From Information Gatherers to Knowledge Creators: The Evolution of the Post-Graduate Student

Elaiza Benitez, David Pauleen and Tony Hooper
Massey University, Palmerston North, New Zealand
D.Pauleen@massey.ac.nz

Abstract: This exploratory study investigates how post-graduate students manage information and knowledge and how these skills evolve over time during their post-graduate studies. The concepts of personal information management, personal knowledge management and brain filtering as well as the critical role of technology are discussed in the context of the post-graduate learning experience. A short illustrative case study is presented that highlights the evolution in the way that post-graduate students learn to handle information and develop new knowledge. The study contributes to the still nascent literature on personal knowledge management through increased understanding of the way students learn and their use of technology tools. The findings have implications for universities as well as the private sector to better develop genuine knowledge creators.

Keywords: personal information management; personal knowledge management; post-graduate study; experience; technology

1. Introduction

Vast amounts of information need to be managed by post-graduate students in their academic studies. To be academically successful, post-graduate students must be able to find and retrieve information and then transform it into knowledge. Learning to transform information into knowledge is critical to successful academic learning and research (Zuber-Skerritt, 2005). Davenport and Prusak's (1998) much cited definition explains 'working knowledge' as the constant learning and the renewal of information that adds to an individual's existing knowledge base. This renewal is critical to innovative and knowledge-creation-based industries (Murphy and Pauleen, 2007), areas which post-graduate students often enter after graduation.

While expectations vary for what students will have experienced in their undergraduate studies, post-graduate students need to develop new academic skills (Fischer and Zigmond, 1998), as the structure and expectations of undergraduate and post-graduate studies are very different. Methods of finding information are essential to post-graduate students and they must find ways of re-accessing that information when required and using it in the production of personal knowledge (Miller, 2005).

Dr. Indira Nair of Carnegie-Mellon University describes the transition process this way: 'students are "consumers" of knowledge in their undergraduate years and when they become post-graduate students they are "creators" of new knowledge' (Fischer and Zigmond, 1998: 31). Therefore post-graduate students 'must go beyond what is known, ask questions, seek answers and evaluate their findings' (Fischer and Zigmond, 1998: 31). Furthermore, post-graduate students are responsible for their own achievements as they assign their own tasks and objectives. Information resources are needed and personal management of the information and knowledge retrieved from these resources will affect students' abilities to accomplish these tasks and objectives. The practice of both personal information management (PIM) and personal knowledge management (PKM) appear to have great relevance to post-graduate studies.

PIM has been described as a new field with ancient roots (Jones, 2007) and the same is arguably true with PKM. However, the practice of PKM has not yet been explored empirically in depth by researchers (Pauleen, 2009). The purpose of this study is to gain more insight into how post-graduate students apply PKM as they locate and use information to create knowledge (Fischer and Zigmond, 1998). Specifically, we ask how do post-graduate students understand their journey from information users to knowledge producers, and what is the role of technology in this journey?

This paper is structured as follows: in the next section the relevant literature and the background to this research are reviewed. This is followed by sections on the methodology, the case study, and further discussion. Finally the conclusions and implications of the research are offered.

Reference this paper as: Benitez, E, Pauleen, D and Hooper, T. "From Information Gatherers to Knowledge Creators: the Evolution of the Post-Graduate Student" *The Electronic Journal of Knowledge Management* Volume 11 Issue 2 (pp139-149) available online at www.ejkm.com

2. Literature review

Post-graduate students' management of information and knowledge affects the success of their research (Fischer and Zigmond, 1998). This section introduces some practical and theoretical background on post-graduate education, as well as the concepts of PIM and PKM.

2.1 Post-graduate education and the learning experience

In many Commonwealth countries (e.g. Great Britain, Australia and New Zealand), Honours is a year of study following a bachelor's degree in which a student continues with a chosen field of study to build upon the knowledge gained in the bachelor's degree. In the Honours year the student experiences self-directed study and individual research under supervision. A student does intensive coursework and research, which involves learning how to collect and interpret information from academic sources. Following the Honours programme, a student may continue on to do a Master's degree (usually a one year thesis), or if they achieved a high cumulative grade in Honours (usually a minimum of B+) they may be admitted directly into a PhD programme.

The level of attainment in a Master's thesis can be understood as follows: 'the master's thesis must demonstrate the candidate's ability to make use of appropriate research procedures, to organize primary and secondary information into a meaningful whole, and to present the results in acceptable prose. The length of the thesis is not important so long as these ends are fulfilled' (Stuart, 1979: 1). The PhD degree, on the other hand, is awarded on the basis of a thesis where the student is able to reflect independent and original research, which adds value and contributes to their field of study. Research conclusions are drawn from 'critical examination of materials hitherto dealt with or from the re-examination of traditional materials by means of new techniques or from new points of view' (Stuart, 1979: 1). The research undertaken at this level requires mastering the skills needed for producing knowledge that is accredited to the student's chosen field of study.

The aim of education has been described as the expansion of the self as a meaning-making, or sensemaking, system (Hayes and Oppenheim, 1997) and scholarship is 'a conversation in which one participates and contributes by knowing what is being discussed and what others have said on the subject' (Glassick et al, 1997: 27). Ramsden (2003: 107) maintains that learning is 'a change in your conceptions – a change in your understanding of something' and that while 'university teachers can tell students what a right and a wrong understanding is…only students can make sense of it for themselves'. Säljö (1979, in Barkley et al, 2005) asked adult learners what they understood by 'learning' and categorized their answers in a hierarchical pattern, observing that each higher conception implied all that preceded it:

- Learning is acquiring information or 'knowing a lot';
- Learning is memorizing or 'storing' information;
- Learning is acquiring facts and skills that can be used;
- Learning is making sense or 'making meaning' of the various parts of information;
- Learning involves comprehending or understanding the world by reinterpreting knowledge.

When discussing learning in graduate situations, we need to have a clear idea of which of the above conceptions of learning we are talking about. Constructivist theorists argue that people construct their knowledge and therefore their learning needs based on their interpretation of their experiences in the world around them (Taylor et al, 2000; Ben-Ari, 2001; Hayes and Oppenheim, 1997). One can argue that humans adjust to the environment in which they live by building on their prior knowledge and experience. This is a cyclical process in which we identify our individual learning needs based on our past knowledge and skills, constantly increasing our competitive advantage. In such a conceptualization of learning we are accepting that learning 'involves comprehending or understanding the world by reinterpreting knowledge'.

If one accepts this view, the educational experience should provide students with the means for discovering what is known and what they personally still need to know or to discover. Mezirow's (1996: 162) definition of learning elaborates on this point: 'Learning is understood as the process of using a prior interpretation to construe a new or revised interpretation of the meaning of one's experience in order to guide future action'.

According to Wickersham and McGee (2008) deeper learning is manifested when the learner does not just regurgitate information but reflects on and actively explores it, producing knowledge. Cross (2005: 1) on the other hand explains that students 'learning for deeper understanding' are "'actively engaged in learning' and 'likely to learn more than students not so engaged'. Her emphasis on autonomy is reflected in Atherton's (2005) perspective that 'deep' and 'surface' learning correlate fairly closely with motivation: 'deep' with intrinsic motivation and 'surface' with extrinsic. Both Cross and Atherton's perspectives emphasize the abstract element of learning and the necessity of reflecting on reality in order to integrate new experience and discoveries with older learning and experiences.

Weick (1995: 15) writes: 'People make sense of things by seeing a world on which they already impose what they believe'. They do not arrive at the scene alone and empty; patterns are present. People realize reality by reading into a situation patterns of significant meaning. This cyclical approach to learning and discovery assumes that humans are 'active, growth-oriented organisms who are naturally inclined toward the development of an organized coherence among the elements of their psychological makeup and between themselves and the social world' (Deci and Ryan, 2000: 262). This 'organized coherence' involves interaction with others as well as with the content of their discipline.

According to Kanuka and Anderson (1998), content interaction that leads on to the construction of knowledge by students takes place in a five-stage process in which students:

1. share their information and opinions;
2. explore inconsistencies in that material;
3. work together to construct knowledge from the information and opinions;
4. test and modify that newly-constructed knowledge; and
5. form statements about and apply that new knowledge.

However, the authors found that the interactions seldom rose above stage 2.

Two points emerge from this – the first being the importance of interaction in the 'sharing' of information and opinions and the 'exploration' of inconsistencies. These two processes in items 1 and 2 above involve others. They reflect the findings of Deci and Ryan (2000) who emphasized the importance of relatedness and interpersonal interaction in the learning process. In their explanation of self-determination theory, Deci and Ryan (2000) argue that there are three innate psychological needs: for competence, autonomy, and relatedness. Activities that are characterized by novelty, by optimal challenge, deep task absorption and 'flow' are intrinsically motivated activities. They are also associated with better learning, performance, and well-being.

The second point to emerge from Kanuka and Anderson's findings is that items 1 and 2 above describe a process of 'sense making'. Sense making is about the ways people construct a plausible account of what they interpret – how users "'make sense' of their experience as they work towards an interpretation (Weick, 1995). Aaltonen (2007) considered 'sense making' to be a form of constructionism (as opposed to a cognitive viewpoint). 'While we observe and communicate reality, we simultaneously take part in the process of creating it. Therefore, every sense-maker is by nature a social constructionist' (Aaltonen, 2007: xix). In other words, we construct meaning out of our interpretation of the situation based on our prior learning or experience, and in doing so participate in the creation of meaning.

Students develop and create knowledge through relatedness with others as well as through content interaction. An integral part of this process involves personal information management.

2.2 Personal information management

Early work in the personal information management area focused on helping university students to develop information literacy skills and use technology to organize and use information (Frand and Hixon, 1999; Avery et al, 2003). Effective PIM is a necessary skill for post-graduate students. PIM is the ordering of information through categorization, placement, or embellishment in a manner that makes it easier to retrieve when it is needed (Jones and Teevan, 2007). It is an activity in which an individual stores personal information for later use (Bergman et al, 2008). Personal knowledge is used to identify information relevant to one's work and life

and to organize that new information so that it is meaningful and useful (Jefferson, 2006). The ability to determine whether information is relevant or irrelevant presumably increases with experience.

Jones and Teevan (2007) organize PIM into the following activities: information seeking, information keeping, organization and information maintenance. They explain information seeking as 'finding' and 'refinding' information. 'Finding' is seeking information to satisfy some goal of the individual. Technology such as the World Wide Web and library databases are often used (Wilson, 2000). 'Refinding' is the process of finding information that was seen before and is based on an 'information keeping' action in which the individual has recognized the value and relevance of the information. This is followed by the organization of the information and how to represent that information when storing it, in order to be able to retrieve it at a later stage (Jones and Teevan, 2007). Information maintenance is then required and involves the individual deciding on the composition and preservation of information, how the information is stored and when the information is no longer useful (Jones and Teevan, 2007).

Barreau (1995) lists five PIM activities: acquisition, organization and storage, maintenance, retrieval and output. She describes PIM as a system supported by the technology found in the personal computer environment such as the operating system, mailbox and browser. PIM systems have become ubiquitous as the searching, storing and managing of information is a fundamental aspect of computer-based activity. Computer users manage their personal information through technology as a daily routine (Barreau, 1995).

PIM is connected to PKM in that once an individual has found, managed and made use of information it becomes a part of their personal knowledge. Specifically the information literate PKM practitioner is engaged in the construction of knowledge, uses PKM to solve problems and resolve needs, critiques information before committing it to affective and effective personal knowledge, and absolutely creates new knowledge through the information-seeking and knowledge acquisition process (Gorman and Pauleen, 2011). PKM is part of the meaning-making process and the way students, themselves, make sense of the information they work with.

2.2.1 Personal knowledge management

PKM is a relatively new research area with few empirical studies (Pauleen, 2009; Tsui, 2005). The focus of PKM is on helping individuals to be more effective in personal, organizational and social environments (Pauleen, 2009). PKM is rooted in a number of diverse fields such as KM, PIM, cognitive psychology, philosophy, management science and communication (Pauleen, 2009). Martin (2000) describes personal knowledge management as knowing what knowledge we have and how we can organize it, mobilize it and use it to accomplish our goals, and from this, how we can continue to create new knowledge. This is similar to Dorner and Gorman's (2006) understanding of information literacy as an individual's awareness and understanding of information to create new knowledge to resolve needs in specific situations such as at work.

This suggests a close relationship between PKM and PIM, as an individual needs to be able to manage information in order to gain or create knowledge. Arguably though, PKM is essential for making use of the information an individual has collected. The Anderson School (Frand and Hixon, 1990) created a conceptual framework as a method to organize and integrate information that is viewed as valuable by an individual as the information adds to their personal knowledge base. This process of discovering and valuing information is based on an individual's prior knowledge even as it adds to the individual's knowledge base. Using knowledge to manage new and relevant information enhances the ability to learn from new experiences and resolve problems (Cheong and Tsui, 2011).

Avery et al (2003) see PKM as a set of learning-to-learn information skills: retrieving information, securing information, evaluating information, organizing information, collaborating around information, analyzing information, securing information and presenting information. They also consider information technology as a means for accessing, retrieving and storing large amounts of information that contribute to PKM. The choice of technology is an individual one (Gorman and Pauleen, 2011). How the technology is used contributes to an individual's learning, creation and management of knowledge.

Jefferson (2006) argues that PKM is a conceptual framework for blending personal skills and processes., Like Gorman and Pauleen (2011), she argues technology is only a supporting tool and that individuals must have PIM skills that allow the retrieving, processing, filtering, structuring, storing and securing of information.

PKM assumes individuals have developed self-awareness of the limits of what they know and can do (Avery et al, 2003). Individuals understand what they know and do not know and have methods for obtaining new knowledge and accessing new information when needed (Avery et al, 2003). The core focus of PKM is 'personal inquiry': the quest to find, connect, learn and explore (Clemente and Pollara, 2005). Viewed another way, PKM is a personal approach to learning and discovery that Deci and Ryan (2000) attributed to 'growth-oriented humans' inclined to understanding their roles as individuals in a social world.

2.3 Research background

In a previous exploratory study (Benitez and Pauleen, 2009) we interviewed seven post-graduate students from a department of information management at an Australasian university. Using grounded theory techniques we developed a conceptual model that linked PIM and PKM. The link, brain filtering, was a concept that emerged from the interview data. Figure 1 illustrates how brain filtering links PKM and PIM. As Davenport and Prusak (1998) explain, knowledge is used to make decisions about strategy. This understanding is applied to how the post-graduate students use their PKM (values and beliefs, expert insight, experience, and sense making) to engage in brain filtering in order to access, select, structure and re-access information.

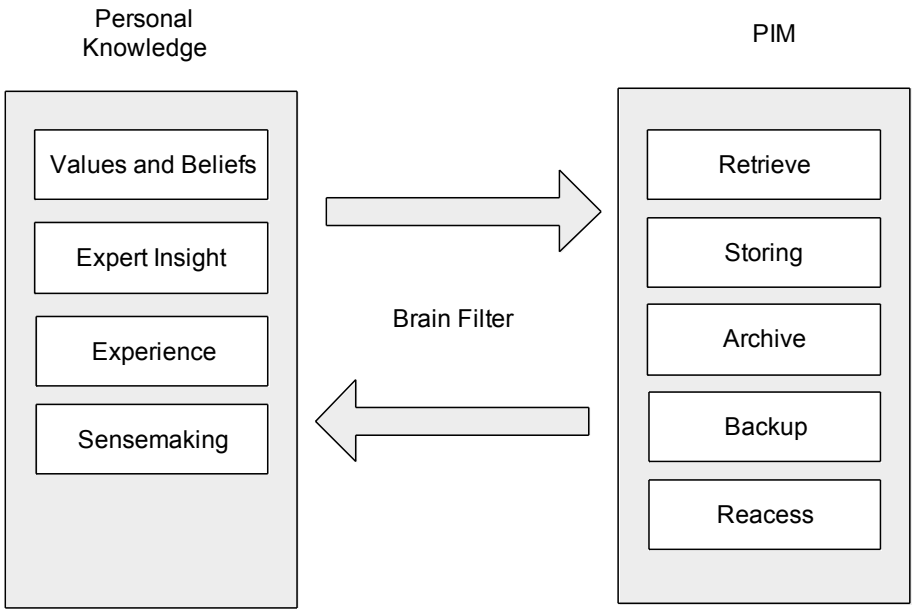

Figure 1: Brain filtering and the relationship between Personal Knowledge and Information Management (from Benitez and Pauleen (2009)

The arrows in Figure 1 indicate the recursive nature of the relationships between PKM, PIM and brain filtering. Our findings showed that a student's ability in these three areas usually increases over time as they learn from teachers and supervisors and gain experience through trial and error. Davenport and Prusak (1998) explain working knowledge as the constant learning and the renewal of information that adds to an individual's existing knowledge base. Through the learning experience of brain filtering during the retrieval and storing of information sources, personal knowledge grows and the student becomes more effective in managing information.

In the next section we provide background findings used to develop the conceptual model followed by a supporting case study that illustrates how one post-graduate student evolved from an information gatherer to a knowledge creator during a two-year period beginning as a Master's student and (now) well into his PhD research. Data was collected during a one-hour interview and in shorter subsequent follow-up interviews.

2.4 PIM, brain filtering, PKM and the role of technology

Before presenting the case study, we briefly summarize the data from the previous study to give a greater understanding of PIM, PKM, brain filtering and the role of technology as understood by post-graduate students.

2.4.1 Personal information management

Students engaged in PIM in a process similar to that described by Barreau (1995) and Jones and Teevan (2007). The retrieving process involves seeking and storing information, such as journal articles and conference papers, needed for their studies. Storing and archiving involve organizing information in such a way that it can be re-accessed later (Barreau, 1995; Jones and Teevan, 2007) Information is also backed up in case anything happens to the original files.

Students demonstrated these personal information management skills when they were questioned about their PIM. One student described creating folders and subfolders of information categorized with names meaningful to the student. This process implies that information can be easily accessed when folders are categorized according to the student's preferences. How they decide what to name each folder is personal to them because they have categorized it in a meaningful way which perhaps only they understand. Students realized it was important to store, retrieve and re-access information effectively, especially PhD students who are dealing with a large number of information sources, including journal articles, conference papers and books.

Students used technology to assist in their PIM. Information resources such as library databases and online academic journals were used to retrieve information needed for their studies. As they selected information sources appropriate for their study, a personally meaningful approach was taken when naming and storing each electronic file. This enhanced their ability to find the file later on. Some students preferred to store files electronically, others in paper form. However, because so many articles and other academic information sources are used, it is more effective to store them electronically because of easier re-access.

Students are aware of the consequences if they do not back up their electronic files. They have invested a lot of time and effort in locating information sources. The students have either lost work themselves or are aware of colleagues who have lost their work.

2.4.2 Brain filtering

With their research topic in mind, students have an idea of what information to look for. The term 'brain filtering' describes how the students identify what information needs to be incorporated as personal knowledge. Brain filtering is a process used to determine what information is relevant, and for what purposes it will be used. PKM attributes such as experience, sense making, and critical thinking, are used to identify worthwhile information.

Skyttner (1998: 889) provides a definition of the relationship between data, information and knowledge that relates to this process of brain filtering:

> *Data reaches our senses and makes us aware that something has changed or is going on and is said to give us information. That is, we have cognitive or physical representation of data about which we are aware of. In other words, we have been informed. Assigning meaning and understanding to information by the use of higher mental processes then makes it possible to speak about knowledge.*

Post-graduate students use information resources such as journal databases to gather data, which in turn becomes information for their research. This information is then transformed into something meaningful and useful in their studies (Skyttner, 1998). Through analysis and reflection they engage in a form of knowledge creation. By applying communication skills, students develop their thesis and demonstrate academic achievement as they make explicit the knowledge that they have created (Fischer and Zigmond, 1998). The students are able to 'speak about knowledge' which they developed from data and information.

Post-graduate students are knowledge creators, a clear progression from when they were undergraduate students and mere knowledge consumers (Fischer and Zigmond, 1998). As post-graduate students they go

beyond what is known, ask questions and disseminate their results (Fischer and Zigmond, 1998). Brain filtering involves determining what information will be of use and how this information will provide meaning and understanding.

Post-graduate study makes students aware of this brain filtering process, something which they may not have acquired in the workforce or as an undergraduate. They use brain filtering to efficiently manage information. While doing so they add to their personal knowledge of how to filter irrelevant information.

2.4.3 Personal knowledge management

Davenport and Prusak's (1998: 5) definition of working knowledge – 'a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information' – implies individuals are constantly exposed to learning environments as they continually integrate new information. Here we evaluate PKM using this concept of working knowledge as a frame for dealing with new experiences and information. Values will first be assessed followed by experiences, expert insight and sense making.

Values influence an individual's behaviours: 'people with different values "see" different things in the same situation and organize their knowledge by their values' (Davenport and Prusak, 1998: 12). The following quote shows how personal values can affect the managing of information:

> *At the beginning of the year I didn't know how to do a lit review so I followed the steps that our lecturers advised... keeping tidy notes, etc, and I tried that… it just messed with my head and I couldn't find anything when it was tidy. But when it was a big mess I knew where everything was. (Participant C)*

The PhD students recognized it was crucial to have a personal management approach to deal with an increasing number of journal articles. Most PhD students came to understand they needed an efficient personal management system. As the volume of information increased, so did their level of PIM. The simple realization that a system of PIM is needed is a step into PKM. As time goes by, sense making, experience and expert insight are developed. As Davenport and Prusak (1998) explain, 'experience' and 'expert' are related words and that experts are people with knowledge about a subject developed by past and new experiences. Experience allows individuals to formulate connections between what is happening now and what happened then.

Experience teaches the individual to act according to the situation as exemplified by the student recognizing the need for a PIM system in their PhD studies. In their previous studies they had not developed a PIM system. After moving up to PhD level, the students learned the importance of PIM that allowed them to efficiently retrieve important information.

As for sense making, the students apply their own context to incorporate the new information received into a personal knowledge base. An example of this can be seen in this explanation of a student's perception of personal knowledge:

> *If I go back and see notes I wrote months ago I can't remember the context. I might have thought it was meaningful at the time but it doesn't connect. So to make it personal it's the connection with something that is meaningful to you in the context of what you are doing. I guess the other thing is that it's the language that I can relate to. It's not jargonistic, the terms used are ones that I can connect with. So it relates to my experience. (Participant E)*

2.4.4 The critical role of technology

The summary of findings and discussion above demonstrates that technology played a critical role in helping students with their PIM, brain filtering and PKM skills. Technology influenced these processes in several ways. First, technology gave students access to the information resources they needed, including the Internet, library databases, online journals, and e-versions of conference papers. All the students used the Internet to access these information resources.

The Internet allows the students to 'information seek' (Jones and Teevan, 2007), and use their brain filtering skills to identify relevant information. There is a symbiotic relationship between PIM and brain filtering because to find information in the library databases and on the Internet, students have to be able to distinguish between irrelevant and relevant information sources. As they continue to research and practice their brain filtering skills, this experience is added to their PKM skills.

Technology is also used as a 'mechanical support'. The students used technological applications and devices to increase their PIM and PKM skills. As discussed earlier, information is organized according to the student's personal approach to management. This personal approach is formed from their values and experience but also as they deal with technology and large volumes of information (Avery et al, 2003). The students developed personal management systems through their relationship with technology, reflecting the cyclical nature of PIM: information seeking, information keeping, organization and information maintenance (Jones and Teevan, 2007).

The students process large quantities of information while their mental capacity can only handle a certain amount. Other 'devices' apart from the human mind are needed to store the knowledge and information. Technology, such as Google Desktop and mobile devices, is used as knowledge repositories.

2.5 From information to knowledge: an illustrative case

In this short case we highlight how one student applied personal information management by using technology to organize a large number of journal articles. Moreover, we show how he used what we have termed brain filtering, again assisted by technology, to analyze the articles and as a result create new knowledge. TT is a PhD student in an Australasian university researching in the area of entrepreneurship in the information technology industry and was an acquaintance of the authors. He has finished presenting his formal proposal for his programme and is now collecting data. This case highlights how he conducted his literature review for the formal proposal.

His strategy for the PhD literature review was based in large part on his experience as a Master's student. He explains his experience with his Master's project:

> *It got quite complicated having lots of different articles and keep ... and read something and couldn't figure out where I had seen it, and forgot all about it... spent hours trying to hunt it down and all that sort of stuff. [I] used post it notes, highlighter pens.... big stacks of paper.*

TT's explanation suggests that he needed support in organizing the retrieved articles that would contribute to his PhD literature review. He took up his supervisor's suggestion to use NVivo, which provided support to his personal information management, which in his words was a 'very process-oriented approach'. After discussions with his supervisors he developed an article summary form that had a number of different categories such as the purpose of the article, key outcomes, the methodology, and the relevance of the paper. He then started researching and reading articles. He continued to develop the structure of the form and added sections for definitions that he found useful in the paper and for those points he thought important. He also added sections for his comments and observations on the paper. He filled out one form for most of the articles he read and uploaded them into NVivo. He then coded the article summaries, which gave him a database of the existing literature.

This system allowed him to see linkages based on his coding between multiple articles. When it came to the PhD stage of writing up sections of his thesis such as the literature review he was able to go into the NVivo database and in his own words have 'a collection of issues, topics, and information...basically it was information'. He would then print them out, interpret them and choose what to follow up. Essentially, TT created a searchable database of not only the articles he read, but also the article summary sheets that he had coded. All of this was searchable and as he explains:

> *I can go into the database and type it (a key term) there and it brings information up. I was using it this morning, I'm using it all the time. Been reading heaps. I'm coding my summaries today. Then I'm going to write it up and it makes it a lot easier. I can cover a lot more ground. It's also like if I can't remember stuff I study, I don't worry. Don't need to, it's all there when I need to come and understand it.*

Essentially, what has been described above represents a PIM approach to dealing with a great deal of information. However, by creating article summary forms and coding the documents TT was in fact applying knowledge in the form of a preliminary analysis of the information. About midway through this process he became aware of grounded theory, and began to apply more formal grounded theory coding processes to the information. As he explained when doing a literature review, 'it's not always clear what is relevant and what is not'. He explained that he had to go 'very broad and very deep'. He found that grounded theory allowed him to be open to the process and to see where the literature would take him.

The grounded theory method facilitates theory creation (Jones and Teevan, 2007) and TT's use of it at the stage of the literature review was a novel application of the method that resulted in a number of benefits (he subsequently published papers on the use of grounded theory in conducting literature reviews) that directly helped him develop new knowledge from the literature. One method he used from grounded theory was memoing in which he would formally write down his thoughts and ideas about what he was reading and then include and link them in the database. These memos led to the designation of 'waypoint' articles, those articles that he believed were critical and which took him in new directions or to higher levels of understanding. TT explains:

> *Every now and then I come across a critical article and I declare this a waypoint article. And that meant on my journey of discovery I think this is quite a seminal article that is going to take me to the next stage. And if I ever get lost on that journey I'll come back to it.*

In the following quote TT explains his understanding of the relationship between information and knowledge:

> *Each person can have access to the same information. How you interpret it and come to understand it will be heavily influenced by your own world views, your environment, your experiences and all that sort of stuff. Information is what you would then apply your own interpretation to, which will then result into the knowledge.*

He goes on to explain how one can take knowledge a step further to the development of theory. He understood that it was of great importance to be able to communicate what he learned, i.e. making tacit understanding explicit to others:

> *So therefore this reading that you're doing, this wide reading, is giving you some knowledge. I have knowledge as a practitioner but you also need theoretical knowledge. So I have to do quite an extensive reading and understanding. That's what my proposal was all about, is going through that, absorbing that. And then showing that I can articulate it and have an awareness of what it was [I learned].*

TT called his NVivo database his 'knowledge centre'. He coded it, structured it and believes it will serve him in good stead for the coming years. He explains that he can update it and build on it and he sees it as a 'growing thing'. He even coded his proposal and put it in the database and by doing so got useful variables and constructs. Moreover, he points out the database provides rigour to his study, indeed it provides an auditable trail of his research.

This case presents a clear example of how a post-graduate student can develop a system of PKM. In this case TT's system evolved from an initial PIM approach of managing large amounts of information with the help of technology to a PKM system using brain filtering supported by his previous experience, ongoing knowledge acquisition, and increasing insight and sense making techniques (using grounded theory). A significant intangible in this process was TT's personal motivation, which Clemente and Pollara (2005) explain as the quest to find, connect, learn and explore.

2.6 The importance of experience

The 'experience' and 'information' Davenport and Prusak (1998) speak of in their definition of working knowledge is evident when looking at the increasing ease with which PhD students use their brain filtering and PIM skills. This 'growth' of experience is evident in the case of TT. While PhD students engage in Kanuka and Anderson's (1998) five-stage process of knowledge construction, much of their work is done solo, with occasional input from supervisors. During Honours, students are not only shown how to use the information resources such as the library databases and guided in how to write a literature review, but they are much more likely to construct knowledge socially through the sharing of information and opinions and the exploration of inconsistencies in the classroom situations, after-hours studying and socializing that form the bulk of their

learning experiences. As their studies continued, post-graduate students' experiences in PIM increased, improving their brain filtering skills and abilities to apply knowledge and experience to the tasks at hand. As knowledge workers, they are constantly applying their brain filtering and PIM skills as they work through their studies. They are responsible for their own success (Fischer and Zigmond, 1998).

2.7 Conclusions

Universities rely heavily on the creation and dissemination of knowledge as their 'core activity' (Rowley, 2000). Graduate schools and academic research are central in the creation of knowledge, a role they have played for centuries. Therefore post-graduate students, particularly PhD students, are vital to university knowledge creation. In the same vein, the business world, particularly consulting and other "'creative' industries where large amounts of information must be analyzed, based on knowledge, experience and insight, and formed into (knowledge) strategies, also succeed in great part on their effectiveness in developing and applying new knowledge.

The successful evolution of the post-graduate student is based in great part on the ability to move successfully from the management of information to the management of knowledge and ultimately to the creation of new knowledge. We have shown that students understand that through learning and experience, and the effective use of technology, they develop the ability to brain filter and so make the jump from PIM to PKM. Brain filtering, a term used by students in this study, is how they make sense of what information is useful and relevant. As they progress in their studies, the students are exposed to new learning environments in which their personal knowledge grows through their increasing use of brain filtering. This was reflected in the illustrative case study where a PKM system was generated from the use of a technology program that supported TT's PIM for his PhD. Brain filtering skills improve as they continually search for literature and become more efficient and effective in their PIM skills. Technology can be used to support the improvement of brain filtering skills as identified in the case study where a database was created to identify and summarize the articles that contributed to his PhD literature review. Brain filtering is a skill which they may not have acquired as undergraduates, but is essential to learn for successful post-graduate studies and successful careers as knowledge workers. Further research into PKM skill development would have benefits to both academia and the private sector. With respect to the field of knowledge management, in this study we see clearly see that technology plays a critical part in the access and management of information. As information provision is a significant part of organizational KM initiatives, this study would seem to support this aspect of KM. However, it is equally clear that post-graduate students' effective use of technology and information in creating new knowledge is predicated on their learning PKM and brain filtering skills, a process that takes 2-3 years of intensive effort. In addition, these students are receiving significant mentoring from their teachers and supervisors, which demonstrates that even individual learning takes place in a social context (Deci and Ryan, 2000).

This exploratory study contributes to the still nascent literature on personal knowledge management through increased understanding of the way students learn and their application of technology tools. As the study is based on a limited and localized data set, the findings are realistically only indicative and require larger empirical studies to confirm and add to them. However, we do believe the study's findings have potentially important implications for universities as well as the private sector in the development of genuine knowledge creators.

Note**: An earlier version of this paper appeared at AMCIS – American Conference of Information Systems**

References

Aaltonen, M. (2007) The third lens: Multi-ontology sense-making and strategic decision-making, Aldershot: Ashgate Publishing.

Atherton, J.S. (2005) *Learning and teaching:* Deep and surface learning, [Online], Available: http://www.learningandteaching.info/learning/deepsurf.htm [15 May 2009].

Avery, S., Brooks, R., Brown, J., Doresey, P. and O'Conner, M. (2003) Personal knowledge management: Framework for integration and partnerships, [Online], Available: www.millikin.edu/pkm/pkm_ascue.html [23 July 2008].

Barkley, E.F., Cross, K.P. and Major, C.H. (2005) Collaborative learning techniques: A handbook for College Faculty, 1st edition, San Francisco: Jossey-Bass Publishers.

Barreau, D.K. (1995) 'Context as a factor in personal information management systems', Journal of the American Society for Information Science, vol. 46, no. 5, pp. 327-339.

Ben-Ari, M. (2001) 'Constructivism in computer science education', Journal of Computers in Mathematics and Science Teaching, vol. 20, no. 1, pp. 45-73.

Benitez, E. & Pauleen, D. (2009) 'Brain filtering: The missing link between PKM and PIM?', *AMCIS 2009 Proceedings*, Paper 13, [Online], Available: http://aisel.aisnet.org/amcis2009/13 [28 August 2010].

Bergman, O., Beyth-Marom, R. and Nachmias, R. (2008) 'The user-subjective approach to personal information management systems design: Evidence and implementations', Journal of the American Society for Information Science and Technology, vol. 59, no. 2, pp. 235-256.

Cheong, R. and Tsui, E. (2011) 'Exploring the linkages between personal knowledge management and organizational learning', in Pauleen, D. and Gorman, G. (eds.) Personal knowledge management: Individual, organisational and social perspectives, Oxford: Gower.

Clemente, B.E. and Pollara, V.J. (2005) 'Mapping the course, marking the trail', IT Professional, vol. 7, no. 6, pp. 10-15.

Cross, K.P. (2005) What do we know about students' learning and how do we know it?, Paper CSHE-7-05), Center for Studies in Higher Education, Berkeley.

Davenport, T.H. and Prusak, L. (1998) Working knowledge: How organizations manage what they know, Boston: Harvard Business School Press.

Deci, E.L. and Ryan, R.M. (2000) 'The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior', Psychological Inquiry, vol. 11, pp. 227-268.

Dorner, D. and Gorman, G. (2006) 'Information literacy education in Asian developing countries: Cultural factors affecting curriculum development and programme delivery', IFLA Journal, vol. 32, no. 4, pp. 281-93, [Online], Available: http://ifl.sagepub.com/cgi/reprint/32/4/281 [3 November 2009].

Fischer, B.A. and Zigmond, M.J. (1998) 'Survival skills for graduate school and beyond', New Directions for Higher Education, vol. 101, pp. 29-40.

Frand, J. and Hixon, C. (1999) Personal knowledge management: Who, what, why, when, where, how?, [Online], Available: http://www.anderson.ucla.edu/faculty/jason.frand/researcher/speeches/PKM.htm [23 June 2008].

Glassick, C.E., Huber, M.T. and Maeroff, G.I. (1997) Scholarship assessed: Evaluation of the professoriate, San Francisco: Jossey-Bass Publishers.

Gorman, G. and Pauleen, D. (2011) 'The nature and value of Personal Knowledge Management', in Pauleen, D. and Gorman, G. (eds.), Personal knowledge management: Individual, organisational and social perspectives, Oxford: Gower.

Hayes, R.L. and Oppenheim, R. (1997) 'Constructivism: Reality is what you make it', in Sexton, T. and Griffin, B.L. (eds.) Constructivist thinking in counselling practice, research, and training, New York: Teachers College Press, pp. 157-173.

Jefferson, T.L. (2006) 'Taking it personally: Personal knowledge management', VINE: The Journal of Information and Knowledge Management Systems, vol. 36, no. 1, pp. 35-37.

Jones, W. (2007) Keeping found things found: The study and practice of personal information management, San Francisco: Morgan Kaufmann.

Jones, W. and Teevan, J. (2007) Personal information management, Seattle: University of Washington Press.

Kanuka, H. and Anderson, T. (1998) 'Online social interchange, discord, and knowledge construction', Journal of Distance Education, vol. 75, no. 1, pp. 57-74.

Martin, J. (2000) 'Personal knowledge management', in Martin, J. and Wright, K. (eds.) Managing knowledge: Case studies in innovation, Edmonton: Faculty of Extension, University of Alberta, [Online], Available: www.spottedcowpress.ca/KnowlegeManagement/pdfs/06MartinJ.pdf [23 June 2008].

Mezirow, J. (1996) 'Contemporary paradigms of learning', Adult Education Quarterly, vol. 44, no. 3, pp. 158-173.

Miller, R. (2005) 'The evolution of knowledge: This time it's personal', Econtent, vol. 28, no. 11, pp. 38-42.

Murphy, P. and Pauleen, D. (2007) 'Managing paradox in a world of global knowledge', Management Decision, vol. 45, no. 6, pp. 1008-1022.

Pauleen, D. (2009) 'Personal knowledge management: Putting the person back into the knowledge equation', Online Information Review, vol. 33, no. 2, pp. 221-224.

Ramsden, P. (2003) Learning and teaching in higher education, 2nd edition, London: RoutledgeFalmer.

Rowley, J. (2000) 'Is higher education ready for knowledge management?', The International Journal of Educational Management, vol. 14, no. 7, pp. 325-333.

Skyttner, L. (1998) 'Brain cybernetics – Models and theories', Kybernetes, vol. 27, no. 8, pp. 882-899.

Stuart, E. B. (1979) A manual for preparation of theses and dissertations for the school of engineering, 4th edition, Pittsburgh, PA: The University of Pittsburgh.

Taylor, K., Marienau, C. and Fiddler, M. (2000) Developing adult learners: Strategies for teachers and trainers, 1st edition, San Francisco: Jossey-Bass.

Tsui, E. (2005) 'The role of IT in KM: Where are we now and where are we heading?', Journal of Knowledge Management, vol. 9, no. 1, pp. 3-6.

Weick, K. (1995) Sensemaking in organizations, Thousand Oaks: Sage Publications.

Wickersham, L.E. and McGee, P. (2008) 'Perceptions of satisfaction and deeper learning in an online course', The Quarterly Review of Distance Education, vol. 9, no. 1, pp. 73-83.

Wilson, T. (2000) 'Human information behavior', Informing Science, vol. 3, no. 2, pp. 49-55.

Zuber-Skerritt, O. (2005) 'A model of values and actions for personal knowledge management', The Journal of Workplace Learning, Vol. 17, no.1/2, pp. 49-64.