hours to engage in professional reading activities and paid leave to attend conferences.
Based on these results H5 was rejected: there is a significant difference in workplace accessibility to mediating tools for workplace profile, work context (university, clinical).

Consequently, work context (WC) was included as an influencing variable in the professional knowledge updating activity system in Figure 5.6 under community.

Mediating tools of information sources are less accessible to MRS professionals employed in clinical workplaces. Of particular importance for the clinical workplace is the impact that limited or no access to primary mediating tools for updating professional knowledge may have on patient outcome. The patient is the raison d’être of clinical practice in medical radiations (Harvey, 2012). As previously identified, information sources are purposefully utilised by health professionals to improve patient care (Bryant, 2004; Usher, 2011; Westbrook et al., 2004). As a positive relationship was shown to exist between workplace access and frequency of use of mediating tools to update professional knowledge (Research Question 4), this suggests that clinical MRS professionals who have poor workplace access to information sources may update their knowledge less frequently and so base their professional practice on knowledge that may no longer be current. Lack of access in the workplace to information sources utilised to update professional knowledge can compromise the quality of care afforded to patients undergoing diagnostic and therapeutic examinations.

The following section examines clinical workplaces in greater detail to establish if accessibility of information sources is homogenous across clinical workplaces or if hierarchies of access also exist across these environments.

### 5.3.2 Clinical workplaces

Workplace factors utilised to test for homogeneity of access or the presence of hierarchies of access across clinical workplaces were three physical profiles (health sector, geographic location and workplace type) and three
professional profile characteristics (area of specialisation, workplace role and employment fraction). These six variables that exist in clinical workplaces were used to generate hypotheses 6–11. Measurements of accessibility utilised were those described for Hypothesis 5 in Section 5.3.1.

5.3.2.1 H6 Health sector

The second factor listed under community in the professional knowledge updating model (Figure 5.5) that may influence the individual’s access to mediating tools within clinical workplaces is health sector. As previously discussed (Section 2.5.4.2), while research identified that health professionals employed in the public sector report greater access to journals and the Internet than their clinical colleagues employed in the private sector (Jones & Lambros, 2003; McClusky, 2003), the influence of health sector on other primary mediating tools for updating professional knowledge such as seminars, conferences and health and medical databases had not been established. To address this deficit, the influence of health sector on MRS professionals’ workplace access to multiple primary mediating tools for updating professional knowledge was examined. Hypothesis 6, stated in the null, predicts no relationship between health sector and accessibility of tools to individuals within the clinical workplace. Specifically, Hypothesis 6 was:

H6 Workplace accessibility of mediating tools will be no different for clinical workplace profile, health sector (public, private).

Survey data was analysed for those employed in clinical workplaces (N=320, Table 5.7) in the public and private health system (Table 5.11).
TABLE 5.11

**INFLUENCING FACTOR AND CONTEXTUALISED VARIABLE FOR INVESTIGATING HYPOTHESIS 6**

<table>
<thead>
<tr>
<th>Influencing factor in Engeström’s Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical workplace</td>
<td>Public</td>
<td>169</td>
</tr>
<tr>
<td>Health sector</td>
<td>Private</td>
<td>149</td>
</tr>
<tr>
<td>Total valid</td>
<td></td>
<td>318</td>
</tr>
<tr>
<td>No response</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>320</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency</th>
<th>Per cent</th>
<th>Valid Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>169</td>
<td>53.1</td>
<td>53.1</td>
</tr>
<tr>
<td>Private</td>
<td>149</td>
<td>46.6</td>
<td>46.9</td>
</tr>
<tr>
<td>Total valid</td>
<td>318</td>
<td>99.4</td>
<td>100.0</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>320</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

For Hypothesis 6, the relationship between health sector and both the individual’s effective access and physical access to tools were examined. The two health sectors investigated were public (n=169) and private (n=149). A summary of MRS professionals’ effective and physical access to primary mediating tools within the workplace is displayed in Table 5.12.

As demonstrated in Table 5.12, MRS professionals employed in the private sector report lower effective access to electronic journals, print journals and health and medical databases in their workplace than their colleagues employed in the public sector. Thirty-three per cent (n=47) of MRS professionals employed in the private sector rated their workplace access to electronic journals as *not easy* (13%) or *no access* (20%) compared to 18% (n=30) in the public sector (11%, 7%). Similarly, effective access to print journals in the workplace was lower amongst MRS professionals employed in the private sector, with 35% (n=50) rating their workplace access to print journals as *not easy* (24%) or *no access* (11%) compared to 24% (n=40) in the public sector (18%, 6%). In relation to access to health and medical databases, 45% (n=62) of MRS professionals employed in the private sector rated their workplace access to databases as *not easy* (21%) or *no access* (24%) compared to 18% (n=29) in the public sector (13%, 5%). The observed difference in effective access was significant for electronic journals, print journals and health and medical databases (Table 5.12). This finding
<table>
<thead>
<tr>
<th>Health sector</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td><strong>Effective access in the workplace</strong></td>
<td>Books, E-journals, Print journals, Internet, Seminars, Health and medical databases</td>
<td>4.202&lt;sup&gt;a†&lt;/sup&gt;</td>
<td>p=.530</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td></td>
<td>19.880&lt;sup&gt;b&lt;/sup&gt;</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11.516&lt;sup&gt;b&lt;/sup&gt;</td>
<td>p=.042</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10.143&lt;sup&gt;b&lt;/sup&gt;</td>
<td>p=.071</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.703&lt;sup&gt;b&lt;/sup&gt;</td>
<td>p=.084</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>33.219&lt;sup&gt;b&lt;/sup&gt;</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td><strong>Physical access in the workplace</strong></td>
<td>Journals, Multiple, including books, journals, Internet, Conference</td>
<td>-3.256&lt;sup&gt;c&lt;/sup&gt;</td>
<td>p = .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18.514&lt;sup&gt;b&lt;/sup&gt;</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17.173&lt;sup&gt;b&lt;/sup&gt;</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-4.36&lt;sup&gt;c&lt;/sup&gt;</td>
<td>p = .663</td>
</tr>
</tbody>
</table>

<sup>a</sup> Fisher’s exact test, <sup>b</sup> Pearson chi-square, <sup>c</sup> Mann–Whitney U test
<sup>†</sup> Monte Carlo method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 442399356
indicates that workplace accessibility to these mediating tools is influenced by health sector, thus supporting rejection of the null hypothesis (H7). MRS professionals employed in the public sector reported access to a higher number of journals (median = 5, IQR = 11) than their colleagues employed in the private sector (median = 3, IQR = 5). Thirty-four per cent of respondents employed in the private sector (n=130) reported that they had access to only one (22%, n=29) or none (12%, n=15) of the listed journals. The observed difference in number of journals was significant for health sector (Mann-Whitney U test, Z=-3.258, p=0.001). This finding supports the rejection of the null hypothesis.

In relation to the provision of time during work hours to engage in professional reading, 36% of MRS professionals employed in the public sector (n=166) reported their workplace allocates time for professional reading activities compared to 14% employed in the private sector (n=147). Difference in provision of time was significant ($\chi^2 = 18.514, df = 1, p < 0.001$) for health sector, thus providing additional evidence to reject the null hypothesis.

The difference in provision of paid leave to attend conferences was significant ($\chi^2 = 17.173, df = 1, p < 0.001$), with 88% of MRS professionals employed in the public health sector (n=167) receiving paid leave compared to 69% of colleagues employed in the private sector (n=141). In relation to level of financial support from workplaces to attend conferences, the difference was not significant for health sector (Z=-4.36, p=0.663).

To summarise, statistically significant difference in accessibility of information sources for those MRS professionals employed in clinical workplaces has been shown to exist for the variable, health sector. MRS professionals employed in the public sector report that they have greater effective access in their workplace to electronic and print journals and health and medical databases compared to their peers in private sector employment. In addition, MRS professionals employed in the public health sector reported access to a
higher number of journals, greater support for provision of time during work hours to engage in professional reading activities and greater support for paid leave to attend conferences than their colleagues employed in the private health sector.

**Based on these results H6 was rejected: there is a significant difference in workplace accessibility to mediating tools for clinical workplace profile, health sector (public, private).**

Consequently, health sector (HS) was included as an influencing variable in the professional knowledge updating activity system in Figure 5.6 under *community*, clinical workplaces.

The findings from this study reinforce the earlier results of Jones and Lambros (2003), who identified health professionals in the public sector had greater access to the Internet than their colleagues in the private sector. In addition, the findings from this study support and build upon the work of McClusky (2003), who reported that health professionals in the private sector had less access to journals than their colleagues in the public sector. This study supports McClusky’s finding and demonstrates that this differential access exists across both print and electronic journals. MRS professionals in the public sector also report greater access in the workplace to health and medical databases. Government provided electronic information portals provide access to electronic journals and health and medical databases. These portals are available to health professionals employed in the public sector (Section 2.5.1) and, as shown in relation to Research Question 1a, these portals contain a wide range of journals utilised by MRS professionals to update their knowledge, including those from professional societies. The government-initiated differential access to these portals in relation to health sector would contribute to the observed difference in access to journals and health and medical databases reported in this study.

This study also identified that MRS professionals employed in the public sector are provided with greater support for paid leave to attend conferences than their colleagues employed in the private sector. This does not support
findings by Sholer et al. (2011), who identified that assistance from employers for CPD was more prevalent amongst radiographers employed in the private sector in Western Australia. Sholer et al. did not specify the type of assistance and so their reported finding may reflect radiographers’ perception of workplace support for CPD rather than actual measures of effective and physical support reported in this study. Alternatively, support from employers for CPD activities may have increased in recent years, a finding not supported by Hegney et al. (2010), or it may be quite different in Western Australia across health sector.

5.3.2.2 H7 Geographic location

The third factor listed under workplace community in the professional knowledge updating model (Figure 5.5) that may influence the individual’s access to mediating tools is geographic location of the clinical workplace. As noted in Section 2.5.4.2, research investigating health professionals’ access to the Internet across geographic location produced inconsistent results. Furthermore, the influence of geographic location on other primary mediating tools for updating professional knowledge, such as seminars, conferences, journals and health and medical databases, had not been established by quantitative measure. As there was no identified research that had examined MRS professionals’ workplace access to the primary mediating tools for updating professional knowledge, this study sought to address this deficit. Hypothesis 7, stated in the null, predicts no relationship between geographic location and accessibility of tools to individuals within the clinical workplace. Specifically, Hypothesis 7 was:

H7 Workplace accessibility of mediating tools will be no different for clinical workplace profile, geographic location (metropolitan, regional, rural or remote)
Survey data was analysed for those employed in clinical workplaces (N=320, Table 5.7) in three self-identified geographic locations: metropolitan, regional and rural or remote (Table 5.13).

### Table 5.13
**Influencing factor and contextualised variable for investigating Hypothesis 7**

<table>
<thead>
<tr>
<th>Influencing factor in Engeström’s Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>Clinical workplace Geographic location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metropolitan</td>
<td>Frequency: 179, Per cent: 55.9, Valid Per cent: 56.6</td>
</tr>
<tr>
<td></td>
<td>Regional</td>
<td>Frequency: 90, Per cent: 28.1, Valid Per cent: 28.5</td>
</tr>
<tr>
<td></td>
<td>Rural or remote</td>
<td>Frequency: 47, Per cent: 14.7, Valid Per cent: 14.9</td>
</tr>
<tr>
<td></td>
<td>Total valid</td>
<td>Frequency: 316, Per cent: 98.8, Valid Per cent: 100.0</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>Frequency: 4, Per cent: 1.3, Valid Per cent: 100.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Frequency: 320, Per cent: 100.0</td>
</tr>
</tbody>
</table>

For Hypothesis 7, the relationship between clinical workplace geographic location and both the individual’s effective access and physical access to tools were examined. The three self-nominated geographic locations investigated were: metropolitan (n=179), regional (n=90) and rural and remote (n=47). A summary of MRS professionals’ effective and physical access to primary mediating tools within the workplace is presented in Table 5.14.
### Table 5.14

**Relationship between geographic location and workplace accessibility of mediating tools**

<table>
<thead>
<tr>
<th>Geographic location</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan</td>
<td><em>Effective access in the workplace</em></td>
<td>Books</td>
<td>15.254 †</td>
<td>p = .103</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E-journals</td>
<td>10.967 b</td>
<td>p = .360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Print journals</td>
<td>14.284 †</td>
<td>p = .154</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internet</td>
<td>8.280 †</td>
<td>p = .600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminars</td>
<td>32.894 †</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health and medical databases</td>
<td>6.543 †</td>
<td>p = .771</td>
</tr>
<tr>
<td>Regional</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural and remote</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical access in the workplace</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number available</td>
<td></td>
<td>Journals</td>
<td>7.343 c</td>
<td>p = .025</td>
</tr>
<tr>
<td>Provision of time to read information</td>
<td></td>
<td>Multiple, including books, journals, Internet</td>
<td>11.438 b</td>
<td>p = .003</td>
</tr>
<tr>
<td>Paid leave to attend</td>
<td></td>
<td>Conference</td>
<td>16.941 b</td>
<td>p &lt; .001</td>
</tr>
</tbody>
</table>

* Fisher’s exact test, † Pearson chi-square, ‡ Kruskal Wallis test
† Monte Carlo method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 442399356
Apart from seminars, observed difference in effective access to primary mediating tools in professional updating activity between MRS professionals employed in metropolitan, regional and rural or remote locations were not statistically significant. In relation to seminars, 46% of MRS professionals employed in rural or remote locations rated their workplace access to seminars as not easy (26%) or no access (20%) compared to 28% in regional areas (22%, 6%) and 15% in metropolitan location (13%, 2%).

MRS professionals employed in metropolitan locations reported access to a higher number of journals (median = 4, IQR = 11) than their peers employed in regional (median = 3, IQR = 6) and rural or remote (median = 2, IQR = 4) locations. Thirty-seven per cent of respondents employed in rural or remote locations (n=41) reported that they had access to only one (20%, n=8) or none (17%, n=7) of the listed journals. The observed difference in number of journals was significant (Kruskal-Wallis test $\chi^2=7.343$ ($df=2$), $p=0.025$), thus supporting rejection of the null hypothesis, H8.

Difference in provision of time for professional reading was significant for geographic location ($\chi^2=11.438$, $df = 2$, $p = 0.003$), with 33% of MRS professionals employed in metropolitan areas (n=178) reporting their workplace allocates time for professional reading activities compared to 20% employed in regional areas (n=87) and 11% employed in rural or remote (n=46) locations. This finding provides further evidence to support rejection of the null hypothesis, H8.

In relation to the provision of paid leave by employers to attend conferences, 86% of MRS professionals employed in metropolitan areas (n=175) receive paid leave compared to 73% of colleagues employed in regional areas (n=86) and 60% employed in rural or remote (n=45) locations. This observed difference in provision of paid leave to attend conferences was significant ($\chi^2=16.941$, $df = 2$, $p < 0.001$) thus providing additional support to reject the null hypothesis.
The percentage of total funding support MRS professionals receive to attend conferences from four sources was analysed for the three geographic locations. The results are presented in Table 5.15.

### Table 5.15

**Per centage Financial Support to Attend Conferences for Three Workplace Geographic Locations**

<table>
<thead>
<tr>
<th>Funding source</th>
<th>Metropolitan</th>
<th></th>
<th></th>
<th>Regional</th>
<th></th>
<th></th>
<th>Rural or remote</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Median</td>
<td>Mean</td>
<td>SD</td>
<td>Median</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Employer</td>
<td>46.6</td>
<td>35.9</td>
<td>50</td>
<td>45.4</td>
<td>36.5</td>
<td>50</td>
<td>31.2</td>
<td>37.8</td>
</tr>
<tr>
<td>Self</td>
<td>34.2</td>
<td>34.2</td>
<td>25</td>
<td>39.8</td>
<td>37.2</td>
<td>36.5</td>
<td>54.7</td>
<td>43.1</td>
</tr>
<tr>
<td>Professional society</td>
<td>4.6</td>
<td>19.4</td>
<td>0</td>
<td>3.9</td>
<td>14.9</td>
<td>0</td>
<td>0.9</td>
<td>5.6</td>
</tr>
<tr>
<td>Govt CPD funding</td>
<td>11.4</td>
<td>25.5</td>
<td>0</td>
<td>7.7</td>
<td>23.7</td>
<td>0</td>
<td>11.8</td>
<td>27.2</td>
</tr>
</tbody>
</table>

MRS professionals employed in metropolitan and regional locations receive a higher percentage of financial support to attend conferences from their employer than their colleagues employed in rural or remote locations. In relation to self-funding to attend conferences, MRS professionals employed in rural or remote locations have the highest level of self-funding. After testing for the assumption of equal variance (Levene’s statistic) Kruskal-Wallis test was performed. The observed difference in financial support from the workplace to attend conferences ($\chi^2 = 6.202, df = 2, p = 0.045$) and self-financing to attend conferences ($\chi^2 = 6.555, df = 2, p = 0.038$) was statistically significant for geographic location. These findings indicate that financial accessibility of conferences is influenced by geographic location, thus supporting rejection of the null hypothesis.

Statistically significant difference in accessibility in the workplace of primary mediating tools for professional updating activity has been shown to exist for the variable, geographic location. MRS professionals employed in rural or remote locations have less-effective access to seminars, access to fewer journals, less support for provision of time during work hours to engage in
professional reading activities, less support for paid leave to attend conferences, less financial support from their employer to attend conferences and have higher levels of self-funding to attend conferences than their colleagues employed in other geographic locations.

Based on these results, H7 was rejected: there is a significant difference in workplace accessibility to mediating tools for clinical workplace profile, geographic location (metropolitan, regional, rural or remote).

Consequently, geographic location (GL) was included as an influencing variable in the professional knowledge updating activity system in Figure 5.6 under community, clinical workplaces.

The findings from this study establish that Australian MRS professionals, who self-nominated that they worked in rural or remote locations, have less access to multiple information sources to update their knowledge. This includes information sources that support learning as an individual activity such as journal articles and also those that support collaborative learning such as can occur face-to-face at seminars and conferences or online through listservs. As previously established (Section 4.2.3) seminars are the highest rank information source for updating professional knowledge by rural and remote MRS professionals. Lack of access to seminars, which support both accessing new knowledge and also opportunities for discussing and contextualising this new knowledge to their specific workplace practice, may contribute to professional isolation, which is a recognised issue for rural and remote Australian health practitioners (Herrington & Herrington, 2006; Keane et al., 2012).

Geographic location has previously been identified as influencing Australian health professionals’ workplace access to the Internet (Shaw et al., 2006; Taylor & Lee, 2005). The findings from this study do not concur with these earlier published findings. This may reflect an increasing accessibility of the Internet in Australia since these earlier studies. As the Australian government is currently committed to improving accessibility of the Internet to
homes, schools and workplaces through its $43 billion National Broadband Network, this suggests that previously observed difference in Internet accessibility across geographic location is likely to reduce. The increased accessibility of high speed broadband in Australia could be harnessed to improve the accessibility of journals, seminars and conferences to Australian professionals working in rural and remote locations. This view is shared by Sholer et al. (2011) who recommend greater use of the Internet for CPD to reduce the barriers of distance and expense of CPD activities experienced by rural radiographers in Western Australia. However, to be effective, the use of the Internet to support CPD or professional knowledge updating must offer both access to new knowledge and opportunities to unpack and discuss this new knowledge so it can be contextualised and implemented in their given workplace.

Attending CPD lectures was not identified as an issue for non-metropolitan MRS professionals in the United Kingdom (Henwood et al., 2010). This finding may indicate that MRS professionals in rural regions in the United Kingdom are afforded more time and financial support to attend CPD activities than their Australian colleagues. The explicit role assigned in CPD policy documents in the United Kingdom for workplaces to support CPD through the provision of on-site resources, time and support (Section 2.5.4.2) may contribute to this observed difference between countries. Alternatively, the magnitude of difference in geographic size between the United Kingdom and Australia may contribute to the finding that rurality, whilst a recognised factor influencing provision of educational opportunities in Australia (Australian Institute of Health and Welfare, 2013) may not have the same impact in the United Kingdom in relation to access to CPD activities.

5.3.2.3 H8 Workplace type

The fourth factor listed under workplace community in the professional knowledge updating model (Figure 5.5) that may influence the individual’s
access to mediating tools in the clinical environment is workplace type. As discussed in Section 2.5.4.2, while research identified that health professionals employed in teaching hospitals reported higher levels of access to the Internet in their workplace (Jones & Lambros, 2003), the influence of workplace type on access to other primary mediating tools such as the journals, health and medical databases and conferences that are utilised to update knowledge has not been determined. To address this deficit, this study examined the influence of workplace type on employees’ workplace access to multiple primary mediating tools for updating professional knowledge. Hypothesis 8, stated in the null, predicts no relationship between workplace type and accessibility of tools to individuals within the workplace. Specifically, Hypothesis 8 was:

**H8 Workplace accessibility of mediating tools will be no different for workplace profile, workplace type (teaching hospital, non-teaching hospital, clinic).**

Survey data was analysed for those employed in clinical workplaces (N=320, Table 5.7) in three self-identified workplace types: teaching hospital, non-teaching hospital and clinic (Table 5.16).

<table>
<thead>
<tr>
<th>Influencing factor in Engeström’s Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Workplace type</td>
<td>Characteristic</td>
<td>Frequency</td>
</tr>
<tr>
<td>Clinical workplace</td>
<td>Teaching hospital</td>
<td>173</td>
</tr>
<tr>
<td>Workplace type</td>
<td>Non-teach hosp</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Clinic</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Total valid</td>
<td>312</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>320</td>
</tr>
</tbody>
</table>
For Hypothesis 8, the relationship between clinical workplace type and both the individual’s effective access and physical access to tools were examined. A summary of MRS professionals’ effective and physical access to primary mediating tools within the workplace is presented in Table 5.17.

Consistent and statistically significant differences were observed across all examined information sources. MRS professionals employed in non-teaching hospitals and clinics reported lower effective access to these mediating tools in their workplace than their colleagues employed in teaching hospitals. Approximately one-quarter of respondents employed in non-teaching hospitals reported that they have no access to the Internet (24%, n=11), electronic journals (25%, n=12) or health and medical databases (29%, n=13) in their workplace. This finding of differential access to information sources across different workplace types supports the rejection of the null hypothesis.

MRS professionals employed in teaching hospitals reported having access to a higher number of journals (median = 5, IQR = 9) than MRS professionals employed in non-teaching hospitals (median = 3, IQR = 5) and clinics (median = 2, IQR = 4). This observed difference in number of journals that MRS professionals can access was significant for work context (Kruskal-Wallis test, $\chi^2 = 19.950, df=2, p <0.001$), thus further supporting rejection of the null hypothesis. Forty-two per cent of respondents employed in non-teaching hospitals and 40% employed in clinics reported that they had access to only one (28%, n=12; 28%, n=22) or none (14%, n=6; 12%, n=9) of the listed journals, respectively.
## Table 5.17

**RELATIONSHIP BETWEEN WORKPLACE TYPE AND WORKPLACE ACCESSIBILITY TO MEDIATING TOOLS**

<table>
<thead>
<tr>
<th>Workplace type</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching hospital</td>
<td>Effective access in the workplace</td>
<td>Books</td>
<td>17.735 a†</td>
<td>p=.044</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E-journals</td>
<td>43.943 b</td>
<td>p=.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Print journals</td>
<td>28.606 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internet</td>
<td>34.451 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminars</td>
<td>21.599 a†</td>
<td>p = .014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health and medical databases</td>
<td>49.180 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Non-teaching hospital</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical access in the workplace</td>
<td></td>
<td>Journals</td>
<td>19.950 c</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Number available</td>
<td></td>
<td>Multiple, including books, journals, Internet</td>
<td>22.116 b</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Provision of time to read information</td>
<td></td>
<td>Conference</td>
<td>27.567 b</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Paid leave to attend</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Fisher’s exact test, † Pearson chi-square, ‡ Kruskal-Wallis test
† Monte Carlo method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 624387341
Thirty-six per cent of MRS professionals employed in teaching hospitals (n=170) reported that their workplace allocated time for professional reading activities compared to 11% employed in non-teaching hospitals (n=45) and 13% employed in clinics (n=92). This observed difference in provision of time was significant \( \left( \chi^2 = 22.116, df = 2, p < 0.001 \right) \), providing further support to reject the null hypothesis. Support to attend conferences was also shown to vary across workplace type. Ninety per cent of MRS professionals employed in teaching hospitals (n=172) reported that they receive paid leave to attend conferences compared to 64% of colleagues employed in non-teaching hospitals (n=44) and 65% employed in clinics (n=86). The difference in provision of paid leave to attend conferences was significant \( \left( \chi^2 = 27.568, df = 2, p < 0.001 \right) \), thus supporting rejection of the null hypothesis.

The total percentage of funding support MRS professionals receive from four sources to attend conferences were analysed for three workplace types. The results are presented in Table 5.18.

**Table 5.18**

**Percentage financial support to attend conferences for three workplace types**

<table>
<thead>
<tr>
<th>Funding source</th>
<th>Teaching hospital</th>
<th>Non-teaching hospital</th>
<th>Clinic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Median</td>
</tr>
<tr>
<td>Employer</td>
<td>47.4</td>
<td>36.1</td>
<td>50</td>
</tr>
<tr>
<td>Self</td>
<td>32.6</td>
<td>35.0</td>
<td>20</td>
</tr>
<tr>
<td>Professional society</td>
<td>5.3</td>
<td>19.7</td>
<td>0</td>
</tr>
<tr>
<td>Govt CPD funding</td>
<td>11.9</td>
<td>25.4</td>
<td>0</td>
</tr>
</tbody>
</table>

MRS professionals employed in hospitals receive greater financial support for the cost of attending conferences from their employer than their colleagues employed in clinics. In relation to level of self-funding to attend conferences, MRS professionals employed in clinics self-fund a higher percentage of financial cost than their colleagues employed in hospitals. After testing for
the assumption of equal variance (Levene’s statistic) one-way ANOVA was performed. The observed difference in financial support from the employer ($F=4.024, \text{df}=2, p=0.019$) and level of self-funding ($F=4.897, \text{df}=2, p=0.008$) to attend conferences was statistically significant for workplace type, providing additional evidence to reject the null hypothesis.

To summarise, consistent and statistically significant difference in accessibility of information sources as mediating tools for professional updating activity exists for the variable, workplace type. MRS professionals employed in teaching hospitals have greater effective access to books, electronic and print journals, seminars, the Internet and health and medical databases in their workplace. In addition, those employed in teaching hospitals report access to more journals, greater support for provision of time during work hours to engage in professional reading activities, greater support for paid leave to attend conferences and have lower levels of self-funding to attend conferences than their colleagues employed in other workplace types.

**Based on these results, H8 was rejected: there is a significant difference in workplace accessibility to mediating tools for clinical workplace profile, workplace type (teaching hospital, non-teaching hospital, clinic).**

Consequently, workplace type (WR) was included as an influencing variable in the professional knowledge updating activity system in Figure 5.6 under community, clinical workplaces.

Jones and Lambros (2003) previously reported that anaesthetists in teaching hospitals had greater access to the Internet than their colleagues in other clinical work environments. This study not only supports this earlier finding but also establishes that this differential access exists across multiple primary mediating tools – books, journals, health and medical databases, conferences and seminars. This finding may be of interest to other health professions, such as nursing, medicine and physiotherapy, where practitioners similarly work across these range of workplace types. However,
studies examining access to and use of information sources from these occupational groups (Eley et al. 2009; Gilmore et al., 2012; Gosling & Westbrook, 2004; Gosling et al., 2004; Veness et al., 2003) do not appear to have investigated workplace type as a factor influencing access to information sources within healthcare organisations. A more holistic understanding needs to be developed for each health profession on the influence of workplace type on access to the suite of information sources that are adopted to update professional knowledge and support the provision of high-quality, safe patient care.

5.3.2.4 H9 Area of specialisation

The first factor listed under workplace division of labour in the professional knowledge updating model (Figure 5.5) that may influence the individual’s access to mediating tools is area of specialisation. Bawden and Robinson (1997) demonstrated that access to relevant journal titles within the nursing profession varied according to the area of specialisation (Section 2.5.4.2). As there was no identified research that had examined MRS professionals’ workplace access to journals across area of specialisation, this study sought to address this deficit. Furthermore, the influence of area of specialisation on other primary mediating tools for updating professional knowledge, such as seminars, conferences, Internet and health and medical databases, has not been established. Hypothesis 9, stated in the null, predicts no relationship between area of specialisation and accessibility of tools to individuals within the workplace. Specifically, Hypothesis 9 was:

**H9 Workplace accessibility of mediating tools will be no different for workplace professional profile, area of specialisation (nuclear medicine, radiation therapy, radiography, sonography).**

Survey data was analysed for those employed in clinical workplaces (N=320, Table 5.7) for four recognised areas of specialisation within the MRS
profession, namely nuclear medicine, radiation therapy, radiography, sonography (Table 5.19).

<table>
<thead>
<tr>
<th>Influencing factor in Engeström’s Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>Nuclear medicine</td>
<td>35</td>
</tr>
<tr>
<td>Clinical workplace</td>
<td>Per cent</td>
<td>10.9</td>
</tr>
<tr>
<td>Area of specialisation</td>
<td>Frequency</td>
<td>10.9</td>
</tr>
<tr>
<td>Radiation therapy</td>
<td>(%)</td>
<td>20.9</td>
</tr>
<tr>
<td>Radiography</td>
<td>(%)</td>
<td>52.5</td>
</tr>
<tr>
<td>Sonography</td>
<td>(%)</td>
<td>15.6</td>
</tr>
<tr>
<td>Total</td>
<td>(%)</td>
<td>100.0</td>
</tr>
</tbody>
</table>

For Hypothesis 9, the relationship between area of specialisation within the clinical workplace and both the individual’s effective access and physical access to tools were examined. Table 5.20 displays a summary of results.

Area of specialisation was observed to influence effective workplace access to electronic journals, Internet and seminars. MRS professionals specialising in radiography reported lower effective access to these mediating tools in their workplace than their colleagues employed in other areas of specialisation within MRS. Twenty-seven per cent (n=43) of MRS professionals specialising in radiography rated their workplace access to electronic journals as *not easy* (13%) or *no access* (14%). In relation to effective access to the Internet in the workplace, 25% (n=41) of MRS professionals specialising in radiography rated their workplace access to the Internet as *not easy* (11%) or *no access* (14%). In comparison, only 12% (n=4) of their colleagues specialising in nuclear medicine and 14% (n=7) specialising in sonography rated their workplace access to the Internet as *not easy* (9%, 6%) or *no access* (3%, 8%) respectively. Whilst 8% (n=13) of MRS professionals specialising in radiography reported that they no access to seminars in their workplace, none of the responding radiation therapists
<table>
<thead>
<tr>
<th>Area of Specialisation</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of Difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear medicine</td>
<td>Effective access in the workplace</td>
<td>Books</td>
<td>14.280 a†</td>
<td>p=.463</td>
</tr>
<tr>
<td>Radiography</td>
<td></td>
<td>E-journals</td>
<td>27.858 a†</td>
<td>p=.015</td>
</tr>
<tr>
<td>Radiation therapy</td>
<td></td>
<td>Print journals</td>
<td>22.067 a†</td>
<td>p=.092</td>
</tr>
<tr>
<td>Sonography</td>
<td></td>
<td>Internet</td>
<td>40.249 a†</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminars</td>
<td>29.490 a†</td>
<td>p=.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health and medical databases</td>
<td>20.934 a†</td>
<td>p=.117</td>
</tr>
<tr>
<td>Physical access in the workplace</td>
<td></td>
<td>Journals</td>
<td>9.491 b</td>
<td>p = .023</td>
</tr>
<tr>
<td>Number available</td>
<td></td>
<td>Multiple, including books, journals, Internet</td>
<td>30.292 a</td>
<td>p = .003</td>
</tr>
<tr>
<td>Provision of time to read information</td>
<td></td>
<td>Conference</td>
<td>24.712 c</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Paid leave to attend</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Fisher’s exact test, † Kruskal-Wallis test, c Pearson chi-square
† Monte Carlo method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 2000000
and just one sonographer indicated they had no access to seminars in their workplace. Statistically significant difference in accessibility of mediating tools provides evidence to support rejecting the null hypothesis, H9. MRS professionals specialising in radiation therapy reported that they had access to a higher number of journals (median = 6, IQR = 11) than MRS professionals specialising in nuclear medicine (median = 4, IQR = 10), sonography (median = 4, IQR = 5) or radiography (median = 3, IQR = 6). Thirty-seven per cent of the responding MRS professionals specialising in radiography (n=147) reported that they had access to only one (23%, n=34) or none (14%, n=21) of the listed journals. This observed difference in number of journals was significant for area of specialisation (Kruskal-Wallis test $\chi^2=9.491$ (df=3), p=0.023), providing further support to reject the null hypothesis.

In relation to provision of time during work hours to engage in professional reading, 49% of MRS professionals specialising in radiation therapy (n=65) reported that their workplace allocates time for professional reading activities compared to 20% specialising in nuclear medicine (n=35), 20% in radiography (n=164) and 16% in sonography (n=50). Difference in provision of time was significant for area of specialisation (Fisher’s exact test = 30.292, p =0.003) providing further evidence to reject the null hypothesis.

Provision of paid leave to attend conferences was examined across the four areas of specialisation. Ninety-two per cent of MRS professionals specialising in radiation therapy (n=65), 90% in sonography (n=50) and 88% in nuclear medicine (n=33) reported that they receive this leave compared to 68% specialising in radiography (n=161). The difference in provision of paid leave to attend conferences was significant ($\chi^2 = 24.712$, df = 3, $p < 0.001$), supporting rejection of the null hypothesis.

The percentage of total funding support from four sources to attend conferences is presented in Table 5.21. MRS professionals specialising in nuclear medicine receive a higher percentage of financial support to attend
**Table 5.21**

*Percentage Financial Support to Attend Conferences for Four Areas of Specialisation*

| Funding source       | Nuclear medicine | | | Radiation therapy | | | Radiography | | | Sonography | |
|----------------------|------------------|---|---|-------------------|---|---|----------------|---|---|----------------|---|---|
|                      | Mean  | SD  | Median | Mean  | SD  | Median | Mean  | SD  | Median | Mean  | SD  | Median |
| Employer             | 60.8  | 38.4| 70     | 34.4  | 33.7| 30     | 45.7  | 37.8| 50     | 44.9  | 33.1| 50     |
| Self                 | 35.0  | 37.6| 22     | 17.3  | 25.0| 0      | 47.8  | 39.1| 50     | 45.3  | 32.7| 50     |
| Professional society | 0     | -   | 0      | 6.9   | 21.4| 0      | 3.9   | 14.9| 0      | 8.7   | 26.5| 0      |
| Govt CPD funding     | 0     | -   | 0      | 39.4  | 37.4| 40     | 1.7   | 7.1 | 0      | 0     | -   | 0      |
conferences from their employer than their colleagues from other areas of specialisation. With respect to other funding sources, MRS professionals specialising in radiation therapy reported the lowest level of self-funding to attend conferences and they received more government-provided CPD funds to support attendance at conferences than their colleagues from the other three areas of specialisation. After testing for the assumption of equal variance (Levene’s statistic), Kruskal-Wallis test was performed. The observed difference in financial support from the workplace to attend conferences ($\chi^2 = 9.360, df = 3, p = 0.025$), self-financing to attend conferences ($\chi^2 = 29.413, df = 3, p < 0.001$) and government-provided CPD funding ($\chi^2 = 112.662, df = 3, p < 0.001$) was statistically significant for area of specialisation. These findings indicate that financial accessibility of conferences is influenced by area of specialisation providing, further support to reject the null hypothesis.

A statistically significant difference in accessibility of information sources as mediating tools for professional updating activity was shown to exist for area of specialisation. MRS professionals specialising in radiography report lower levels of effective access in their workplace to electronic journals, the Internet and seminars than their colleagues from other areas of specialisation. In addition, they also indicate they have access to fewer journals, less support for provision of time during work hours to engage in professional reading activities, less support for paid leave to attend conferences, less financial support from their employer to attend conferences and have higher levels of self-funding to attend conferences than their colleagues from other areas of specialisation. In contrast, MRS professionals specialising in radiation therapy report access to more journals, receive more time during work hours to engage in professional reading activities, more support for paid leave to attend conferences and have the lowest level of self-funding to attend conferences.

Based on these results, H9 was rejected: there is a significant difference in workplace accessibility to mediating tools for
clinical workplace professional profile, area of specialisation (nuclear medicine, radiation therapy, radiography, sonography).

Consequently, area of specialisation (AS) was included as an influencing variable in the professional knowledge updating activity system in Figure 5.6 under community, clinical workplaces.

This study also demonstrates that MRS professionals specialising in radiation therapy have higher levels of access in their workplace to primary tools to update their professional knowledge than their colleagues from other areas of specialisation. Within the nursing profession, Bawden and Robinson (1997) previously observed that area of specialisation influenced workplace access to journals. This current study established that differential workplace access within the MRS profession exists for electronic journals and extends to include seminars, conferences and the Internet. Greater financial support to attend conferences from government provided CPD funding was apparent in this current study for radiation therapists. This increased CPD funding may be attributed to the Australian Government’s Strengthening Cancer Care Initiative, which sought to improve professional development for cancer health professionals (Australian Federal Government, May 2005). Similar to the MRS profession, other health professions, such as nursing and medicine, have members specialising in cancer care. Therefore, in these professions there may also exist across area of specialisation differential access to government-provided support for CPD.

In research related to attitudes toward CPD, qualitative data suggested that sonographers in the United Kingdom were afforded greater workplace support to attend workplace seminars and provision of study days (Henwood et al., 2010). The findings from this study affirm that difference in support for seminars between MRS professionals specialising in sonography and radiography also exists in Australia. For instance, just one sonographer in this study identified that they had no access to seminars in their workplace compared to 8% (n=13) of MRS professionals specialising in radiography. The findings from this study also demonstrate that professionals specialising
in sonography were afforded more assistance from their workplace to attend conferences through the provision of financial and time support.

Previous studies have identified that area of specialisation may influence workplace access to journals (Bawden & Robinson, 1997) and seminars (Henwood et al., 2010). This current study not only supports these findings but also establishes that this differential access exists across multiple primary mediating tools – journals, Internet, conferences and seminars. This finding may be of interest to other health professions where there are distinct areas of specialisation, such as nursing and medicine, so that a more-detailed understanding is developed for each health profession on the influence of area of specialisation on workplace access to the suite of information sources that are adopted to update professional knowledge and support the provision of high-quality, safe patient care.

5.3.2.5 H10 Workplace role

The second factor listed under clinical workplace division of labour in the professional knowledge updating model (Figure 5.5) that may influence the individual’s access to mediating tools is workplace role. Klotz and Reis (2005) and others (Gilmore et al., 2012; Herrington & Herrington, 2006) demonstrated that whilst Internet access was physically available in the workplace, passwords were used to restrict access to staff with management roles. The influence of workplace role on access to the Internet within the MRS profession has not been established. In addition, the influence of workplace role on access to other information sources such as journals, health and medical databases and conferences within the MRS profession or health professions more generally needs to be established. Hypothesis 10, stated in the null, predicts no relationship between workplace role and accessibility of tools to individuals within the workplace. Specifically, Hypothesis 10 was:
H10 Workplace accessibility of mediating tools will be no different for workplace professional profile, workplace role (manager, clinical educator, senior practitioner, non-senior practitioner).

Survey data was analysed for those employed in clinical workplaces (N=320, Table 5.7) for four nominated roles, namely manager, clinical educator, senior practitioner and non-senior practitioner (Table 5.22).

<table>
<thead>
<tr>
<th>Influencing factor in Engeström's Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>Clinical workplace, Workplace role</td>
<td></td>
</tr>
<tr>
<td>Manager</td>
<td>57</td>
<td>17.8</td>
</tr>
<tr>
<td>Clinical educator</td>
<td>28</td>
<td>8.8</td>
</tr>
<tr>
<td>Senior practitioner</td>
<td>84</td>
<td>26.3</td>
</tr>
<tr>
<td>Non-senior practitioner</td>
<td>50</td>
<td>47.2</td>
</tr>
<tr>
<td>Total</td>
<td>320</td>
<td>100.0</td>
</tr>
</tbody>
</table>

For Hypothesis 10, the relationship between area of specialisation within the clinical workplace and both the individual’s effective access and physical access to tools were examined. Table 5.23 presents a summary of results.

As demonstrated in Table 5.23, a relationship exists between workplace role and effective access to electronic journals, print journals, Internet, seminars and health and medical databases. MRS professionals employed in non-senior practitioner roles report lower effective access to these mediating tools in their workplace than their colleagues employed in managerial and education roles. Thirty per cent (n=42) of MRS professionals in practitioner roles rated their workplace access to e-journals as not easy (15%, n=21) or no access (15%, n=21) compared to 7% (n=2) in education (0%, 7%) and
TABLE 5.23

RELATIONSHIP BETWEEN WORKPLACE ROLE AND WORKPLACE ACCESSIBILITY OF MEDIATING TOOLS

<table>
<thead>
<tr>
<th>Workplace role</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager</td>
<td>Effective access in the workplace</td>
<td>Books, E-journals, Print journals, Internet, Seminars, Health and medical databases</td>
<td>13.083 a†</td>
<td>p=.560</td>
</tr>
<tr>
<td>Clinical educator</td>
<td></td>
<td></td>
<td>25.503 a†</td>
<td>p=.035</td>
</tr>
<tr>
<td>Senior practitioner</td>
<td></td>
<td></td>
<td>41.385 a†</td>
<td>p &lt;.001</td>
</tr>
<tr>
<td>Non-senior practitioner</td>
<td></td>
<td></td>
<td>29.797 a†</td>
<td>p=.007</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24.552 a†</td>
<td>p=.042</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25.504 a†</td>
<td>p=.033</td>
</tr>
</tbody>
</table>

Physical access in the workplace

<table>
<thead>
<tr>
<th>Workplace role</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number available</td>
<td>Journals, Multiple, including books, journals, Internet</td>
<td>19.107 b</td>
<td>p &lt;.001</td>
</tr>
<tr>
<td></td>
<td>Provision of time to read information</td>
<td>Multiple, including books, journals, Internet</td>
<td>19.528 a</td>
<td>p = .113</td>
</tr>
<tr>
<td></td>
<td>Paid leave to attend</td>
<td>Conference</td>
<td>16.336 c</td>
<td>p = .001</td>
</tr>
</tbody>
</table>

* Fisher's exact test, † Kruskal-Wallis test, ‡ Pearson chi-square
† Monte Carlo method used for Fisher's exact test (95% CI) based on 10000 sampled tables with starting seed 2000000
20% (n=11) in managerial roles (9%, 11%). In relation to print journals, 34% (n=49) of respondents in practitioner roles rated their workplace access as not easy (24%, n=35) or no access (10%, n=14). This compares to 11% (n=3) in education (11%, 0%) and 13% (n=7) in managerial roles (11%, 2%). Twenty-nine per cent (n=43) of MRS professionals in practitioner roles rated their workplace access to Internet as not easy (13%, n=19) or no access (16%, n=24). In contrast, 5% or less of their colleagues in education (4%, n=1) or managerial roles (5%, n=3) reported that they had no workplace access to the Internet. An association was also observed between workplace role and access to health and medical databases. Thirty-nine per cent (n=54) of respondents in practitioner roles rated their workplace access to databases as not easy (22%, n=31) or no access (17%, n=23). This compares to 8% (n=2) in education (4%, 4%) and 20% (n=11) in managerial roles (9%, 11%). In relation to workplace access to seminars, 26% (n=38) of respondents in practitioner roles rated their workplace access to seminars as not easy (19%, n=28) or no access (7%, n=10). In comparison, 4% of their colleagues in an education role (n=1) reported that their workplace access to the seminars was not easy (0%, n=0) or no access (4%, n=1). Statistically significant difference in accessibility of multiple examined mediating tools provides evidence to support rejecting the null hypothesis, H10.

MRS professionals in the role of clinical educator reported access to a higher number of journals (median = 6, IQR = 17) than MRS professionals working in managerial (median = 6, IQR = 7), senior practitioner (median = 3, IQR = 8) or practitioner (median = 2.5, IQR = 5) roles. Thirty-seven per cent of the responding MRS professionals working in the non-senior practitioner role (n=124) reported having access to only one (23%, n=28) or none (14%, n=17) of the listed journals. This observed difference in number of journals was significant for professional role (Kruskal-Wallis test $\chi^2=19.107, df=3$, $p<0.001$), providing further support to reject the null hypothesis.

Provision of paid leave to attend conferences was examined across four workplace roles. Ninety-six per cent of MRS professionals working in an
education role (n=28), 91% in managerial roles (n=56) and 80% in senior practitioner roles (n=83) were provided with paid leave to attend conferences compared to 70% employed in non-senior practitioner roles (n=142). The difference in provision of paid leave to attend conferences for professional role was statistically significant ($\chi^2 = 16.336, df = 3, p = 0.001$), providing further evidence to support rejection of Hypothesis 10.

The percentage of funding support MRS professionals receive from four sources were analysed for four workplace roles. The results are presented in Table 5.24. The employer was the primary funding source for MRS professionals in managerial and education roles. In relation to self-funding to attend conferences, MRS professionals employed in the role of clinical educator reported the lowest level of self-funding to attend conferences. After testing for the assumption of equal variance (Levene’s statistic), one-way ANOVA was performed to examine if difference in financial support from the employer to attend conferences was significant for workplace role and the Kruskal-Wallis test undertaken to examine if the difference in financial support from self to attend conferences was significant. Difference between groups was significant for financial support from the workplace ($F=5.262, df=3, p=0.002$) and level of self-funding ($\chi^2 =14.871, df=3, p=0.002$) to attend conferences. These findings provide additional support to reject the null hypothesis.
## Table 5.24

**Percentage Financial Support to Attend Conferences for Four Professional Workplace Roles**

<table>
<thead>
<tr>
<th></th>
<th>Practitioner</th>
<th>Senior Practitioner</th>
<th>Clinical Educator</th>
<th>Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean SD</td>
<td>Mean SD Median</td>
<td>Mean SD Median</td>
<td>Mean SD Median</td>
</tr>
<tr>
<td><strong>Employer</strong></td>
<td>36.8 36.3</td>
<td>40 40.9 35.4 40</td>
<td>53.5 36.8 50</td>
<td>59.4 34.2 60</td>
</tr>
<tr>
<td><strong>Self</strong></td>
<td>48.7 39.2</td>
<td>50 36.6 37.4 30</td>
<td>21.5 31.8 5</td>
<td>30.1 27.7 25</td>
</tr>
<tr>
<td><strong>Professional society</strong></td>
<td>2.7 14.0</td>
<td>0 4.7 17.8 0</td>
<td>10.6 30.1 0</td>
<td>1.4 7.2 0</td>
</tr>
<tr>
<td><strong>Govt CPD funding</strong></td>
<td>8.7 24.1</td>
<td>0 14.4 30.2 0</td>
<td>10.6 19.8 0</td>
<td>7.7 21.4 0</td>
</tr>
</tbody>
</table>
Statistically significant difference in accessibility of information sources as mediating tools for professional updating activity exists for workplace role. MRS professionals working in the clinical educator role report that they have greater effective access to books, electronic journals, the Internet and health and medical databases in their workplace than their colleagues in other examined professional roles. Clinical educators also report that they have access to more journals, receive more time during work hours to engage in professional reading activities and receive more support for paid leave to attend conferences than their colleagues in other workplace roles. In contrast, MRS professionals employed in non-senior practitioner roles report the lowest level of effective workplace access to print and electronic journals, the Internet, health and medical databases. They also receive less support for paid leave to attend conferences, less financial support from their employer to attend conferences and have higher levels of self-funding to attend conferences than their colleagues employed in other workplace roles.

Based on these results, H10 was rejected: there is a significant difference in workplace accessibility to mediating tools for clinical workplace professional profile, workplace role (manager, clinical educator, senior practitioner and non-senior practitioner).

Consequently, workplace role (WR) was included as an influencing variable in the professional knowledge updating activity system in Figure 5.6 under community, clinical workplaces.

Senge (1990) identified that hierarchical structures in organisations influence access to resources with those in managerial positions have greater access to resources than their less senior colleagues. Other studies have identified that employment role can influence workplace access to the Internet, with those in senior roles reporting greater access than their non-senior colleagues (Gilmore et al., 2012; Herrington & Herrington, 2006; Klotz and Reis, 2005). The findings from this current study support and build upon these other studies by establishing that MRS professionals in non-senior roles report the lowest level of workplace access to the Internet, which is in accordance with other studies. The findings from the current study also
establish that those employed in non-senior roles also report the lowest level of access to books, journals, health and medical databases, time for professional reading, leave and financial support from their employer to attend conferences. This finding establishes that the influence of workplace role on accessibility of information sources extends across multiple key learning tools that are utilised to update professional knowledge.

In addition, as shown in relation to Research Question 4, configuration of computers with Internet access within the workplace influences frequency of use of electronic tools, such as the Internet and journals, by MRS professionals to update their knowledge. In particular the universal inclusion of Internet access onto all workplace computers was shown to support knowledge updating activity. In MRS workplaces, offices are typically restricted to managers and some senior staff. Non-senior MRS professionals typically work in an assigned modality area, which may or may not have computers with Internet access. Difference in effective access in the workplace to electronic mediating tools such as the Internet was statistically significant for MRS professionals (Table 5.23). As observed by one manager describing the use of electronic information tools in the workplace:

[electronic information] resources are used mainly by people who are looking up areas that they’re unfamiliar with so it could be a new technique or some new name – or it could be an old name of say a view within the X-ray – or what they should be seeing as a result, where that experience and expertise is not available. (RP3 interview)

Unfamiliarity and lack of experience and expertise is more likely to exist in recent graduates. Ninety-one per cent of survey respondents with less than five years’ clinical experience were employed in a non-senior role. In workplaces where all computers have Internet access, 65% of non-senior practitioners rated their ease of access as very easy. In contrast, in workplaces where Internet access was restricted to offices only, 43% of non-senior practitioners reported they had no access and a further 19% described their access as not easy, the lowest scale on the five-point Likert scale.
Restricting Internet access to offices only, therefore, particularly disadvantages the recent graduate practitioner, a group that should be actively supported in developing their knowledge, skills and expertise.

5.3.2.6 H11 Employment fraction

The third factor listed under workplace division of labour in the professional knowledge updating model (Figure 5.5) that may influence the individual’s access to mediating tools is employment fraction. Palarm et al. (2001) identified that fewer radiographers employed part time attended conferences than their peers in full-time employment and questioned whether part-time radiographers are afforded the same opportunities to attend conferences as their full-time colleagues. In addition, the influence of employment fraction on access to other information sources, such as journals, health and medical databases and seminars, within the MRS profession or health professions more generally needs to be established. To investigate if employment fraction does influence access to primary tools, employment fraction was introduced as a variable in the professional knowledge updating model (Figure 5.5). Hypothesis 11, stated in the null, predicts no relationship between employment fraction and accessibility of tools to individuals within the workplace. Specifically, Hypothesis 11 was:

**H11 Workplace accessibility of mediating tools will be no different for workplace professional profile, employment fraction (full time, part time).**

Survey data was analysed for those employed in clinical workplaces (N=320, Table 5.7) for two employment fractions – full time, part time (Table 5.25).
For Hypothesis 11, the relationship between employment fraction and both the individual's effective access and physical access to tools were examined. A summary of results is displayed in Table 5.26.

Employment fraction was shown to influence effective workplace access to electronic journals, print journals, seminars and health and medical databases. MRS professionals employed part time reported a lower level of effective access to these mediating tools in their workplace than their colleagues employed full time. A higher proportion of part-time employees reported that they had no access to electronic journals (22%, n=17) or print journals (16%, n=13) in their workplace compared to their colleagues in full-time employment (10%, n=22; 5%, n=12, respectively). In relation to health and medical databases, 20% (n=15) of MRS professionals employed part time reported that they had no access in their workplace compared to 11% (n=25) in full-time employment. Thirteen per cent (n=11) of MRS professionals employed part time stated that they no access (13%, n=11) to seminars in their workplace compared to 2% (n=4) in full-time employment. Statistically significant difference in accessibility of multiple examined mediating tools provides evidence to support rejecting the null hypothesis, H11.

### Table 5.25

<table>
<thead>
<tr>
<th>Influencing factor in Engeström's Activity System model (2001)</th>
<th>Variable contextualised for investigation in this study examining professional knowledge updating</th>
<th>Respondents in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Characteristic</td>
<td>Frequency</td>
</tr>
<tr>
<td>Community</td>
<td>Full-time</td>
<td>226</td>
</tr>
<tr>
<td>Employment fraction</td>
<td>Part-time</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Total Valid</td>
<td>310</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>320</td>
</tr>
</tbody>
</table>

For Hypothesis 11, the relationship between employment fraction and both the individual's effective access and physical access to tools were examined. A summary of results is displayed in Table 5.26.
### Table 5.26

**RELATIONSHIP BETWEEN EMPLOYMENT FRACTION AND WORKPLACE ACCESSIBILITY OF MEDIATING TOOLS**

<table>
<thead>
<tr>
<th>Employment fraction</th>
<th>Measurement of accessibility</th>
<th>Mediating tools</th>
<th>Test of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td><em>Effective access in the workplace</em></td>
<td>Books</td>
<td>9.264 <em>a†</em></td>
<td>p=.090</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E-journals</td>
<td>18.159 <em>b</em></td>
<td>p=.003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Print journals</td>
<td>17.336 <em>b</em></td>
<td>p=.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internet</td>
<td>4.764 <em>b</em></td>
<td>p=.445</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminars</td>
<td>17.286 <em>a†</em></td>
<td>p=.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health and medical databases</td>
<td>14.411 <em>b</em></td>
<td>p=.013</td>
</tr>
<tr>
<td>Part time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Physical access in the workplace</em></td>
<td>Journals</td>
<td>-4.853 <em>c</em></td>
<td>p &lt;.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provision of time to read information</td>
<td>4.271 <em>b</em></td>
<td>p =.039</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paid leave to attend</td>
<td>23.866 <em>b</em></td>
<td>p &lt;.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial support to attend</td>
<td>1.773 <em>d</em></td>
<td>p =.077</td>
</tr>
</tbody>
</table>

* Fisher’s exact test, † Pearson chi-square, * Mann-Whitney U test, ‡ t-test for independent samples

† Monte Carlo method used for Fisher’s exact test (95% CI) based on 10000 sampled tables with starting seed 1216981036
MRS professionals employed full time report access to a higher number of journals (median = 5, IQR = 9) than their colleagues in part-time employment (median = 2, IQR = 3). Forty-six per cent of respondents employed part time (n=72) reported that they had access to only one (32%, n=23) or none (14%, n=10) of the listed journals. The observed difference in number of journals was significant for employment fraction (Mann-Whitney U test, Z=-4.853, p<0.001) providing further support to reject the null hypothesis.

Employers can support professional updating activity through the provision of time during work hours to engage in professional reading. Twenty-nine per cent of MRS professionals employed full-time (n=225) reported that their workplace allocates time for professional reading activities compared to 18% employed part time (n=80). This difference in provision of time was statistically significant ($\chi^2 = 4.271, df = 1, p = 0.039$), providing further evidence to reject the null hypothesis.

In relation to support from the employer to attend conferences, 87% of MRS professionals employed full time (n=222) identified that they receive paid leave compared to 61% employed in a part-time capacity (n=79). This observed difference was statistically significant ($\chi^2 = 23.866, df = 1, p < 0.001$), providing additional evidence to reject the null hypothesis. Difference in financial support from the employer to attend conferences was not significant for employment fraction.

Statistically significant difference in accessibility of information sources as mediating tools for professional updating activity exists for employment fraction. MRS professionals working full time report greater effective access in their workplace to electronic and print journals, seminars and health and medical databases than their colleagues employed part time. Full-time employees also report that they have access to more journals, receive more time during work hours to engage in professional reading activities and receive more support for paid leave to attend conferences than their part-time colleagues.
Based on these results, H11 was rejected: there is a significant difference in workplace accessibility to mediating tools for clinical workplace professional profile, employment fraction (full time, part time).

Consequently, employment fraction (EF) was included as an influencing variable in the professional knowledge updating activity system in Figure 5.6 under community, clinical workplaces.

Palarm et al. (2001), in a study of radiographers in the United Kingdom (n=444), identified that one-third of radiographers (35%) employed part time attend conferences to update their knowledge compared to 56% of their peers in full-time employment. The authors of this study concluded that either part-time radiographers do not take advantage of CPD opportunities available to them “or these opportunities do not exist” (p. 52). As shown in this current research, part-time employees were not afforded the same access to paid leave to attend conferences as their full-time colleagues. It was also established in relation to Research Question 4 that the provision of paid leave to attend conferences influences frequency of attendance \( \chi^2 = 38.495, df = 3, p < 0.001 \). The finding by Palarm et al. (2001) may reflect the disparity of access part-time radiographers experience to paid leave from their employer to attend conferences. The findings from this current research also demonstrate differential access to primary tools for updating professional knowledge extends beyond conferences to include seminars, journals, health and medical databases and time during work hours to engage in professional reading activities.

As noted in Section 4.1, the percentage of survey respondents employed part time (29.9%, n=108) was in accord with national data, where 29.5% of MRS professionals report working less than 35 hours per week (Australian Institute of Health and Welfare, 2009). MRS professionals employed part time are, therefore, a significant group within the workforce. In addition, within some sectors, such as those working within BreastScreen Australia, the majority of
MRS professional’s work part time (Moran & Warren-Forward, 2012). Whether employed full time or part time, MRS professionals face the same level of CPD requirement. However, the findings from this study establish that those employed part time are not provided with the same level of workplace support to maintain currency of their professional knowledge as their full-time peers.

### 5.3.3 Professional knowledge updating model with community and division of labour

Physical characteristics of the workplace and professional profile characteristics were shown to influence the workplace accessibility of multiple information sources. Multiple measures of accessibility were utilised examining both effective and physical access to these mediating tools in professional knowledge updating activity. The findings of this study in relation to hypotheses 5–11 are displayed in Figure 5.6.

Statistically significant difference in workplace accessibility was observed for all examined information sources. Books were utilised by MRS professionals as tools to update their professional knowledge. This study identified that workplace access to books, whilst the most homogenous of any examined information source, was not uniform. Work context and workplace type influence effective access to books in the workplace. MRS professionals employed in universities and those employed in teaching hospitals indicate higher levels of access to books in their workplace than their colleagues employed in non-teaching hospitals and clinics.
Journals are important tools for disseminating new knowledge. This study identified that workplace access to journals within the MRS profession is influenced by work context, workplace type, health sector, geographic location, area of specialisation, workplace role and employment fraction. Wide variation existed in the number of journals MRS professionals could access. MRS professionals working in universities reported access to many professionally relevant journals (median = 23), however, this was not the case for their colleagues in clinical practice. Forty per cent of MRS professionals employed in non-teaching hospitals or clinics reported that they had access to one or no journals.

The Internet is utilised by MRS professionals as an informative and communicative tool to update professional knowledge. Whilst it may appear...
reasonable to assume that MRS professionals would have access to the Internet in their workplace, this study identified that workplace access to the Internet was not uniform. Work context, workplace type, area of specialisation and workplace role were shown to influence access to the Internet in the workplace. Twenty-four per cent of MRS professionals employed in non-teaching hospitals could not access the Internet in their workplace.

Health and medical databases are important tools for searching the literature and used by MRS professionals to update their knowledge. This study established that work context, workplace type, health sector, workplace role and employment fraction influence accessibility of this tool in the workplace. Over one-quarter of MRS professionals in non-teaching hospitals (29%) and clinics (26%) reported that they had no access to these types of databases in their workplace.

In relation to conferences, accessibility was not uniform across the MRS profession. The factors identified in this study as influencing the provision of leave or funding to attend conferences were work context, workplace type, health sector, geographic location, area of specialisation, workplace role and employment fraction. A large proportion of respondents employed in rural and remote locations (40%), non-teaching hospitals (36%) and those working part time (39%) were not provided with paid leave from their employer to attend conferences.

MRS professionals ranked seminars as the most important tool for updating professional knowledge. This study has shown that workplace accessibility to seminars is influenced by workplace type, geographic location, area of specialisation, workplace role and employment fraction. Twenty per cent of MRS professionals in rural and remote locations do not have access to seminars in their workplace.
Protected time during work hours supports health professionals to update their knowledge. This study has established that workplace type, geographic location, area of specialisation and employment fraction influence MRS professionals’ access to protected time. Whilst the majority (94%) of MRS professionals employed by universities are provided with protected time, this is not the case for their colleagues in non-teaching hospitals (11%) and rural and remote locations (11%).

It has been established in this present study (Research Question 4) that a positive relationship exists between workplace accessibility of mediating tools and level of use of these tools in knowledge updating by MRS professionals. This study has provided an initial dataset of factors influencing workplace accessibility of primary tools used by MRS professionals to update their professional knowledge. It has been shown that accessibility of all the examined mediating tools for professional updating activity varies widely across the MRS profession. A large proportion of MRS professionals do not have access to primary tools for updating professional knowledge in their workplace. As identified by Eraut (1994), professionals need support from their employing organisation to maintain and develop their professional knowledge. The findings from this study indicate that workplaces can proactively support professional knowledge updating by increasing effective and physical access of primary mediating tools in the workplace.

5.4 Addressing Research Questions 3, 4 and 5

The following section discusses the significance and implications of the findings associated with Research Questions 3, 4 and 5. These three research questions focused on factors influencing professional knowledge updating. A summary of findings in relation to Research Questions 3, 4 and 5 is displayed in Table 5.27.
### Table 5.27
*Summary of Results Research Questions 3–5*

<table>
<thead>
<tr>
<th>Research question</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. What factors associated with professions influence the use of mediating tools in updating professional knowledge?</td>
<td>Statistically significant results indicate a positive relationship exists between both membership of a professional society and enrolment in a CPD program and level of professional knowledge updating activity. This association was limited to tools associated with the professional society, such as conferences and seminars organised by professional societies.</td>
</tr>
<tr>
<td>4. Does workplace accessibility of mediating tools influence their use in updating professional knowledge?</td>
<td>Statistically significant results demonstrate a positive relationship between workplace access to mediating tools and level of use of these tools in professional knowledge updating activity. This finding was observed across all examined information sources. Employers can, therefore, play an important role in professional knowledge updating by the level of access they provide to information sources in the workplace.</td>
</tr>
<tr>
<td>5. What factors influence workplace accessibility of mediating tools and do hierarchies of access to these tools exist across workplaces?</td>
<td>Statistically significant results demonstrate that workplace access to primary mediating tools for updating professional knowledge was not uniform across the MRS profession. A relationship was shown to exist between workplace accessibility of mediating tools to MRS professionals and both physical profile of the workplace (work context, workplace type, health sector, geographic location) and professional profile of the employee (area of specialisation, workplace role, employment fraction). Professionals employed by universities reported greater level of access to multiple information sources than those employed in clinical workplaces. Within clinical workplaces, greater access to examined information sources was reported by those in teaching hospitals, public health sector and metropolitan locations, specialising in radiation therapy, clinical educators and employed full time.</td>
</tr>
</tbody>
</table>
In relation to Research Question 3, it has been demonstrated that a positive relationship exists between both enrolment in CPD and membership of a professional society and level of knowledge updating activity. This finding is in accord with research reported by Landers et al. (2005) who identified that enrolment in CPD and membership of professional societies increased the number of hours health professionals engaged in formal learning activities. It was established in the current study that difference in level of activity was statistically significant only for learning activities associated with professional societies. For example, formal learning activities such as attendance at seminars and conferences organised by professional societies. This finding thus extends current understanding of the influence of membership of a professional society and enrolment in a CPD program on level of learning activities.

Information sources are primary tools for updating professional knowledge. Whilst the workplace is recognised as having an important role in supporting learning (Billett, 1999; Burns, 2002; Eraut, 1994; Health Professions Council, nd; Wenger et al., 2002), there was a paucity of research that has examined the influence of workplace accessibility of information sources on level of learning activity and the factors that influence workplace accessibility of information sources. These issues were the focus for Research Questions 4 and 5 respectively.

Research Question 4 sought to examine the relationship between influence of individual access in the workplace to information sources and level of use of these tools. This study established MRS professionals with greater physical and effective workplace access to tools report higher use of those tools in professional knowledge updating. This finding is in accord with research involving nursing (Nagy et al., 1991) and physical therapy (Bohannon & Larkin, 1986), which demonstrated that improved access to journals in the workplace was associated with an increased level of journal reading. This current study confirms these earlier findings by demonstrating that improved accessibility to journals in the workplace is positive associated
their increased use for updating professional knowledge. In addition, as this current study examined multiple information sources, the influence of workplace accessibility of information sources other than journals on level of use has now been established.

Utilising the model of learning as an activity mediated by information sources, the learner is an active agent purposefully utilising information sources as cognitive tools to construct their knowledge (Hill et al., 2004; Neuman, 2004). This conceptualisation may be broadened to include the shared learning that can occur between members of a profession as they discuss and contextualise new knowledge. As shown in this study, this shared learning occurs within, and external to, the workplace (Section 4.2.1) and is indicative of MRS professionals participating in both their local CoP and distributed learning communities within the broader MRS profession. Whether learning mediated by information sources occurs as an individual or shared learning activity, underpinning the model of mediated learning is that relevant information sources are readily available to learners. However, as established in this current research, for many health professionals information sources are not readily accessible in the workplace and this negatively impacts their level of learning activity.

Identification of factors influencing workplace accessibility of information sources was the focus for Research Question 5. The results from this study clearly demonstrate that there were issues associated with workplace accessibility for each examined information source. It was observed that MRS professionals employed in universities had high levels of access to information sources within their workplace. This difference in workplace accessibility was further enhanced, as the majority of MRS professionals employed in universities (93%, n=26) also had the ability to remotely access workplace electronic information sources, compared to 19% (n=55) of their colleagues in clinical workplaces. In educational institutions there exists easy access to multiple sources of information and learners can access these tools at places and times that are convenient to them. Translation of results
from research investigating learning mediated with information sources within educational institutions (Hill et al., 2004; Jonassen et al., 2008; Neuman, 2004) into other workplaces, where lower levels of access to information sources exist, needs to consider the issue of accessibility so that learning outcomes are not compromised.

Mediating tools of information sources are less accessible to MRS professionals employed in clinical workplaces. The implication of this finding is that MRS professionals in clinical workplaces cannot fully harness the primary mediating tools to update their professional knowledge, improve patient care and improve organisational outcomes – the identified outcomes of professional knowledge updating (Section 4.4). Of particular importance for the clinical workplace is the impact that limited or no access to primary mediating tools for updating professional knowledge may have on patient care and other recognised priorities within clinical workplaces. The patient is the raison d’être of clinical practice (Harvey, 2012) and, as previously identified, information sources are purposefully utilised by health professionals to improve patient care. Limited or no access to primary tools for updating professional knowledge within clinical workplaces can compromise the ability of health professionals to provide safe, high-quality patient care (Health Professions Council, 2010; Runciman et al., 2012). For instance, this study has established that employment in the private health sector is associated with lower access in the workplace to primary mediating tools for professional knowledge updating. Forty-four per cent of hospitals in Australia operate in the private sector and account for 40% (3.6 million) of all hospital admissions in Australia (Australian Institute of Health and Welfare, 2012). The importance of this sector contributing toward positive health outcomes for Australia is apparent. However, the finding from this study that employment in the private sector is negatively associated with access to primary information sources for updating professional knowledge suggests that the ability of these health professionals to utilise current discipline knowledge to improve patient care is compromised. It was also shown in this study that health professionals employed in rural and remote locations had
less access to multiple primary mediating tools for professional knowledge updating than their colleagues in metropolitan locations. Health outcomes are poorer for Australians living outside of metropolitan areas (Australian Institute of Health and Welfare, 2010). It is, therefore, probable that due to lack of access to new knowledge rural health professionals’ ability to embed new knowledge into their professional practice, and so positively impact the acknowledged health outcome divide that currently exists between metropolitan and rural Australians, would be compromised.

Cross tabulation was performed to determine if a relationship exists between health sector and geographic location. In this study, no association was shown to exist ($\chi^2=3.063, df=2, p=0.226$), which suggests that health sector and geographic location of the workplace are independent variables operating within the professional knowledge updating system. As this study is a single sample, caution must be adopted in extrapolating from this single sample to the wider healthcare context.

Lack of access to primary tools that disseminate new discipline knowledge also impacts other priority areas for the MRS profession, including evidence-based practice and advanced practice (Freckelton, 2012; Hardy, Poulos, Emanuel, & Reed, 2010; Howson et al., 2010). In a recent investigation of advanced practice performed by Australian radiographers, Hardy et al. (2010) noted that engagement in research was not widespread and was an area that needed immediate development within the MRS profession. The findings from this study establish that, for many MRS professionals, their access to discipline knowledge via key mediating tools is highly problematic. For instance, 29% (n=82) of clinical MRS professionals have access to one or no journal, a fundamental tool for disseminating new research (Oermann et al., 2008). In addition, access to health and medical databases was highly problematic for many MRS professionals in clinical workplaces, with over one-quarter of MRS professionals in non-teaching hospitals (29%, n=13) and clinics (26%, n=22) reporting that they had no access to these tools in their workplace. Therefore, a large proportion of MRS professionals employed in
clinical workplaces do not have access to primary tools such as journals and health and medical databases necessary to undertake a literature review – an essential aspect of the research process and evidence-based practice (Brettle & Gambling, 2003; Howson et al., 2010; Lefebvre & Clarke, 2003). With 52% (n=186) of respondents in this current study reporting that they are engaged in research, the lack of access to primary tools, such as journals and health and medical databases, which support the research process is a concerning finding.
CHAPTER 6 – CONCLUSIONS

This chapter begins with a summary of the broader research context within which this study is situated. Next, the findings from the study in relation to the research questions are discussed. The theoretical and practical implications deriving from the study are presented. The chapter concludes with recommendations for future research.

6.1 Summary of the research context and findings

Healthcare systems and health professional associations worldwide acknowledge that, for high-quality, safe and effective healthcare, individual health professionals must engage in an ongoing process of updating their professional knowledge. Although such requirements have been in place for some years, professional knowledge updating remains an important issue. The Australian CareTrack study (Runciman et al., 2012) compared healthcare delivered to patients against evidence-based or consensus guidelines and established that 43% of healthcare practice was not in accord with the latest standards. This suggests that a large number of health professionals base clinical practice on professional knowledge which may no longer be current.

While large infrastructure investments have been made by governments to provide current, high-quality information electronically to health professionals to inform their practice (Gosling & Westbrook, 2004; Hall, 2008: National Institute of Clinical Studies, 2002), access to online information within the workplace remains problematic for many individuals. Recent studies demonstrate that current use of electronic information and communication tools within healthcare organisations continues to be limited by lack of access to computers, restrictions on web sites that can be accessed including those used for learning, and lack of time to engage with electronic learning tools.
due to heavy workloads (Bogossian & Kellett, 2010; Eley et al., 2009; Mills et al., 2011; Newman et al., 2009; Nisselle, et al., 2012; Soar, 2010; Turner et al., 2009). To add to the problem of ongoing inequitable access to electronic information sources in workplaces, little attention has been paid to non-digital information sources, such as seminars and conferences that provide learning opportunities that extend from one hour to several days, and are highly valued and utilised by health professionals to update their professional knowledge (Hegney et al., 2010; Keppell et al., 2001; Mills et al., 2011). Given that new knowledge is critical for performing at the highest standards, there remains a pressing need to investigate the complex, yet under-researched domain of professional knowledge updating.

Professional knowledge updating was defined in this study as the practice by an individual health professional of using information sources to add new disciplinary knowledge to their existing knowledge base. This study adoptedEngeström’s (2001) Activity System model as a framework for examining professional knowledge updating as a learning activity mediated by information sources (tools) and situated within ‘real world’ organisations that can afford or constrain level of activity. In this research, the information sources examined included: books, journals, Internet, health and medical databases, seminars and conferences. The current study was unique as it concomitantly examined the contemporaneous value and use of multiple primary electronic and non-electronic information sources that are integrated and adopted into the overall health professional’s knowledge updating practice; factors that influence level of use of these tools and factors that influence workplace access to these information sources.

In summary, this research informs a fundamental aspect of delivery of high-quality healthcare – the essential requirement that health professionals maintain currency of their knowledge. This study forms the first attempt to examine knowledge updating activity within the MRS profession. This study identified the information sources that are utilised to update professional knowledge and provided a quantitative ranking of their importance. The
research also established factors that influence level of professional knowledge updating activity, as well as factors influencing access within the workplace to primary tools for updating professional knowledge. More generally, the findings from this study provide an enriched understanding of learning mediated by information sources and professional and workplace factors that influence this form of learning activity. The findings addressing each research question are discussed in the following section.

6.1.1 Addressing the research questions

Based on the analysis of data from this study the following conclusions were derived:

Research Question 1 was: **What information sources do MRS professionals use as tools to update their professional knowledge and why are they used?**

This study provides baseline data on the value and use of information sources by MRS professionals to integrate new discipline knowledge into their professional knowledge. Key findings are:

- MRS professionals use multiple information sources, including books, journals, Internet web pages and search engines, conferences, health and medical databases, seminars and workshops to update their professional knowledge.

- Updating professional knowledge occurs both as an individual and a shared learning activity, within and external to the workplace.

- Statistically significant difference was observed in the rated value of information sources for professional updating. Seminars and conferences were the most highly valued primary tools for updating professional knowledge.
The contemporaneous use of multiple information sources suggests that professional knowledge updating operates concurrently as an individual and a shared learning activity. On an individual basis, MRS professionals read and search for information to construct their professional knowledge. When information sources and search engines are purposefully used for learning they become cognitive tools supporting active intentional knowledge construction (Hill et al., 2004; Jonassen et al., 2008; Jonassen, 2000). The new information, obtained from tools such as seminars, conferences, journals, web pages and books, is used both to expand professional knowledge by adding valuable new content (Kegan, 2009; Todd, 1999, 2006) and also to transform it through greater linkage and coherence of understanding (Illeris, 2009; Todd, 1999, 2006). The active use of information sources to update professional knowledge supports informative and transformative learning, both of which are necessary for developing and maintaining expert knowledge in the learner’s discipline area (Barba & Rubba, 1992; Bryce & Blown, 2012; Kegan, 2009).

MRS professionals also engage in activities that provide opportunities to access new information as well as learn with others. For example, conferences and seminars provide participants with the latest knowledge in their discipline area, as well as present opportunities for participants to discuss findings and their implementation into daily practice. In such cases, knowledge construction expands beyond the individual, becoming an active shared process amongst those who share a common language and practice (Billett, 1995; Lave & Wenger, 1991). By attending conferences, seminars and workshops that run internal to and outside of the workplace, and participating in online communities through listservs, professional knowledge updating encompasses both the local CoP of the workplace and multiple distributed learning communities that may exist within the broader workplace organisation, within the MRS profession and across health professions. Through participation in these distributed CoPs (Wenger et al., 2002), MRS professionals can update and share new knowledge, techniques and tools beyond their workplace. This integration of new knowledge from outside the
local CoP is an essential aspect for developing best practice within organisations (Wenger, 1998; Wenger et al., 2002) and within and across professions (Meagher-Stewart et al., 2012; Rolls et al., 2008; Tolson et al., 2005).

The overall ranking of seminars and conferences as the two most highly valued tools for updating professional knowledge is in accord with the earlier finding by Keppell et al. (2001) and also in alignment with the initial stages of knowledge dissemination in professions identified by Garvey and Griffith (1972) forty years ago. The results from this study highlight the importance these non-electronic information sources continue to play in learning within professions in the 21st century. In particular, seminars and conferences offer health professionals access to new knowledge, as well as the opportunity to unpack this knowledge and discuss its implementation within the context of their local workplace.

Research Question 2 was: **What areas of knowledge are updated?**

This study provides baseline data on the areas of knowledge that are updated by MRS professionals. Key findings are:

- MRS professionals update their knowledge across multiple areas including the medical condition of the patient, anatomy and physiology, new technologies and their applications, procedure or treatment techniques and their effectiveness, professional issues and guidelines.

MRS professionals update their knowledge across multiple areas, which encompass non-discipline specific (e.g., medical condition of the patient, anatomy and physiology) as well as discipline-specific (procedure or treatment techniques, application of new technologies) content. Although the emphasis underpinning the need for CPD for MRS professionals is on
technological change (Australian Institute of Radiography, 2007; Society of Radiographers, 2007) the findings from this study illustrate that it is neither the new technologies nor their direct application that are the areas in which new knowledge is most commonly sought. Rather, the principal area in which MRS professionals update their knowledge is the medical or health condition of the patient. This finding is in accord with information-seeking behaviour across health professions (Bryant, 2004; Gilmore et al., 2012; Jones & Lambros, 2003; Usher, 2011). That is, the principal reason health professionals, including MRS professionals, seek information to update their knowledge is in relation to the health or medical condition of the patient. This suggests a similarity in professional knowledge updating exists between MRS professionals and other health professionals. It appears that the findings from this current study have relevance beyond the MRS profession.

In addition, as shown in Section 4.4, the findings from this study indicate that improving patient outcomes was a driver of knowledge updating within the MRS profession. That is, in order to provide the best outcome for their patients, MRS professionals purposefully utilise information sources to update their professional knowledge, so that their practice is based on the latest available evidence. This finding concurs with the practice of other health professionals, who similarly report that they purposefully use information sources to modify and improve patient care (Bennett et al., 2007; Gosling & Westbrook, 2004; Gosling et al., 2004; Jones & Lambros, 2003; O’Leary & Mhaolrunaigh, 2011; Usher, 2011; Veness et al., 2003; Westbrook et al., 2004). Across health professions, knowledge updating is an important workplace learning activity used to improve patient care.

In addition, health professionals place a high reliance on their own professional knowledge and that of their peers for decision making (O’Leary & Mhaolrunaigh, 2011) and problem solving (Creswick et al., 2009) in the clinical environment. The more-detailed understanding of knowledge updating practice and factors influencing this activity provided in this study, can also inform these other areas of research.
Research Question 3 was: **What factors associated with professions influence the use of mediating tools in updating professional knowledge?**

This study provides baseline data on factors associated with professions that influence professional knowledge updating within the MRS profession. The key findings are:

- Enrolment in CPD and membership of a professional society are positively associated with level of knowledge updating activity.

- Statistically significant difference was limited to learning activities associated with professional societies.

This finding is in agreement with research reported by Landers et al. (2005), who identified that enrolment in CPD and membership of professional societies increased the number of hours health professionals engaged in formal learning activities. It was also established in this current study that difference in level of activity was statistically significant only for learning activities associated with professional societies, such as attendance at seminars and conferences organised by professional societies. This finding is of particular interest in the current climate of mandatory CPD requirements linked to registration of health professionals, as it suggests that mandating CPD will have a limited impact. A recent study of MRS professionals in the United Kingdom demonstrated that the introduction of mandatory CPD influenced compliance requirements, that is, the recording of CPD, but not level of CPD activity (Henwood & Flinton, 2012). The introduction of mandatory CPD requirements in Australia may, therefore, have limited or no impact on level of knowledge updating activity of health professionals.

Research Question 4 was: **Does workplace accessibility of mediating tools influence their use in updating professional knowledge?**
This study provides baseline data on the relationship between workplace access to tools and their level of use in updating professional knowledge within the MRS profession. The key findings are:

- A statistically significant positive association was shown to exist between physical access to information sources and level of use of these tools to update professional knowledge.

- A statistically significant positive association was shown to exist between perceived effective access to information sources and level of use of these tools to update professional knowledge.

The positive association was shown to exist for the following information sources: Internet, health and medical databases, journals, books, seminars and national annual professional conference. This result concurs with earlier research that demonstrated that improved access to journals in the workplace was associated with an increased level of journal reading (Nagy et al., 1991). As this current study examined multiple information sources, the influence of workplace accessibility of information sources other than journals on level of use has now been established. The results of this research thus highlight the important role workplaces play in affording or constraining professional updating activity through the access they provide their employees to information sources.

The findings from this study identified two changes that would positively impact use of electronic information sources, such as journals and health and medical databases – universal inclusion of Internet access onto all computers in the workplace and the provision of remote access to workplace information sources. As these information sources are widely recognised as primary tools for supporting the delivering of high-quality, effective healthcare (Eley et al. 2009; Gilmore et al., 2012; Gosling & Westbrook, 2004; Gosling et al., 2004), organisations should move to adopt these changes.
Research Question 5 was: **What factors influence workplace access to mediating tools in professional knowledge updating activity and do hierarchies of access to these tools exist across workplaces?**

Identification of factors influencing workplace accessibility of information sources was the focus for Research Question 5. As established in Research Question 1, learning with information sources is fundamental to professional knowledge updating activity. Whilst the workplace is an important community where adult learning occurs (Billett, 1999; Burns, 2002; Eraut, 1994; Wenger et al., 2002), there was a paucity of research that examined workplace accessibility of the range of information sources utilised in professional knowledge updating activity. Factors influencing workplace accessibility were established for each examined information source and hierarchies of access determined. Key findings are:

- A statistically significant relationship was shown to exist between geographic location and workplace accessibility of mediating tools of seminars, conferences and journals. Professionals employed in rural and remote areas had access to fewer journals, fewer seminars and were provided with less support from their workplace (financial and time) to attend conferences than their colleagues in regional and metropolitan areas.

- A statistically significant relationship was shown to exist between health sector and workplace accessibility of mediating tools of seminars, conferences, seminars, journals and health and medical databases. Professionals employed in the private sector were afforded less support from their workplace to access these mediating tools than their colleagues in the public sector.

- A statistically significant relationship was shown to exist between work environment and workplace accessibility of mediating tools of conferences, journals, health and medical databases and the
Internet. Professionals employed in clinics and non-teaching hospitals were provided with less support to access these mediating tools than their colleagues in teaching hospitals.

- A statistically significant relationship was shown to exist between work context and workplace accessibility of mediating tools of conferences, journals, health and medical databases and the Internet. Professionals employed in universities had access to more journals, were provided with more support from their workplace (time) to attend conferences and reported greater workplace access to health and medical databases and the Internet than their colleagues employed in clinical centres.

- A statistically significant relationship was shown to exist between area of specialisation and workplace accessibility of mediating tools of conferences, journals and the Internet. Professionals specialising in radiography received less support from their workplace to access these mediating tools than their colleagues from the other three areas of specialisation.

- A statistically significant relationship was shown to exist between workplace role and workplace accessibility of mediating tools of conferences, journals, health and medical databases and the Internet. Professionals employed in non-senior roles were afforded less support from their workplace to access these mediating tools than their more-senior colleagues.

- A statistically significant relationship was shown to exist between employment fraction and workplace accessibility of mediating tools of seminars, conferences, journals and health and medical databases. Professionals employed in a part-time capacity were provided with less support from their workplace to access these mediating tools.
Information sources that provide current, relevant health information must be readily accessible in the workplace so that care of the patient is not compromised (Gosling et al., 2003; Hall, 2008; Scott et al., 2000). However, the results of this study demonstrate that accessibility to information sources was not uniform across or within workplaces and issues associated with workplace accessibility were observed for each examined information source. The implication is that in workplaces where accessibility to information sources is compromised patient outcomes will be negatively affected.

Large infrastructure investment such as the Australian Government's National Broadband Network may overcome access limitation associated with physical profile characteristics of workplaces such as geographic location, although this is not yet apparent. Recent data from Australia demonstrates that, whilst over 90% of organisations have Internet access (Australian Bureau of Statistics, 2012), just 52% of Australians employed in metropolitan locations report that they access the Internet at work and this reduces to 43% for those employed in non-metropolitan workplaces (Australian Bureau of Statistics, 2011b). Studies from the fields of health and education demonstrate that current use of electronic information and communication tools within organisations continues to be limited by lack of access to computers, restrictions on web sites that can be accessed, including those used for learning, and lack of time to engage with electronic learning tools due to heavy workloads (Bogossian & Kellett, 2010; Maher, 2010; Nisselle et al., 2012; Turner et al., 2009). These studies also demonstrate that Internet access restrictions imposed by organisations negatively impact the learning of not only employees, but within health and education settings the learning of students and school-age patients. This highlights the importance of conducting research, as was the approach adopted in this study, across the range of workplaces where learning occurs.

Furthermore, while open access journals overcome many access limitations their value is limited. A recent study by Walters and Linvill (2011) identified that the majority of open access journals published seven or fewer articles
Bail and colleagues (2013) examined open access for journals relevant to the nursing profession and identified that only 12% (27/224) of journals had unrestricted open access. Within the field of medical radiations, a professional journal (Journal of Medical Radiation Sciences) has recently become open access (Agustin, 2013). Whilst this overcomes access limitations to this single journal, as previously noted (Section 4.2.1) MRS professionals read a broad range of journals to update their professional knowledge. This indicates that open access journals are unlikely to provide professionals with the range of journal articles they need to update their professional knowledge. Workplaces, therefore, must continue to provide access to subscription-based journals so that health professionals can base their practice on current, peer-reviewed evidence.

In summary, this study informs a fundamental aspect of delivery of high-quality healthcare – the essential requirement that health professionals maintain currency of their knowledge. This is the first study to concurrently examine value and use of electronic and non-electronic information sources, individuals’ access within workplaces to these information sources and to utilise multiple measures of access. The findings from this study enrich the extant literature concerning learning mediated by information sources and the factors that afford or constrain employee access within the workplace to information sources. In doing so, this study not only examined the contemporaneous use of multiple information sources for updating professional knowledge but it also allowed the perceived current value of electronic and non-electronic information sources for this learning activity to be ascertained. This study also established factors that influence level of professional knowledge updating activity as well as factors influencing access within the workplace to primary tools for updating professional knowledge.

The following sections discuss the theoretical and practical implications associated with these key findings.
6.2 Implications for theory

This study theorised professional knowledge updating as a learning activity mediated by information sources and situated within the ‘real world’ complexity of organisations that may afford or constrain level of activity. Two embedded models were utilised to provide a more robust understanding of this complex activity. First, Vygotsky’s (1981) simple triadic representation of learning as a mediated activity provided a simple model for understanding professional knowledge updating. In essence, the individual health professional (subject) utilises an information source (tool) to update their professional knowledge (object). The findings from this study support adaptations to this model, as displayed in Figure 6.1 in red, to provide a more detailed model of professional knowledge updating.

The findings from this study establish that multiple information sources, including seminars, conferences, Internet, books, journals and health and medical databases, are contemporaneously utilised by MRS professionals to update their knowledge. This is represented by the change from ‘Tool’ (in Figure 2.1) to ‘Tools’ in Figure 6.1. The results also highlight the importance that non-electronic information sources continue to have for learning in the 21st century, despite current research focusing on electronic information sources (Frandsen, 2009; Gilmore et al., 2012; Gilmore et al., 2008; Jonassen et al., 2008; Usher, 2011; Younger, 2010).

It is also evident that the value attributed to information sources for updating professional knowledge was not uniform amongst learners. This is evidenced by the overall ranking of information sources for updating professional knowledge; change in ranked importance of information sources between rural and non-rural MRS professionals and for those who have participated in journal clubs (Section 4.2.3). This finding supports adaptation of the simple
triadic model to represent professional knowledge updating, to include ‘value’ as a mediating factor between subject and tools, as shown in Figure 6.1.

**Figure 6.1**: Adaptation of the simple triadic model to provide a more detailed model of professional knowledge updating as a learning activity mediated by information sources.

The results suggest that professional knowledge updating is both an individual and a shared learning activity. On an individual basis, MRS professionals read books (90%), journal articles (88.1%), search the Internet (86.8%) and health and medical databases (73.9%) for needed information to construct their knowledge. This is represented in Figure 6.1 when an individual learner uses the information source to update their professional knowledge. MRS professionals also engaged in activities, such as participating in conferences (75.3%), seminars (61.4%), workshops (54.3%), listserv (39.4%) and journal clubs (17.1%), which provides them with the opportunity to not only access new information but also to share knowledge construction with other learners. This finding that MRS professionals engage
in activities that present opportunities for both individual and shared learning.

is in accord with a recent study by Nerland and Jensen (2010), who reported that engineers used web sites for both individual and shared learning activities. As an individual learning activity, engineers reported that they used manufacturers’ web sites to obtain information on advancements in their field. If a discussion forum was available on the web site, engineers also reported that they used them to share and build knowledge with other online participants regarding the particular advancement in their engineering field. Information sources, therefore, continue to be important tools for learning, bringing new information into professionals’ knowledge, on an individual and a shared learning basis. This finding supports adaptation of the simple triadic model to represent professional knowledge updating, to include ‘shared learning’. This is portrayed in Figure 6.1 when learners interact with each other as they use the same face-to-face (e.g., seminar or conference) or online (e.g., listserv, discussion forum) information source to update their professional knowledge. In addition, the findings of Nerland and Jensen (2010) suggest that the professional knowledge updating model (Figure 6.1) has applicability beyond the health professions.

Professional knowledge updating can encompass both the local CoP of the workplace and multiple distributed learning communities. By attending conferences, seminars and workshops that run internal to and outside of the workplace, and participating in online communities through listservs, professional knowledge updating can involve the local CoP of the workplace and multiple distributed learning communities that may exist within the larger workplace organisation, within the MRS profession and across health professions. Through participation in these distributed CoPs (Wenger et al., 2002), MRS professionals can update and share new knowledge, techniques and tools beyond their workplace. This integration of new knowledge from outside the local CoP is an essential aspect for developing best practice within organisations (Wenger, 1998; Wenger et al., 2002) and within and across professions (Meagher-Stewart et al., 2012; Rolls et al., 2008; Tolson et al., 2005). The introduction of CoPs into the extended triadic model of
professional knowledge updating is displayed in Figure 6.1. In the presented model (Figure 6.1), learners from different local CoPs can interact with each other when they use the same face-to-face (e.g., seminar or conference) or online (e.g., listserv, discussion forum) information source to update their professional knowledge. This is represented with CoP↔CoP interactions in Figure 6.1. In addition, learners within the same CoP can, as Wenger (2002) advocates, share new knowledge they obtain at, for example, a conference with their workplace colleagues who did not attend that particular conference. This is represented in Figure 6.1 with learner↔learner interactions within the CoP.

Professional knowledge updating mediated by information sources can include both informative and transformative learning. Information can change learners’ knowledge in two ways. Information can add factual knowledge (Todd, 1999, 2006; Tynjala, 1999). This type of learning with information sources was termed in-form-ative by Kegan (2009), to denote its role in bringing valuable new content that is essential to ensure mastery in the learners’ field or discipline. Informative learning can occur when new discipline knowledge, made available through information sources such as journal articles and conference presentations, is added to the existing professional knowledge of the individual learner. Information can also change the way the learner knows and become what Kegan (2009) calls trans-form-ational. In this case, the information does not just expand an already existing knowledge framework but the framework itself is reconstructed or changed (Illeris, 2009; Kegan, 2009). Transformational learning can occur when a learner critically reflects on an experience (Kegan, 2009). As an example, a diagnostic radiographer could present a paper at a conference describing their experience as a patient undergoing a new procedure. A MRS professional who was in the audience, could learn about the technical requirements of the new procedure (informative). The person could also be struck by the presenter’s description of the impersonal but technically proficient manner in which the procedure was performed. This could cause the MRS professional to re-evaluate their understanding and
practice of high-quality patient care (transformational). Both informative and transformative learning with information sources is necessary for developing and maintaining expert knowledge in the learner’s discipline area (Barba & Rubba, 1992; Bryce & Blown, 2012; Chi, Feltovich, & Glaser, 1981).

Professional knowledge updating mediated by information sources can be inclusive of both informative and transformative learning.

It was also apparent from the findings of this study that factors, both external and internal to the individual learner, influence knowledge updating activity. To provide a more holistic understanding of knowledge updating activity, Engeström’s (2001) Activity System model, was utilised as a second theoretical framework, to investigate factors that influence level of learning activity. Three factors were investigated: membership of a professional society, enrolment in a CPD program and individuals access within the workplace to primary mediating tools for updating professional knowledge. Membership of a professional society and enrolment in a CPD program were positively associated with level of professional knowledge updating activity. This finding supported their inclusion in the professional knowledge updating model. However, it was also apparent that their influence was limited to tools over which professional societies exert control, such as seminars and conferences run by professional societies. This finding suggests that external regulatory requirements, such as mandatory CPD linked to registration, would, at best, result in a limited change in knowledge updating activity. This concurs with a recent study demonstrating that the introduction of mandatory CPD requirements had increased reporting of CPD but not the level of participation in CPD (Henwood & Flinton, 2012). As discussed in Section 4.4, the desire of the MRS professional to improve patient outcomes drives professional knowledge updating activity. This finding, together with the observed limited influence of enrolment in CPD program (this study) or mandatory CPD (Henwood & Flinton, 2012) on level of learning activity, suggests that professional knowledge updating is primarily an internally motivated learning activity which is characteristic of adult learning (Knowles et al. 1998). Motivation, influenced by both internal and external factors, has
been incorporated into the extended triadic model of professional knowledge updating between subject and object of activity (Figure 6.1)

The findings from this study also demonstrated that a positive relationship exists between the individual’s access within the workplace to primary tools for updating professional knowledge and level of activity across all examined information sources. Level of use was introduced as a mediating factor between tools and object in Figure 6.1. Accessibility was introduced in the extended triadic model of professional knowledge updating as a broken line surrounding tools. This adaptation aims to demonstrate diagrammatically that while information sources exist they may not be accessible to the learner. The findings from this study establish that organisations impact on the accessibility of information sources by the physical and effective workplace access they provide to information sources. Workplace was included in Figure 6.1 as a factor influencing accessibility of information sources to learners. Governments, at the state and federal level, can also influence accessibility of information sources to health professionals. State governments limit access to electronic health information portals to those employed in the public sector. At the federal government level, strategic projects such as the Strengthening Cancer Care Initiative, provide financial and resource support for professional learning to certain groups within professions, in this case, those working in cancer care such as radiation therapists within the MRS profession. Consequently, government was included in Figure 6.1 as a factor influencing accessibility of information sources to learners, in this case, specifically health professionals. These findings highlight the importance of examining context when investigating learning mediated by tools such as information sources. The findings from this study highlight the important role that workplaces and governments play in affording or constraining learning activity through the access they provide their employees to information sources. This addresses a concern voiced by Fenwick (2001) that workplace learning educators tend to assume a level playing field while inequities that exist in the workplace lie hidden. The findings from this study highlight the complex nature of inequity to information
sources in the workplace, extending within and across workplaces and also influenced by government policy. While large-scale infrastructure developments such as the Australian Government’s National Broadband Network may improve physical access to electronic information for workplaces, the findings from this study suggest that this will not translate uniformly to individual employees being able to harness this benefit. That is, improvement in physical access to the Internet within a workplace on its own does not necessarily increase an individual’s effective access to requisite information within the workplace.

It was also evident that amongst MRS professionals there was a low level of awareness and low skill level in relation to specialised electronic information sources such as government electronic information portals and health and medical databases. This finding would also contribute to the underutilisation of these tools for updating professional knowledge. This highlights that accessibility of information sources expands beyond measures of the individuals’ physical and effective access to information sources within the workplace to include the awareness, knowledge and skills of individuals when specialised information sources are introduced into the workplace to support learning. Individual was therefore included in Figure 6.1 as a factor influencing accessibility of information sources to learners.

The implication of information sources not being accessible to health professionals, be it due to physical or effective access restrictions, within the workplace, imposed by governments or the individual’s knowledge or skill level, is that informative and transformative learning with information sources will be compromised for those professionals with reduced accessibility. As informative and transformative learning with information sources is necessary to develop and maintain expertise in discipline areas (Kegan, 2009), reduced accessibility of information sources threatens loss of discipline expertise for professionals. In addition, as professionals use information sources to modify and improve patient care (Bennett et al., 2007; Gosling & Westbrook, 2004; Gosling et al., 2004; Jones & Lambros, 2003; O’Leary & Mhaolrunaigh,
reduced accessibility of information sources in the workplace threatens quality of patient care.

This research provides a further insight. Elkjaer (2009) asserted that practice-based models of learning have “the tendency to recycle knowledge” (p. 87). Practice-based models such as communities of practice (Lave & Wenger, 1991) and workplace learning (Billett, 1994, 1995), posit that other participants who are more experienced, wiser or more knowing, by sharing their knowledge and experience are essential to the process of transforming learners from novice to competent practitioners in their field. What remains hidden in such models is how personal knowledge of these experienced people is refreshed. This study informs this hidden issue by examining how one group of experienced people, namely those holding a professional qualification in medical radiations, update their professional knowledge. It has been identified in this current study that experienced people concurrently use multiple information sources to build their professional knowledge. Through this active, ongoing process, new discipline knowledge is incorporated into their existing knowledge (Grabowski, 2004; Hill et al., 2004; Jonassen, 2000). Through recognition of this process, knowledge sharing in practice-based models can move beyond the appearance that old or outdated knowledge is recycled from the experienced person to the novice or student, to one, that recognises the important role that information sources play in maintaining currency of knowledge in practice-based models of learning.

It is also worth noting that studies, that have examined clinical decision-making (O'Leary & Mhaolrunaigh, 2011) and problem solving (Creswick et al., 2009) in the clinical environment, have demonstrated that health professionals place a high reliance on their own professional knowledge and knowledge of peers in their professional group. The detailed understanding of knowledge updating practice provided in this study can also inform these other areas of research.
A detailed analysis of the practical implications of the results obtained in this study is provided in the following section.

6.3 Implications for policy and practice

Consideration of the results and conclusions drawn from this study led to a number of practical and policy recommendations to support professional knowledge updating activity.

Seminars and conferences were ranked as the two most important information sources for updating professional knowledge. The findings from this study identified that access to seminars and conferences was not uniform across the MRS profession, in particular for MRS professionals employed in rural or remote locations: 20% reported that they do not have access to seminars and 40% were not provided with paid leave to attend conferences. In addition, MRS professionals employed in rural or remote locations reported the lowest level of financial support from their employer to attend conferences and the highest level of self-funding. A recent study of Queensland nurses by Hegney et al. (2010) investigated nurse professionals’ access to and support for CPD. The major barriers identified in this study to attendance at CPD activities for nurses was financial, with 39.8% of nurses reporting that they could not afford the fee involved and 33.4% reporting that they could not afford to take unpaid leave. Lack of financial support and lack of provision of paid leave to attend conferences and seminars exists in both the MRS and the nursing profession. It is, therefore, important that alternate ways of providing health professionals with access to seminars and conferences, the two highest ranked tools for updating professional knowledge, be investigated. Given that this current study has shown that seminars and conferences are afforded the highest ranked values for updating professional knowledge and that difference in Internet access was not statistically significant for geographic location, together these findings
support greater use of Internet-based tools such as webinars to overcome issues of unpaid leave and lack of financial support experienced by health professionals in attending seminars and conferences. This leads to:

**Recommendation 1:** Providers of seminars and conferences should consider the use of live or delayed electronic delivery of seminars and conference sessions to support professional updating activity by those not able to attend face-to-face learning activities.

This study has shown that workplace configuration of Internet access is a significant influence on frequency of use of Internet search engines, web pages, email, listservs, health and medical databases and journals for the purpose of updating professional knowledge. In particular, this study has identified that workplace configuration of Internet access on all workplace computers was associated with increased frequency of use of electronic mediating tools for professional updating activity compared to more-restrictive workplace practices of limiting Internet access to offices only. This finding, that frequency of use of journals and health and medical databases was positively associated with increased effective access within the workplace, may be of interest to the many health professions where practitioners are being urged to increase their use of evidence-based information sources (McClusky, 2003; Nail-Chiwalal & Ratner, 2006). This leads to:

**Recommendation 2:** Workplaces should consider adopting a policy of universal inclusion of Internet access onto all workplace computers to positively support the use of electronic mediating tools in professional updating activity and evidence-based practice.

Journals are one of the most common information sources for disseminating new knowledge to professionals (Garvey & Griffith, 1972; Hurd, 2004; Oermann et al., 2008) and, not surprisingly, are considered an important mediating tool for updating professional knowledge (Bennett et al., 2004;
Casebeer et al., 2002; Davies, 2007; Gosling & Westbrook, 2002a). The findings of this study show that over 88 per cent of MRS professionals read journal articles to update their professional knowledge. It has also been established in this current study that MRS professionals employed in the private sector have access to fewer journals than their colleagues employed in the public sector. McClusky (2003), in a small study of Australian occupational therapists (n=85), also reported that journal access varied according to sector of employment. A contributing factor could be that Australian Government health information portals, such as Clinicians Health Channel (Victorian Government) and Clinicians Knowledge Network (Queensland Government), contain health and medical databases and journals and these portals restrict access to those employed in the public sector. This leads to:

**Recommendation 3:** State government-provided health information portals be made available to all health professionals regardless of their sector of employment.

It was also noted that journals available through these health Information portals varied considerably across state territories. The Queensland Government’s portal, CKN, provided MRS professionals with access to the highest number of relevant journals. This leads to:

**Recommendation 4:** The scope of journals available through state government-provided health information portals be reviewed to ensure these portals provide health professionals with access to relevant titles.

The findings of this study demonstrate a self-reported low level of awareness (45%) and use (25%) of government-provided electronic information portals amongst MRS professionals employed in the public health sector. This finding is in accord with other studies that have identified a low level of awareness for these portals across a range of Australian health professions (Gosling & Westbrook, 2002a, 2002b). This leads to:
Recommendation 5: Workplaces, governments and professional societies promote awareness and use of government-provided electronic information portals to health professionals.

Lack of time has been identified as a major barrier that limits health practitioners from engaging in activities to update their professional knowledge (Gilmore et al., 2008; Henwood & Huggett, 1999; Jackowski & Akroyd, 2001; Masters, 2008; Nail-Chiwetalu & Ratner, 2006). This study identified that 75% of clinical MRS professionals are not provided with protected time during work hours to engage in professional learning activities. It was also observed that the provision of protected time for radiation therapists (49%), whilst much higher than their colleagues specialising in radiography (19%) and sonography (19%), was similar to that of radiation oncologists (58.1%) (Veness, 2001). This suggests that there are work-related organisational and resource similarities between radiation therapists and radiation oncologists that are not apparent between radiation therapists and their MRS colleagues. Increased funding to radiation therapy and radiation oncology departments through the Australian Governments’ Strengthening Cancer Care Initiative may be a contributing factor. The Strengthening Cancer Care Initiative was multi-pronged, with funding to reduce staff shortages, extend cancer services to regional areas and improve professional development for cancer health professionals (Australian Federal Government, 2005). An interview comment by a radiation therapist identified one supportive structure for professional development that is currently in place and provides protected time, which can be used for updating professional knowledge:

We also have within the department part time – not a full-person position but part-of-a-person position is actually funded to cover staff for professional development activities. So people can apply to use that time for whatever project they might be involved in or whatever professional development like sitting down and reading a journal or going to the library to research something.
There does not appear to be an equivalent government initiative to increase funding to other MRS services and so it is likely that the observed inequity of organisational support for protected time for professional learning across area of specialisation will continue. In addition, staff shortages that have been experienced within radiography and sonography (Department of Immigration and Citizenship, 2011) may make the provision of protected time difficult to implement. There is, therefore, a need for employers to investigate implementing protected time or alternate flexible ways of supporting staff.

This current study has shown that only 19% of clinical MRS professionals had remote access to workplace electronic information resources, such as journals. As noted in Section 5.2.2, MRS professionals indicated that they were too busy at work to spend time reading and they would like remote access to electronic journals available in their workplace. Remote access to e-resources would benefit MRS professionals and other health professionals, particularly those in workplaces experiencing staff shortages where protected time may not currently be a feasible option. These professions experiencing staff shortages include occupational therapy, medicine, nursing, pharmacy, physiotherapy, podiatry, radiography, speech pathology and sonography (Department of Immigration and Citizenship, 2011). A recent study by Novak and McIntyre (2010) of Australian allied health professionals, which included occupational therapists, physiotherapists and speech pathologists, reported that workplace supports of protected time, Internet access and greater access to journals through Document Delivery Service were implemented by management to foster evidence-based practice. This demonstrates that even in professions experiencing staff shortages, supports such as improved access to information sources and protected time can be implemented with management commitment. This leads to:

**Recommendation 6:** Workplaces should investigate the provision of protected time and remote access to electronic information sources, such as journals and health and medical databases, to support learning activity in the workplace.
Updating professional knowledge is a central tenet of CPD policies. Across nations and professions CPD policies clearly outline the role of the individual in meeting CPD requirements (American Society of Radiologic Technologists, 2006; CPA Australia, 2013; Engineers Australia, 2013; Medical Board of Australia, 2010; General Medical Council, 2013; Health Professions Council, 2010; Medical Radiation Practitice Board of Australia, 2012; Society of Radiographers, 2007). The role of the workplace in supporting employees to meet CPD requirements is, however, less clear. For instance, in the United Kingdom CPD policy for health professionals clearly states that workplaces have an important role in supporting employees to meet their CPD requirements. (General Medical Council, 2013; Health Professions Council, 2010; Society of Radiographers, 2007). In contrast, CPD policy for health professionals in Australia does not recognise or state that workplaces have a role in supporting this activity (Australian Institute of Radiography, 2007, 2010; Medical Board of Australia, 2010; Medical Radiation Practitice Board of Australia, 2012; Nurses Board of Victoria, 2009; Physiotherapists Registration Board of Victoria, 2008). The findings from this research highlight the widespread inequity that currently exists across an Australian profession in relation to workplace provision of information sources, financial support and time support for professional learning. This identified inequity leads to the following two recommendations:

**Recommendation 7:** Governments and professional societies mandating CPD activities should include in CPD policy the need for workplaces to provide information sources, time and support.

**Recommendation 8:** Workplaces employing health professionals should investigate ways of reducing the identified widespread inequity that currently exists so that all health professionals are supported to meet this mandated requirement.
6.4 Further research

The use of qualitative and quantitative methods in this study has provided a detailed understanding of professional knowledge updating and the factors that influence this activity. The introduction of mandatory CPD requirements for professionals in Australia and internationally clearly highlights the importance governments and professional societies attribute to updating professional knowledge. In the United Kingdom, the role of workplaces in supporting CPD has been identified in policy documents, but this is not the case in Australian CPD documents. As shown in this research, level of professional updating activity is positively associated with level of access workplaces provide to information sources. This highlights the need for further research: International comparison of professional updating practice within the MRS profession examining if the explicit identification of the role of the workplace to support learning in CPD policy translates into greater workplace access, both physical and effective, to primary tools for updating professional knowledge.

This study examined a single profession. Replicating this study in other professions would further enhance understanding of professional knowledge updating and the factors influencing level of activity. This type of study replication could then establish the transferability of the model across occupational groups. This highlights the need for further research: Investigating professional updating activity in other professions.

This study collected survey data at one point in time. Repeating the survey on a regular basis, would allow trends over time to be established. For instance, Hegney et al. (2010) reported that workplace financial support for CPD for nursing had significantly decreased in recent years. This means that the level of time and financial support from workplaces to update professional knowledge reported in this study may not reflect ongoing practice. In addition,
newer information and communication technologies such as smart phones and iPads, that were not investigated as part of this study as they had not appeared in the literature or were identified in the interview phase as being used by MRS professionals to update their knowledge, should be included in a follow-up replication study. This highlights the need for further research: Repeating the survey so that trends over time such as financial and time support from the workplace and introduction of new technologies that support professional knowledge updating can be investigated.

Mobile learning devices such as smartphones and iPads have been recommended for use by health professionals to increase their access to new discipline knowledge (Runciman et al., 2012). However, issues associated with access to electronic information sources within the workplace that were identified in this study may also exist for mobile learning devices. For instance, many health professionals in this study reported that they were not provided with the code to access the Internet on computers within their workplace. This same type of access restriction would also limit the usefulness of mobile learning devices for accessing new discipline knowledge within the workplace. This highlights the need for further research: Investigating how mobile learning devices are being utilised within the workplace to access discipline knowledge and to identify if access restrictions within workplaces also exist for these tools.

Open access journals offer the potential to support professional knowledge updating. Currently, however, only a small number of journals that are relevant to a given health professions provide open access (Bail et al. 2013). This is likely to be an area in which change will happen over time. Within the field of medical radiations, a professional journal has recently become open access (Agustin, 2013). Whilst this overcomes access limitations to particular journals, health professionals read a broad range of journals. This highlights the need for further research: Longitudinal study investigating which journals used by MRS professionals have open access.
This study adopted Engeström’s (2001) Activity System model, which suggests that rules, community and division of labour influence level of professional knowledge updating activity. As professional knowledge updating is a complex system it is also reasonable to assume that the operationalised variables, adopted in this study, have not identified all variables that influence level of professional knowledge updating activity. For instance, characteristics of the individual (e.g. educational qualification, individual attitudes), represented by Subject in the Activity System model, may also influence level of use of information sources to update professional knowledge. This highlights the need for further research: Investigating the influence of characteristics of individuals on professional knowledge updating activity.

Adoption of Engeström's (2001) Activity System model as a framework for data analysis has identified a number of variables that are associated with level of professional knowledge updating and workplace accessibility of primary mediating tools for updating knowledge. These variables, however, may not all be independent. This highlights the need for further research: Investigating the interrelationship of variables within the Activity System model.

As previously identified (Section 2.5), ease of access, a quantitative measure of effective access, does not appear to have been used in studies that examined health professionals' workplace access to information sources. Therefore, the relationship between ease of access in the workplace to information sources and level of use of these tools to update professional knowledge has not been tested. As statistically significant relationships were shown to exist for all examined information sources, the findings from this study demonstrate that ease of access is a useful quantitative measure for studies examining workplace access to, and level of use of, information sources to adopt. This would allow other studies to compare workplace ease of access across information sources, and replicate the finding.
A focus for this study was on updating professional knowledge. This study demonstrated a diverse range of information sources are utilised for this activity. As choice of information sources is contextually bound to the object of activity (Keppell et al., 2001), further research examining other activities also mediated by information sources, such as evidence-based practice, would provide additional understanding of learning with information sources in workplace environments. This highlights the need for further research: Investigating other learning activities mediated by information sources, such as evidence-based practice and research situated within the 'real world' complexity of organisations, which may afford or constrain level of activity.

A focus for this study was on learning mediated by information sources. As demonstrated in this study, professional knowledge updating is inclusive of both individual and shared learning and occurred within and external to the local CoP of the workplace. The role of other learners and learning communities in professional knowledge updating was not specifically investigated in this study. This presents an opportunity for further research: Investigating the role of other learners and learning communities in professional knowledge updating activity.

Although not directly investigated in this study, the professional knowledge updating model is inclusive of informative and transformative learning. This presents an opportunity for further research: Direct investigation of informative and transformative learning within professional knowledge updating activity.

More broadly, publications from this study (listed on p.vi & vii) have been cited within conference proceedings, journals and theses, in the fields of medical radiations, medicine, complementary medicine and information science. This suggests that this current study has added to the knowledge base of multiple disciplines and may have provided impetus for others engaged in research to examine, within their research context, learning mediated by information sources and workplace, professional and
government factors that influence the physical and effective access to these tools within workplaces.
REFERENCES


Chartered Society of Physiotherapists. (2007). *Policy statement on continuing professional development (CPD)*. Retrieved from


Guo, R., Bain, B. A., & Willer, J. (2008). Results of an assessment of information needs among speech-language pathologists and


Dear

I write to invite you to participate in research project *Accessibility of information resources by health professionals: A case study focused on the Medical Radiations Science profession*. This study seeks to identify a range of information resources relevant to the MRS profession and explore the accessibility of these identified information resources to MRS professionals. The MRS profession has areas of specialisation and you have been selected to participate due to your expert knowledge in the discipline area of

I am enclosing an Information Statement that outlines the research project and its methods and a Consent Form. If you would like to participate in this research you need to return the Consent Form to me. If you are not able to participate you need take no further action, as non-return of the consent form will indicate refusal to participate.

Please do not hesitate to contact me by phone on 03 9925 7527 or by email mshanahan@rmit.edu.au if you have any questions regarding this research project.

Yours sincerely,

Madeleine Shanahan
Senior Lecturer, Discipline of Medical Radiations, RMIT University
Doctoral student, University of Wollongong
Dear Colleague,

This letter is to inform you of the purpose and nature of research into the accessibility of information to health practitioners. The study is entitled *Accessibility of information resources by health professionals: A case study focussed on the Medical Radiations Science profession.*

This research is being conducted as part of a Doctorate of Education, through the University of Wollongong, NSW.

The purpose of this study is to explore how accessible professionally relevant information resources are to members of a health profession. It is being investigated using the Medical Radiation Science (MRS) profession as the health profession for study. This study seeks to identify a range of information resources relevant to the MRS profession and explore how these information resources are being made available to MRS professionals, and explore the access to and use of these information resources by MRS professionals.

The research is comprised of telephone interviews with willing participants, web site content analysis and an anonymous survey. **You have been selected for inclusion in this study as you have expert knowledge in the field of Medical Radiation Science.** Your participation will be beneficial to employers, employees, government agencies and academics to understand, in this time of rapid technological advances in the healthcare system, how accessible professionally relevant information resources are to health practitioners.

If you agree to participate in this research, there will be no discomfort to you, or any risks. Confidentiality is assured, and you will not be identified in any part of the research, rather coded references would be used such as Medical Imaging Technologist A, Radiation Therapist A, Sonographer A, Nuclear Medicine Technologist A. If you participate in the interview part of this research, you will be interviewed on the telephone for approximately 30 – 60 minutes. The telephone conversations will be audio taped for analysis. You are free to withdraw from this study at any time for any reason and to withdraw any data you have provided to that point. If you have any concerns or complaints regarding the way the research is or has been conducted, you can contact the Ethics Officer, Human Research Ethics Committee, University of Wollongong on 02 4221 4457.

If you agree to participate in this research please return the questionnaire AND/OR the attached consent form (if you are willing to participate in the interview) in the post-paid envelope to:

Madeleine Shanahan  
Discipline of Medical Radiations,  
School of Medical Science  
RMIT University  
PO Box 71  
Bundoora. VIC. 3083

If you have any questions about this project, please direct them to:

<table>
<thead>
<tr>
<th>Madeleine Shanahan</th>
<th>Associate Professor Tony Herrington</th>
<th>Associate Professor Jan Herrington</th>
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<td>02 4221 4643</td>
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APPENDIX C CONSENT FOR PARTICIPATING IN RESEARCH BY INTERVIEW

I, ______________________________________________ (Name of Participant)

have read the Information Statement about Accessibility of information resources by health professionals: A case study focussed on the Medical Radiations Science profession and discussed the research project with Madeleine Shanahan who is conducting this research as part of a Doctorate of Education supervised by Associate Professor Tony Herrington and Associate Professor Jan Herrington in the Faculty of Education at the University of Wollongong. Any questions I have about his research have been answered to my satisfaction.

I understand that if I agree to participate in this project by telephone interview
  • my participation in the interview is voluntary
  • I may withdraw from or stop participating at any time
  • the telephone conversation will be audio taped for analysis purposes
  • my confidentiality will be maintained as coded reference will be used when the interview is transcribed and research data disseminated

If I have any concerns or complaints regarding the way the research is or has been conducted, I can contact the Ethics Officer, Human Research Ethics Committee, University of Wollongong on 02 4221 4457.

Signed _________________________________ Date _____________________

Name (Print) __________________________________

Contact work telephone number ______________________

I can be contacted at work for an interview at the following times:

Monday _______________________
Tuesday _______________________
Thursday _______________________
Friday _______________________

Please return completed Consent Form to: Madeleine Shanahan
Discipline of Medical Radiations,
School of Medical Science
RMIT University
PO Box 71
Bundoora. VIC. 3083
### APPENDIX D  CHARACTERISTICS OF INTERVIEW PARTICIPANTS

*Characteristics of participants in Phase 1 semi-structured interview*

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APPENDIX E  GUIDE FOR SEMI-STRUCTURED INTERVIEWS

Over the last ten years there has been a lot of change in the Medical Radiation Science profession such as new procedures, new equipment and new roles and professional responsibilities.

1) I’d like to hear about how your area of specialisation has changed over the last ten years?
   Probe how do you stay up to date?

2) What information sources do you use to stay up to date with changes in your area of specialisation?
   Prompts: journals, conferences (ask if conference provides conference proceedings),
   electronic guidelines or manuals, professional societies
   Probe for membership or use of Australian and international professional societies

3) You’ve talked about getting the information you needed from  (name of sources).
   Lets take a look at each of the information sources you are using
   a. how do you access this (name of ) information source?
      Prompts: university, hospital, departmental library, government health information portal,
      professional society web page
      Probe for other options available for accessing the information source, restrictions to access
      and ease of access

4) Do you have access at your workplace to (if not covered in Q2)
   a. Internet
   b. State Government Information Access Programmes
   c. Departmental library
   d. Hospital Library
   e. University library
      Probe for ease of access and information sources they access through each of them?

5) Are you aware of other (name of specialisation) using different (name of information sources)?

6) What would you say are the major information sources for staying up-to-date in your area of specialisation?
   Probe if differences between 2, 3 and 4 such as access issues

7) What about for (name of specialisation) generally do you think they would name the same information sources?
   Probe for within area of specialisation differences in key information resources

8) What type of workplace do you think would provide the best access to the information sources you’ve been talking about today?
   Probe for healthcare sector, size of workplace, characteristic of workplace eg teaching or non-teaching

9) What does it mean to you to have access to information sources you’ve talked about today?
   Probe for what it may mean if they had no access

10) What has been your best experience of having professional relevant information sources available to you?

11) What if any impediments have you experienced accessing information sources?

12) How could information sources be made more available to you?

13) Is there anything more you’d like to add?
    Probe for whether there is anything that they feel is important about professional updating that we haven’t talked about
### APPENDIX F

**INTERVIEW AND SURVEY ADMINISTRATION TECHNIQUES**

**A COMPARISON ACROSS DATA COLLECTION TECHNIQUES OF SOME TYPICAL FEATURES OF SURVEYS**

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<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Length (number of questions)</strong></td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Ability to clarify questions with respondent</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Ability to probe respondent</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Range and volume of data collected</strong></td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Inclusion of open questions</strong></td>
<td>Yes</td>
<td>Limited</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td><strong>Wide geographic area covered</strong></td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Potentially yes</td>
</tr>
<tr>
<td><strong>Utilises probability sampling</strong></td>
<td>Typically No</td>
<td>Commonly Yes</td>
<td>Commonly Yes</td>
<td>Typically No</td>
</tr>
</tbody>
</table>

## APPENDIX G  SCHEDULE AND DURATION OF SEMI-STRUCTURED INTERVIEWS

<table>
<thead>
<tr>
<th>Interviewee code</th>
<th>Date of Interview</th>
<th>Duration of Interview (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA1</td>
<td>07/04/2006</td>
<td>47:09</td>
</tr>
<tr>
<td>SA1</td>
<td>11/04/2006</td>
<td>31:02</td>
</tr>
<tr>
<td>RC4</td>
<td>23/05/2006</td>
<td>28:08</td>
</tr>
<tr>
<td>RTC1</td>
<td>25/05/2006</td>
<td>46:24</td>
</tr>
<tr>
<td>SA2</td>
<td>29/05/2006</td>
<td>38:44</td>
</tr>
<tr>
<td>RC1</td>
<td>02/06/2006</td>
<td>53:23</td>
</tr>
<tr>
<td>RA1</td>
<td>22/06/2006</td>
<td>32:46</td>
</tr>
<tr>
<td>SA3</td>
<td>26/06/2006</td>
<td>40:40</td>
</tr>
<tr>
<td>RTC2</td>
<td>30/06/2006</td>
<td>37:16</td>
</tr>
<tr>
<td>NMA1</td>
<td>03/07/2006</td>
<td>58:51</td>
</tr>
<tr>
<td>RTC3</td>
<td>07/07/2006</td>
<td>42:06</td>
</tr>
<tr>
<td>RA2</td>
<td>14/07/2006</td>
<td>32:28</td>
</tr>
<tr>
<td>RA3</td>
<td>18/07/2006</td>
<td>63:12</td>
</tr>
<tr>
<td>RA4</td>
<td>18/07/2006</td>
<td>41:45</td>
</tr>
<tr>
<td>NMC1</td>
<td>19/07/2006</td>
<td>39:12</td>
</tr>
<tr>
<td>NMC2</td>
<td>20/07/2006</td>
<td>58:17</td>
</tr>
<tr>
<td>RIC2</td>
<td>21/07/2006</td>
<td>42:49</td>
</tr>
<tr>
<td>SC1</td>
<td>31/07/2006</td>
<td>40:21</td>
</tr>
<tr>
<td>RTA2</td>
<td>07/08/2006</td>
<td>43:57</td>
</tr>
<tr>
<td>SC2</td>
<td>08/08/2006</td>
<td>30:34</td>
</tr>
<tr>
<td>NMC3</td>
<td>14/08/2006</td>
<td>22:00</td>
</tr>
<tr>
<td>RIC3</td>
<td>23/08/2006</td>
<td>44:20</td>
</tr>
<tr>
<td>SC3</td>
<td>24/08/2006</td>
<td>26:25</td>
</tr>
<tr>
<td>NMA2</td>
<td>08/09/2006</td>
<td>44:38</td>
</tr>
<tr>
<td>NMA3</td>
<td>24/10/2006</td>
<td>41:04</td>
</tr>
<tr>
<td>NMA4</td>
<td>27/11/2006</td>
<td>28:22</td>
</tr>
<tr>
<td>RTC4</td>
<td>30/11/2006</td>
<td>37:03</td>
</tr>
<tr>
<td>RTA3</td>
<td>18/12/2006</td>
<td>38:59</td>
</tr>
</tbody>
</table>

Mean 40:26
## APPENDIX H  INTRA- AND INTER-CODER AGREEMENT FOR INTERVIEW DATA

<table>
<thead>
<tr>
<th>Code</th>
<th>% Agreement Intra-coder Coder 1 Time 1–Time 2</th>
<th>% Agreement Inter-coder Coder 1–Coder 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminars</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Conferences</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Journals</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Books</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Health and medical databases</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Internet</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Research</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Continuing professional development</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Formal study</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
APPENDIX I  PARENTAL NODES (PHASE 1) AND RELATED QUESTIONS ON SURVEY INSTRUMENT (PHASE 2)

<table>
<thead>
<tr>
<th>Parent Nodes (NVivo)</th>
<th>Related Survey Instrument Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEMINARS</td>
<td>Q15, Q16, Q29</td>
</tr>
<tr>
<td>CONFERENCES</td>
<td>Q15, Q26, Q27, Q28, Q29</td>
</tr>
<tr>
<td>JOURNALS</td>
<td>Q15, Q16, Q19, Q24, Q34</td>
</tr>
<tr>
<td>BOOKS</td>
<td>Q15, Q16, Q24</td>
</tr>
<tr>
<td>HEALTH AND MEDICAL DATABASES</td>
<td>Q15, Q16, Q21, Q22, Q24, Q32, Q33</td>
</tr>
<tr>
<td>INTERNET</td>
<td>Q15, Q16, Q18, Q20, Q21, Q23</td>
</tr>
<tr>
<td>WEB PAGES</td>
<td>Q24</td>
</tr>
<tr>
<td>INTERNET SEARCH ENGINES</td>
<td>Q21, Q23, Q24</td>
</tr>
<tr>
<td>EMAIL</td>
<td>Q24</td>
</tr>
<tr>
<td>LISTSERV</td>
<td>Q24</td>
</tr>
<tr>
<td>FORMAL STUDY</td>
<td>Q9, Q10, Q15</td>
</tr>
<tr>
<td>CPD</td>
<td>Q17</td>
</tr>
<tr>
<td>RESEARCH</td>
<td>Q30</td>
</tr>
</tbody>
</table>

Tele- or video-conferencing and journal club were added to the instrument (Questions 15, 16 and 24, and Questions 15 and 29 respectively). Although these were not identified as being used by participants in the semi-structured interviews, the literature pertaining to MRS professionals identified that they were being used (Bloomfield et al., 2002) or being promoted as useful tools (Milinkovic et al., 2004).
Accessibility of professionally relevant information resources to MRS practitioners

The 21st century is a time of rapid change for health practitioners due to technological and scientific advances within professional areas and the changing nature of how information resources are being made available.

This research aims to identify information resources that Medical Radiation Science (MRS) practitioners are using to stay up to date with the changes in their profession and to investigate the accessibility of these information resources to Australian MRS practitioners (MRS practitioners here includes nuclear medicine technologists, radiation therapists, radiographers and sonographers). Please fill in the most appropriate response below with a pencil or pen. It should take approximately 15 minutes. Your responses will be anonymous and confidential and will be used to build a descriptive picture of the accessibility MRS practitioners have to professionally relevant information resources.

Thank you for participating in this research.

<table>
<thead>
<tr>
<th>1</th>
<th>Your area(s) of specialisation</th>
<th>Nuclear Medicine Radiography / Imaging Radiation Therapy Sonography</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Do you sub-specialise</td>
<td>No</td>
<td>1</td>
<td>Yes</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If YES please specify eg CT, PET, brachytherapy, MSK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Your current role is</td>
<td>Practitioner</td>
<td>1</td>
<td>Senior Practitioner</td>
<td>2</td>
<td>Manager of department</td>
</tr>
<tr>
<td>4</td>
<td>Years of professional experience</td>
<td>PDY /Intern</td>
<td>1</td>
<td>1 - &lt;5 years</td>
<td>2</td>
<td>5-10 years</td>
</tr>
<tr>
<td>5</td>
<td>Are you currently</td>
<td>Employed full-time</td>
<td>1</td>
<td>Employed part-time/casual</td>
<td>2</td>
<td>Not in employment</td>
</tr>
<tr>
<td>6</td>
<td>Your employer</td>
<td>Public</td>
<td>1</td>
<td>Private-small/ independent</td>
<td>2</td>
<td>Private-large /corporate</td>
</tr>
<tr>
<td>7</td>
<td>Location of your current employment is</td>
<td>Metropolitan</td>
<td>1</td>
<td>Regional</td>
<td>2</td>
<td>Rural</td>
</tr>
</tbody>
</table>

| 8 | Work environment is | Teaching hospital | 1 | Non-teaching hospital | 2 | Stand alone practice / Clinic | 3 | Other (Please specify) | 4 |
| 9 | Your highest qualification | Doctorate | 1 | Masters | 2 | Graduate Diploma / Cert | 3 | Bachelors | 4 | Diploma | 5 | Ass Diploma / Certificate | 6 | Other (Please specify) | 7 |
| 10 | Are you currently | In full-time study | 1 | In part-time study | 2 | I am not currently studying | 3 |
| 11 | Membership of Australian professional societies | AIR | 1 | ANZSNM | 2 | ASA | 3 | ASUM | 4 | Other (Please specify) | 5 |
| 12 | Membership of overseas professional societies | No | 1 | Yes | 2 |
| 13 | Gender | Female | 1 | Male | 2 |
| 14 | Age group (in years) | 20-29 | 1 | 30-39 | 2 | 40-49 | 3 | 50-60 | 4 | > 60 | 5 |

15 Please rate the relative importance of each of the following for updating your professional knowledge

<table>
<thead>
<tr>
<th>Very important</th>
<th>Important</th>
<th>Not important</th>
<th>These are / are not important to me because</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conferences</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Computerised journal databases</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Formal study eg Grad Dip, Masters</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Internet</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Journals-print</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Journals-online</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Journal Club</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Seminars/workshops</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Study days / half-days</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Text and reference books</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Tele-conferencing</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
16. **Please rate your relative ease of access in your workplace to each of the following**

<table>
<thead>
<tr>
<th>Service</th>
<th>Very easy</th>
<th>Easy</th>
<th>Not easy</th>
<th>No access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computerised journal databases</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journals - print</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journals - online</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seminars / workshops</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study days / half-days</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Text and reference books</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tele- or video conferencing</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. Are you currently enrolled in a Continuing Professional Development (CPD) programme?

- YES
- NO

18. **At your current workplace which computers have access to the internet**

- All computers
- Some computers in the work areas
- Most computers in the work areas
- Only computers in offices, e.g., manager, section chiefs
- No computers
- Other

19. If your workplace has electronic resources e.g., journals, can you access them remotely from home?

- YES
- NO

20. Do you have access to the internet at home?

- YES
- NO

21. **Please rate your skill level for each of the following**

<table>
<thead>
<tr>
<th>Skill</th>
<th>Very high</th>
<th>Moderate</th>
<th>Very low</th>
<th>Never done it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computerised journal database searching</td>
<td>1 2 3 4 5</td>
<td></td>
<td>5 6</td>
<td></td>
</tr>
<tr>
<td>Internet searching</td>
<td>1 2 3 4 5</td>
<td></td>
<td>5 6</td>
<td></td>
</tr>
<tr>
<td>Critically evaluating the content of articles</td>
<td>1 2 3 4 5</td>
<td></td>
<td>5 6</td>
<td></td>
</tr>
<tr>
<td>Evaluating internet information for quality</td>
<td>1 2 3 4 5</td>
<td></td>
<td>5 6</td>
<td></td>
</tr>
<tr>
<td>General computer skills for e.g., word processing</td>
<td>1 2 3 4 5</td>
<td></td>
<td>5 6</td>
<td></td>
</tr>
</tbody>
</table>

22. Have you attended a training programme or session(s) on database searching?

- YES
- NO

23. Have you attended a training programme or session(s) on internet searching?

- YES
- NO

24. On average, how often do you use the following to help you stay up to date in your professional area?

<table>
<thead>
<tr>
<th>Information Source</th>
<th>Several times daily</th>
<th>Daily</th>
<th>Several times a week</th>
<th>Several times a month</th>
<th>Several times a year</th>
<th>Never</th>
<th>Not available to me</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
<tr>
<td>Computerised journal database eg Medline, CINAHL</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
<tr>
<td>Search engine for general internet searches</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
<tr>
<td>Specific web pages from eg vendors, professional societies, government sites</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
<tr>
<td>Journals</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
<tr>
<td>Text and reference books</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
<tr>
<td>Tele- or video conferencing</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
<tr>
<td>List Servs e.g. email bulletin board</td>
<td>□ □                 □ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
<td>□ □</td>
</tr>
</tbody>
</table>

25. **When you search for information to update your knowledge what types(s) of information do you seek?**

- Anatomy
- Physiology
- Medical disorders / pathology
- Procedure or treatment techniques
- Procedure or treatment effectiveness
- Procedure or treatment comparison across workplaces
- New technologies
- Other

- New applications for technologies
- Guidelines
- Product information eg implant type, contrast medium
- Medical equipment or supplies
- Professional issues e.g., role development, CPD
- Resources for patients
- Other
26 How often do you attend the following?

<table>
<thead>
<tr>
<th>Event</th>
<th>&gt; 1 per year</th>
<th>1 per year</th>
<th>1 every 2nd year</th>
<th>1 every 3 or more years</th>
<th>I rarely or never attend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual conference (Scientific Meeting) organised by an Australian Professional Society eg AIR, ANZSNMT, ASA, ASUM</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>International conference eg ISSRT, ECCO, ASTRO, SNM</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

27 Does your current workplace give you time off work (i.e., you do not have to take annual leave) to attend conferences

☐ Yes if I am presenting, e.g., a paper or poster
☐ Yes if I am attending
☐ No

28 In the last two years to what extent have you been supported financially to attend conferences by the following (include registration, accommodation and travel costs in your approximation)

<table>
<thead>
<tr>
<th>Source</th>
<th>Work place</th>
<th>Professional society</th>
<th>Government provided fund eg CPD for RT’s funding project</th>
<th>Self</th>
<th>Other please specify</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

29 In the last year, on average how many of the following activities did you attend to update your professional knowledge. Please write the number attended in the spaces below.

<table>
<thead>
<tr>
<th>Organised by:</th>
<th>Mini-conferences</th>
<th>Seminars</th>
<th>Workshops</th>
<th>Journal Club</th>
<th>Other please specify</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your workplace</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
</tr>
<tr>
<td>Manufacturers or vendors of equipment</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
</tr>
<tr>
<td>Professional societies</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
</tr>
<tr>
<td>Universities</td>
<td>No:</td>
<td>No:</td>
<td>No:</td>
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30 On average, how many hours per week:

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<th>2-3</th>
<th>1-2</th>
<th>&lt;1</th>
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<td>do you spend reading for professional reasons include journal articles, database &amp; internet searches</td>
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<tr>
<td>do you spend involved in research or project work</td>
<td>☐</td>
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<tr>
<td>does your workplace allocate for professional reading or study</td>
<td>☐</td>
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<tr>
<td>does your workplace allocate for research or project work</td>
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</tbody>
</table>

31 How does your current workplace support practitioners accessing and using information resources?

32 For the following databases please indicate those that you have used and are aware of

<table>
<thead>
<tr>
<th>Database</th>
<th>Unaware</th>
<th>Aware but haven’t used. I have access to it</th>
<th>Aware but haven’t used. I have no access</th>
<th>Used it and haven’t found it useful</th>
<th>Used it and found it useful</th>
</tr>
</thead>
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<td>Bandolier Library</td>
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<td>☐</td>
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<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>Clinicians Knowledge Network OR Clinicians</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
<td>☐</td>
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<td>☐</td>
<td>☐</td>
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<td>☐</td>
</tr>
<tr>
<td>Informit OR Meditext</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td>MIMS</td>
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<tr>
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</tr>
</tbody>
</table>

33 Do you have electronic alerts set up?

☐ Yes, with individual journals for new issues with Table of Contents. How many journals? __________
☐ Yes, within databases on specific search topic areas
☐ No

34 Of the following journals which ones do you currently have access to, and which ones do you consider practitioners in your area(s) of specialisation need access to?
<table>
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<tr>
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<th>We need access to</th>
<th>Journals</th>
<th>I have access to</th>
<th>We need access to</th>
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<tbody>
<tr>
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<td>☐</td>
<td>Journal of Radiotherapy in Practice</td>
<td>☐</td>
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<tr>
<td>Acta Radiologica</td>
<td>☐</td>
<td>☐</td>
<td>Journal of Ultrasound in Medicine</td>
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<td>☐</td>
<td>Journal of Vascular Ultrasound</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>American Journal of Neuroradiology</td>
<td>☐</td>
<td>☐</td>
<td>Lancet, The</td>
<td>☐</td>
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</tr>
<tr>
<td>American Journal of Obstetrics &amp; Gynecology</td>
<td>☐</td>
<td>☐</td>
<td>Magnetic Resonance Imaging Clinics of North America</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>American Journal of Roentgenology</td>
<td>☐</td>
<td>☐</td>
<td>Magnetic Resonance in Medicine</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
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<td>Management Today</td>
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<td>Medical Teacher</td>
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<td>☐</td>
<td>☐</td>
<td>Obstetric &amp; Gynecology Clinics of North America</td>
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<tr>
<td>Cancer Treatment Reviews</td>
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<td>Oncology</td>
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<td>Radiographer, The</td>
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<td>Seminars in Ultrasound, CT &amp; MRI</td>
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<tr>
<td>Journal of Bone &amp; Joint Surgery</td>
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<td>Strahlentherapie und Onkologie</td>
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<td>☐</td>
<td>Surgical Clinics of North America</td>
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<td>Journal of Computed Assisted Tomography</td>
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<td>☐</td>
<td>Ultrasonic Imaging</td>
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<td>Ultrasound Bulletin (ASUM)</td>
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<td>Ultrasound in Obstetrics and Gynecology</td>
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<tr>
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<td>☐</td>
<td>☐</td>
<td>Other journals Please specify</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

35 Please comment on any issues you have with access to journals

36 How could professionally relevant information resources be made more available to you?

37 Any other comments?

Please return the questionnaire in the post-paid envelope to: Madeleine Shanahan, Discipline of Medical Radiations, School of Medical Sciences, RMIT University, PO Box 71, Bundoora, VIC. 3083

By returning this survey you will be helping to develop a picture of accessibility of professionally relevant information resources to MRS professionals. THANK YOU for your time in completing this survey.
APPENDIX K  COVER LETTER FOR PARTICIPATING IN POSTAL SURVEY

Dear

As a Medical Radiation Science practitioner specialising in Nuclear Medicine, Medical Imaging, Radiation Therapy, and /or Ultrasound this research is primarily concerned with

- What are professionally relevant information resources in your area of specialisation? and
- How accessible are they to practitioners?

Your experience is the experience of the profession and I would like to encourage you to please provide 15 minutes of your time to completing the questionnaire. A good response rate for the questionnaire will mean the data collected is going to reflect the experience of the profession more accurately. The findings from this research will be communicated back to the profession so that we will have a better understanding of professionally relevant information resources within our profession and issues of accessibility that may be affecting practitioners.

I would like to express my sincere gratitude to you for your generosity of time in participating in this research.

Kind regards

Madeleine Shanahan MApSc (RMIT), BEd, DipAppSc, FIR
Senior Lecturer, Discipline of Medical Radiations
School of Medical Sciences, RMIT University
Outliers and extreme outliers were examined by using respondent numbers to cross-check data entry value (in this case the number of journals MRS professionals reported they can access) against the original questionnaire data. For all cases in this example, the data entry value was correct. In other cases where an error was identified, the correct value (taken from the original questionnaire) was entered into SPSS. This approach of checking ‘unlikely’ codes was a strategy used in this study to enhance factual accuracy of data (Section 3.2.3.3).

For outliers, respondents were working at universities or teaching hospitals, were undertaking study or mentioned libraries on their questionnaire. The only exception was respondent number 109 who did not fit into one of these three broad categories.
INITIAL APPLICATION APPROVAL

6 March 2006
Ms Madeleine Shanahan
7 Gladstone Road
BRIAR HILL VICTORIA 3083

Dear Ms Shanahan,

I am pleased to advise that the Human Research Ethics application referred to below has been approved. The University of Wollongong/SF Sydney and Illawarra Area Health Service Health and Medical HREC is constituted and functions in accordance with the NHMRC National Statement on the Ethical Conduct in Research Involving Humans:

Ethics Number: HE06/057
Project Title: Accessibility of information resources by health professionals; A study focussed on the Medical Radiation Science profession
Name of Researchers: Ms Madeleine Shanahan, Associate Professor Tony Herrington, Associate Professor Jan Herrington.
Approval Date: 2 March 2006
Expiry Date: 1 March 2007

The committee approves this application subject to:

- Please change "Complaints Officer" to "Ethics Officer" in the Participant Information Sheet and Consent Form.

As a condition of approval, the Human Research Ethics Committee requires that researchers immediately report:

- proposed changes to the protocol including changes to investigators involved
- serious or unexpected adverse effects on participants
- unforeseen events that might affect continued ethical acceptability of the project.

You are also required to complete monitoring reports annually and at the end of your project. These reports are sent out approximately 6 weeks prior to the date your ethics approval expires. The reports must be completed, signed by the appropriate Head of School, and returned to the Research Services Office prior to the expiry date.

Yours Sincerely,

A/Professor Arthur Jenkins
Chairperson
Human Research Ethics Committee
cc: Assoc/Professor Tony Herrington, Faculty of Education
## APPENDIX N  JOURNALS READ BY INTERVIEW PARTICIPANTS

### (PHASE 1)

The number of interview participants (N=28) who read particular journals is provided in the table below. Journals in bold identified as core journals for radiologic technology, sonography, radiology, imaging, cardiovascular or oncology by Burnham (1997), Chew (1986), Hill et al. (1998), Hill et al. (2001), Walcott (1999).

<table>
<thead>
<tr>
<th>Journals</th>
<th>Number</th>
<th>Journals</th>
<th>Number</th>
</tr>
</thead>
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<td>Journal of Nuclear Medicine Technology</td>
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<tr>
<td>Acta Radiologica</td>
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<td>Journal of Radiotherapy in Practice</td>
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<td>American Journal of Hematology</td>
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<td>Journal of Ultrasound in Medicine</td>
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<td></td>
<td>Lancet, The</td>
<td>1</td>
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<td>American Journal of Roentgenology</td>
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<td>5</td>
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<td>Applied Radiology</td>
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<td>Management Today</td>
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<td>Australian Journal of Rural Health</td>
<td>1</td>
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<td>Australasian Physical &amp; Engineering Sciences in Medicine</td>
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<td>Medical Physics</td>
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<td>Blood</td>
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<td>Medical Teacher</td>
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<tr>
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<td>1</td>
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<td>Neuroimaging Clinics of North America</td>
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<td>British Journal of Cancer</td>
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<td>Neuropsychiologia</td>
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## APPENDIX O  COUNTRY OF PUBLICATION OF PROFESSIONALLY RELEVANT JOURNALS

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* Netherlands  
† Denmark  
‡ Sweden