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Title	An investigation of innovation and knowledge creation in virtual worlds
Authors	O'Riordan, Niamh
Publication date	2011-11
Original Citation	O Riordan, N. 2011. An investigation of innovation and knowledge creation in virtual worlds. PhD Thesis, University College Cork.
Type of publication	Doctoral thesis
Link to publisher's version	http://library.ucc.ie/record=b2029843~S0
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Download date	2026-11-07 10:08:27
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BUSINESS INFORMATION SYSTEMS

An investigation of innovation and knowledge creation in virtual worlds

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BA, HDip (Comp. Sci.), MBS

A Thesis Submitted for the Degree of Doctor of Philosophy in the National University of Ireland, Cork

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November, 2011

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The author hereby declares that, except where duly acknowledged, this thesis is entirely her own work and has not been submitted for any degree in the National University of Ireland, or any other University.

Acknowledgements

Alfred North Whitehead observed that "no one who achieves success does so without the help of others". So on this sunny, happy day, I would like to raise a metaphoric glass in heartfelt thanks to the following people:

- To the staff at BIS, UCC for your support and encouragement and to Professor Ciaran Murphy for the opportunity to undertake this research
- To my long suffering supervisors, Frédéric Adam and Phillip O'Reilly, who patiently and expertly guided me through every step
- To my many mentors, whose insight helped to light the way: Professor Ciaran Murphy, Dr. Patrick Finnegan, Dr. Joseph Feller, Dr. Brian O'Flaherty, Dr. Tom O'Kane and Dr. Tom Butler
- To my fellow researchers – splendid company on a long, dark road: Dave, Neil, Patrick, Peter, Zhengnan; Paidí and Run; Chloe; Mike, Rob, Sheila and Yvonne; Aonghus, Cathal and Ronan; Carolanne and Denis; Anita, Ciara, Csaba, Fergal, Mary and Simon
- To my dear friends, whose enduring support and stubborn faith kept me going: Margarite, Siobhán, Emma, Odharnait, Pilar, Caroline, Ulrich, Cindy, Ferdinand, Francis, Paul, Gillian and Malachy
- To my fleet of (struggling) proof readers who bravely battled my meandering and opaque writing style in pursuit of clarity: Anita, Caitriona, Cindy, Conor, Dave, Emma, Ian, Johanna, Kathryn, Kevin, Lucy, Nicola-Marie, Noel, Malachy, Odharnait, Patrick, Paul, Pilar, Siobhan and Yvonne
- To my friends at the Wholy Grain who plied me with coffee and croissants while I conjured many of the elements of this thesis and to the musicians of this great world who created all those beautiful sounds that kept me company while I worked

It is to my parents, Noel and Mary, that I owe my greatest debt of gratitude. I could never have completed this thesis without your support and encouragement. It is to you, and to my brothers Ian and Leslie, that I dedicate this work.

You rock!

Reality: one of the few words which mean nothing without quotes

- *Vladimir Nabokov*

Virtual reality! Virtual reality! Aren't all realities virtual?

- *Source unknown*

Trav'ling in the world of my creation...

In a world of pure imagination...

Anything you want to, do it

Want to change the world, there's nothing to it

- *Anthony Newley and Leslie Bricusse*

Everything you can imagine is real

- *Pablo Picasso*

Show without showing / What you know without knowing

- *Massive Attack*

An investment in knowledge always pays the best interest

- *Benjamin Franklin*

Abstract

The Internet and World Wide Web have had, and continue to have, an incredible impact on our civilization. These technologies have radically influenced the way that society is organised and the manner in which people around the world communicate and interact. The structure and function of individual, social, organisational, economic and political life begin to resemble the digital network architectures upon which they are increasingly reliant. It is increasingly difficult to imagine how our 'offline' world would look or function without the 'online' world; it is becoming less meaningful to distinguish between the 'actual' and the 'virtual'. Thus, the major architectural project of the twenty-first century is to "imagine, build, and enhance an interactive and ever changing cyberspace" (Lévy, 1997, p. 10). Virtual worlds are at the forefront of this evolving digital landscape. Virtual worlds have "critical implications for business, education, social sciences, and our society at large" (Messinger *et al.,* 2009, p. 204).

This study focuses on the possibilities of virtual worlds in terms of communication, collaboration, innovation and creativity. The concept of knowledge creation is at the core of this research. The study shows that scholars increasingly recognise that knowledge creation, as a socially enacted process, goes to the very heart of innovation. However, efforts to build upon these insights have struggled to escape the influence of the information processing paradigm of old and have failed to move beyond the persistent but problematic conceptualisation of knowledge creation in terms of tacit and explicit knowledge.

Based on these insights, the study leverages extant research to develop the conceptual apparatus necessary to carry out an investigation of innovation and knowledge creation in virtual worlds. The study derives and articulates a set of definitions (of virtual worlds, innovation, knowledge and knowledge creation) to guide research. The study also leverages a number of extant theories in order to develop a preliminary framework to model knowledge creation in virtual worlds. Using a combination of participant observation and six case studies of innovative

educational projects in Second Life, the study yields a range of insights into the process of knowledge creation in virtual worlds and into the factors that affect it.

The study's contributions to theory are expressed as a series of propositions and findings and are represented as a revised and empirically grounded theoretical framework of knowledge creation in virtual worlds. These findings highlight the importance of prior related knowledge and intrinsic motivation in terms of shaping and stimulating knowledge creation in virtual worlds. At the same time, they highlight the importance of meta-knowledge (knowledge about knowledge) in terms of guiding the knowledge creation process whilst revealing the diversity of behavioural approaches actually used to create knowledge in virtual worlds and. This theoretical framework is itself one of the chief contributions of the study and the analysis explores how it can be used to guide further research in virtual worlds and on knowledge creation. The study's contributions to practice are presented as actionable guide to simulate knowledge creation in virtual worlds. This guide utilises a theoretically based classification of four knowledge-creator archetypes (the sage, the lore master, the artisan, and the apprentice) and derives an actionable set of behavioural prescriptions for each archetype. The study concludes with a discussion of the study's implications in terms of future research.

1 PRESENTATION OF THE RESEARCH STUDY

1.1 Background of the study

In 1991, American Vice President Albert Gore wrote that the printing press "which so empowered Jefferson and his colleagues in their fight for democracy, seems to pale before the rise of electronic communications and innovations, from the telegraph to television, to the microprocessor and the emergence of a new computerised world - an information age" (p. 150). In particular, the impact of the Internet and the World Wide Web on our civilization has been 'incredible' (Dorogovtsev and Mendes, 2003, p.2). Specifically, "the Internet has radically influenced the ways in which individuals around the world communicate, represent themselves, share ideas, and otherwise interact with one another" (Ward and Sonneborn, 2009, p. 211).

At a micro level, the Internet and World Wide Web influence *individuals* and *interpersonal interactions and relationships*. In terms of *individuals*, scholars have explored the impact of the Internet and the World Wide Web on (i) the nature of cognition (Logan, 2007; Fuchs, 2010); (ii) online identity (Turkle, 1997); (iii) social identity (McKenna and Bargh, 2000); (iv) personality (Rhee *et al.,* 2010); and (v) anonymity (McKenna and Bargh, 2000). These technologies have not only altered the ways in which we see ourselves and choose to represent ourselves, they are changing the way our minds work. At a fundamental level, the Internet can be seen as the latest step in the evolution of human language (from speech to writing, mathematics, science and computing) as we strive to record 'ideas' of increasing complexity (Logan, 2007, pp. 28-33). In terms of *interpersonal interactions and relationships*, scholars have explored the impact of the Internet and the World Wide Web on (i) social interaction (McKenna and Bargh, 2000); (ii) relationship formation (Brown, 2011; McKenna and Bargh, 2000); (iii) personal social networks (Haythornthwaite, 2005); and (iv) community involvement (cf. Rheingold, 2000; Bargh and McKenna, 2004). In effect, these technologies have altered the ways in which individuals communicate and interact with others and have enabled new forms of electronically mediated social networks that are qualitatively different from traditional, real world social

networks. At a micro level then, the Internet and related technologies are as much about the digitization (or virtualisation) for humanity (and its social networks) as they are about the digitisation of information and knowledge. In other words, the online world is as much about the creation of a global village (Gore, 1991) as it is about the construction of an information superhighway (Gore, 1991; Benjamin and Wigand, 1995).

At a macro level, the Internet and related technologies offer unprecedented opportunities in terms of the storage, retrieval and transfer of data and information. These technologies have influenced (i) *social and cultural life* (cf. Slevin, 2000); (ii) *civic engagement and political life* (cf. Chadwick, 2009; Kahn and Kellner, 2004; Jennings and Zeitner, 2003); and (iii) *organisational and economic life* (cf. Bargh and McKenna, 2004; Porter, 2001; Litan and Rivlin, 2001). In terms of *social and cultural life*, the emergence of real-time, digital communication networks (e.g. Twitter and Facebook) has changed the role and influence of traditional mass media (e.g. news and entertainment media). In terms of *civic engagement and political life*, the influence of these technologies is well illustrated in the centrality of social media in the 2011 Arab Spring. Taken together, these examples illustrate the manner in which real time communication networks now shape the way our planet is organised (Mattelart, 2000, p. xii). Finally, in terms of *organisational and economic life*, these technologies have led to the emergence of network-enabled organisational forms, business models and modes of value creation. In effect, the network is fast becoming the "nervous system of our society" (van Dijk, 2006, p. 2).

In addition, the Internet itself and related technologies continue to evolve. First, Internet access is no longer accomplished solely by means of personal computers and web browsers: one can access the Internet using a burgeoning collection of mobile devices (Church *et al.,* 2007). This means that the Internet has become "as pervasive and ubiquitous as electricity" (Manasian, 2003, p. 4) and computing and communication services are available anytime and anywhere (Park *et al.,* 2009). Second, advances in machine-to-machine communication, 3D content, and

community networks are expected to facilitate the emergence of new modes of interaction and co-operation (Zahariadis *et al.,* 2008). Thus, the topology of online social networks is also evolving (Kumar *et al.,* 2010). These observations help to explain why it is argued that the Internet (and its related technologies) "will change almost every aspect of our lives—private, social, cultural, economic and political" (Manasian, 2003, p. 4).

These observations serve to illustrate some of the ways in which the structures and functions of individual, social, organisational, economic and political life are coming to resemble the digital network architectures upon which it is increasingly reliant. Thus, we are said to be living in the age of the network society (van Dijk, 2006; Castells, 2010). In fact, it is increasingly difficult to imagine how our 'offline' world would look or could function without the 'online' world; and it is becoming less meaningful to distinguish between the 'actual' and the 'virtual'.

It is for these reasons that "the major architectural project for the twenty-first century" is "to imagine, build, and enhance an interactive and ever changing cyberspace" (Lévy, 1997, p. 10). However, where cyberspace was once simply a metaphor for computer-mediated communication – a "notional environment" ('Cyberspace,' Oxford Concise English dictionary) – it is now possible to literally immerse oneself in online environments such as virtual worlds. Thus, virtual worlds "offer a window into the future of the Internet" (Messinger *et al.,* 2009, p.204) and signify the cyberspace we will inhabit in the future (Noveck, 2004). This study is therefore focused on, and carried out within, a virtual world.

1.2 Introducing virtual worlds

The term "virtual world" is commonly used to describe a computer-simulated, persistent, spatial environment that supports synchronous communication among multiple users who are represented by avatars (Holmstrom and Jakobsson, 2001; Jung and Kang, 2010).

The analysis presented in Chapter Two reveals that non-game oriented virtual worlds represent a compelling research target for this study. Virtual worlds have captured the collective scholarly imagination: in particular, scholars have focused on exploring the potential of virtual worlds to affect:

(i) Communication and collaboration
(ii) Knowledge creation and processes of knowing
(iii) Creativity and innovation

Scholars investigating the impact of virtual worlds on *communication and collaboration* argue that virtual worlds extend the possibilities for (i) communication (Fetscherin *et al.,* 2008; Noveck, 2004, p. 4), (ii) interaction (Chaturvedi *et al.*, 2011; de Freitas and Veletsianos, 2010; Mueller *et al.,* 2010; Messinger *et al.,* 2009; Noveck, 2004, p. 4), and (iii) for collaboration and co-operation (de Freitas and Veletsianos, 2010; Giovacchini *et al.,* 2009; Fetscherin *et al.,* 2008; Kahai *et al.,* 2007). Scholars argue that virtual worlds offer new ways of connecting (Mueller *et al.,* 2010); are important tools for social networking, collaboration and business development (Mennecke *et al.,* 2008) and represent "a frontier in social computing with critical implications for business, education, social sciences and our society at large" (Messinger *et al.,* 2009, p. 204).

Scholars investigating the impact of virtual worlds on *knowledge creation* suggest that virtual worlds facilitate interactive knowing processes and "can be applied for dynamic, practice-based and experience-rich knowledge generation" (Mueller *et al.,* 2010, p.13). Virtual worlds present information in ways which have the ability to attract and retain a participant's attention and excite his/her imagination (Hooker *et al.,* 2009) and provide experiences that can help people to understand

concepts and learn new skills (Chittaro and Ranon, 2007). Further, the analysis presented in Chapter Two extends this view by specifically illustrating that certain facets of virtual worlds affect knowledge creation taking place within them.

Finally, scholars investigating the impact of virtual worlds on *creativity and innovation* suggest that virtual worlds represent new opportunities and scope for creativity (de Freitas and Veletsianos, 2010). At a fundamental level, virtual worlds are a "'blank slate' within which individuals and organisations can bring about novel, custom situations" (Berente *et al.,* 2011). Thus, virtual worlds afford a freedom to experiment that leads to "unprecedented rates of innovation" (Kohler *et al.,* 2011a, pp. 160-161; cf. Ondrejka, 2007, Giovacchini *et al.,* 2009). Thus, companies have started to explore how they might apply virtual worlds in open innovation processes whereby customers and companies can work jointly on new products (Giovacchini *et al.,* 2009).

Based upon the analysis presented in Chapter Two, Second Life® was chosen as a suitable research site in the context of this study. First, Second Life meets with the definition of non-game oriented virtual world presented in Chapter Two. That is to say, Second Life is an online, immersive, interactive environment that is based on community, content creation and commerce. Furthermore, Second Life has a number of unique features that were designed to stimulate user-driven innovation. These include Second Life's (i) marketplace, (ii) currency exchange service (the LindeX), and (iii) terms of service which grant users real-world intellectual property rights on their virtual creations (Ondrejka, 2004). Thus, Second Life is a particularly good choice for creative expression (Ward and Sonneborn, 2009). Finally, Second Life has become the *de facto* virtual world for commerce (Kim *et al.*, 2008) and as a result, Second Life is of particular interest in the IS field. Thus, a review of extant research reveals that most virtual worlds studies in the IS field have focused on Second Life.

1.3 Innovation and knowledge creation in virtual worlds

Chapter Three explores some of the most promising directions being pursued in extant virtual world research. More specifically, Chapter Three reviews extant research in the fields of innovation and knowledge management. The analysis suggests that despite appearances, these fields have much in common.

The analysis reveals, for example, that scholars investigating *innovation* have traditionally under-emphasized the role of knowledge in innovation. However, innovative organisations are increasingly conceptualised as those that are intelligent and creative (Glynn, 1996; Woodman *et al.,* 1993); and are capable of learning effectively (Senge, 1990; Argyris and Schön, 1978) or creating new knowledge (Nonaka, 1994; Nonaka and Takeuchi, 1995; Lam, 2006, p. 123). Thus, the analysis suggests, a knowledge-based view of innovation has developed.

At the same time, *knowledge management* has undergone a paradigm shift from a static, knowledge-warehouse approach to a dynamic, communication-based or network approach (Kuhlen, 2004). It is increasingly recognised that knowledge creation is one of the main sources of the competitive advantage of the firm (Almeida *et al.,* 2002; Leonard-Barton, 1990; Nonaka, 1991; Spender, 1996; Teece, 1998; Von Krogh, 1998; Zollo and Winter, 2002; Jakubik, 2008; Martin-de-Castro *et al.,* 2008). Further, the analysis suggests that knowledge management scholars increasingly recognise that the capability to create and apply new knowledge is essential for, and central to, innovation (Leonard-Barton and Sensiper, 1998; Popadiuk and Choo, 2006). For these reasons, knowledge management researchers have tried to displace the input-output or information processing metaphor of old with a new knowledge creation orientation (e.g. Nonaka, 1994; Malhotra, 2000, pp. 2-20).

Based on this analysis, Chapter Three advocates the adoption of a knowledge-based perspective for the investigation of innovation in virtual worlds. In particular, the analysis suggests that this can be accomplished by focusing specifically on knowledge creation. The analysis reveals that existing research on

knowledge creation has relied on distinguishing between tacit and explicit knowledge but suggests that this approach is problematic for a number of philosophical and methodological reasons. Therefore the chapter makes a case for distinguishing between declarative and procedural knowledge creation.

1.4 Operationalising the research

Based on the analysis presented in Chapters Two and Three, the study's research objective is "*to investigate knowledge creation in innovative virtual world projects"*. A preliminary framework of knowledge creation in virtual worlds was constructed using extant research in order to the guide the study. This framework consists of five main elements (three constructs and two associations) and it is used to structure the presentation of the study's findings in Chapter Five. Therefore, each element is introduced in turn.

The first construct in the preliminary framework is *knowledge creation intentions*. The inclusion of the construct in the framework reflects the conventional view that our actions are fundamentally guided by our intentions. It also reflects the study's conceptualisation of knowledge as something that is used by individuals and groups in a purposeful and instrumental fashion. In particular, the framework suggests that knowledge creation intentions consist of both intrinsic motivation to create knowledge and knowledge creation capacity (stemming from prior related knowledge).

The second construct in the preliminary framework is *knowledge-creating behaviours*. The inclusion of the construct in the framework reflects the study's conceptualisation of knowledge as something that is fundamentally grounded in action. In particular, its inclusion is guided by extant research investigating the role of exploitative and exploratory behaviours in knowledge creation outcomes.

The third construct in the preliminary framework is *knowledge creation outcomes*. The inclusion of the construct in the framework is motivated by the need to be able to evaluate the efficacy of knowledge-creating behaviours in virtual worlds.

The preliminary framework differs from traditional views of knowledge creation by distinguishing between declarative ("know what") and procedural ("know how") knowledge creation outcomes (instead of between tacit and explicit knowledge). This is based upon an analysis and critique of extant conceptualisation of knowledge creation presented in Section 3.6.

The study was carried out using a combination of participant observation and six case studies of innovative educational projects in Second Life. The study's results are presented in Chapter Five as a series of propositions and findings and are synthesized into a revised and empirically supported framework of knowledge creation in virtual worlds.

1.5 Structure of the chapters

The purpose of this section is to provide an overview of how the thesis is structured. The discussion presented herein is structured according to Table 1.1 which examines the primary purpose, key arguments, and outcomes of each chapter in the thesis.

TABLE 1.1 MAPPING THE STRUCTURE AND ARGUMENT OF THE THESIS

Ch	PURPOSE	→ KEY ARGUMENTS →	OUTCOME
2	Articulate a research agenda for this study	✦ There are many types of virtual worlds so it is important to clearly define and classify virtual worlds ✦ It is appropriate to distinguish between game-oriented and non-game-oriented virtual worlds ✦ Existing virtual worlds research looks at the (i) business aspects, (ii) educational aspects, and (iii) social & technical aspects of virtual worlds ✦ These research streams have a common focus on the impact of virtual worlds on communication and collaboration; innovation and creativity; knowledge & processes of knowing	✦ Future research should concentrate on the key areas of research identified in this review
3	Further articulate a research agenda for this study by focusing on research in (i) innovation and (ii) knowledge management	**1. Innovation** ✦ Existing conceptualisations of innovation are problematic. Innovation is as much about the reconfiguration and reapplication of ideas as it is about the generation of 'new' ideas ✦ The traditional distinction between invention and innovation has distracted researchers from the creation of ideas – which is central to the phenomenon of innovation ✦ Scholars have begun to recognise the importance of idea generation in innovation and innovation diffusion scholars in particular have begun to highlight the role of communication and social networks in the social construction of ideas and innovations ✦ Existing innovation research spans eight decades but can be usefully classified any synthesized according to whether it adopts an antecedent-based or process-oriented approach **2. Knowledge management** ✦ Knowledge is increasingly recognised as a key organisational resource and driver of competitive advantage ✦ Philosophical perspectives on knowledge focus on knowledge as (i) justified belief or (ii) that which is experientially based ✦ In the KM field, these perspectives manifest in terms of how knowledge is defined but the dominance of the information-processing view and the data-information-knowledge hierarchy has led to a focus on the storage, retrieval and transfer of knowledge instead of on the creation of knowledge ✦ Scholars have begun to recognise the importance of knowledge for innovation and have specifically recognised the role of knowledge creation in innovation ✦ Existing research on knowledge creation is primarily focused on the distinction between tacit and explicit knowledge ✦ But it may be useful to distinguish between declarative and procedural knowledge. ✦ In particular, this classification can be used to identify four knowledge creator archetypes	✦ Scholars in both fields of research recognise the role of knowledge in innovation. ✦ Conceptualisations of knowledge have changed over time. ✦ By focusing on knowledge creation in particular and by distinguishing between declarative and procedural knowledge creation, it is possible to develop an integrated approach to the investigation of innovation and knowledge in virtual worlds
4	Identify and describe a suitable research objective and approach for the study	✦ The research objective for this study is to *investigate knowledge creation in innovative virtual worlds projects* ✦ A preliminary framework of knowledge creation in virtual worlds is appropriate in terms of carrying out research in a novel setting and in terms of supporting theory building. ✦ This framework should consider knowledge creation (i) intentions, (ii) behaviours, and (iii) outcomes ✦ Research paradigms considered: ✓ ***Pragmatist*** Positivist Interpretivist (✓ = chosen paradigm) ✦ Research modes considered: ✓ ***Qualitative*** Quantitative (✓ = chosen mode) ✦ Research methods considered: ✓ ***Case study*** Ethnography Field study (✓ = chosen method) ✦ Primary data collection options: ✓ ***Observation*** ✓ ***Interview*** (✓ = chosen data collection) ✦ Data analysis options considered: ✓ ***Miles & Huberman approach*** Grounded theory approaches (✓ = chosen data analysis approach)	Provides: ✦ A description of the research protocol carried out during the study. ✦ A description of techniques used to ensure the findings' trustworthiness
5	Present the study's findings (using the preliminary framework as a guide)	✦ Individuals and groups using virtual worlds should consider their knowledge creation strategies in terms of their immediate and future knowledge creation needs ✦ Meta-knowledge (meta-declarative and meta-procedural) knowledge is an important facilitator of knowledge creation ▪ Metaphors are a kind of meta-declarative knowledge that can be used as a template to guide action; meta-declarative knowledge is often created with reference to prior related knowledge ▪ Meta-procedural knowledge is important for knowledge creation but inexperienced virtual world users in particular find it difficult to draw on meta-procedural knowledge ✦ Over time, knowledge creators become less focused on declarative knowledge creation and more focused on procedural knowledge creation ✦ Knowledge creation capacity stemming from prior related knowledge plays an important role in shaping the (i) attitudes, (ii) expectations, and (iii) behaviours of study participants. However, individuals and groups can struggle to recognise and leverage their knowledge creation capacity ✦ Having an intrinsic interest in virtual worlds is important for knowledge creation. Intrinsic motivation to create knowledge in Second Life is largely driven by (i) the hedonic consumption of virtual worlds by study participants; (ii) the pursuit of technical challenge and (iii) social contagion (within teams)	Provides: ✦ A clear statement of the study's findings articulated in terms of the preliminary framework of knowledge creation that was used to guide the study
6	Articulate the study's contribution to research and practice	✦ This study operationalises an effective approach to guide future research on knowledge creation based on the empirically supported (but underutilised) distinction between declarative and procedural knowledge. ✦ This study's contributions to theory are articulated at a high level and are then enumerated and explained by means of a revised and empirically grounded theoretical framework of knowledge creation in virtual worlds ✦ This study's contributions to practice are presented in the form of a practical guide to stimulate knowledge creation in virtual worlds. This guide leverages a theoretically based classification of knowledge creator archetypes	Provides: ✦ A revised and empirically grounded theoretical framework of knowledge creation in virtual worlds ✦ An actionable presentation of the implications of the study's findings for practice (based on 4 knowledge creator archetypes)

The aim of Chapter Two is to provide an introduction to virtual worlds and to leverage extant literature in order to articulate an appropriate research agenda for this study. This chapter provides an account of the emergence and evolution of virtual worlds. The chapter indicates that whilst virtual worlds have their origins in virtual reality technology, online gaming and virtual communities, virtual worlds are also seen as a nascent Internet phenomenon; a novel kind of online platform; a technological innovation. The analysis also shows that as a result of conceptual imprecision in the field; virtual world research remains fragmentary in nature. Therefore, the chapter derives a new definition of virtual worlds from extant literature and argues in favour of classifying virtual worlds according to usage rather than according to technical differences across platforms. Finally, the chapter provides a thematically structured review of extant virtual world research in an effort to articulate a suitable research approach for this study. This review indicates that virtual world research remains in its infancy but that scholars are primarily focused on exploring aspects of virtual worlds that relate to innovation, knowledge, and communication. The chapter concludes by indicating that the development of a suitable research approach for the investigation of virtual worlds may be found by considering these phenomena.

The aim of Chapter Three is to articulate a research objective for this study based on a review of literature. The analysis of literature presented in Chapter Two takes virtual worlds as a starting point and shows that existing virtual world researchers are fundamentally interested in seeking to understand the nature of communication and collaboration; innovation; and knowledge creation in virtual worlds. The analysis presented in Chapter Three therefore investigates extant research in the areas of innovation and knowledge management. The chapter argues in favour of pursuing an integrated approach for the investigation of innovation and knowledge. Beyond this, the analysis indicates that an integrated investigation of innovation and knowledge can be undertaken by means of focusing specifically on knowledge creation. Consequently, the chapter argues in favour of investigating knowledge creation in virtual worlds. In particular, the analysis indicates that extant conceptualisations of the knowledge creation process

are problematic and therefore advocates the development of our understanding of knowledge creation.

Chapter Four consists of six sections. The first section is based upon the analysis presented in Chapters Two and Three and identifies a research objective for the study: *to investigate knowledge creation in innovative virtual world projects*. The second section of the chapter is concerned with deriving a preliminary theoretical framework of knowledge creation from extant literature. The purpose of this framework is to guide the empirical element of the study. The framework focuses on knowledge creation intentions, knowledge-creating behaviours and knowledge creation outcomes. The fourth section of the chapter presents and defends the research design employed in carrying out the study. The fifth section of the chapter describes the study's research protocol in detail. Finally, the sixth section of the chapter discusses the tactics used to ensure the trustworthiness of the study's findings.

Chapter Five is structured according to the preliminary framework presented in Chapter Four. The chapter first explores each construct in turn and then investigates the propositions set forth in the preliminary framework. As each section is presented, a series of more nuanced propositions are presented. This analysis reveals that knowledge creation intentions are especially important for knowledge creation. Knowledge creation capacity stemming from prior related knowledge is shown to shape knowledge creation outcomes. Intrinsic motivation to create knowledge is especially important in Second Life because of the difficulties associated with creating knowledge in a virtual world. The analysis shows that participants in the study grappled with similar issues but that the behavioural approaches adopted across the cases were markedly diverse. Nevertheless, the analysis succeeds in identifying the key issues facing team members at different stages of the projects and identifies two distinct behavioural patterns across the cases. Finally, the analysis reveals the importance of meta-knowledge in terms of facilitating knowledge creation in virtual worlds. In particular, the analysis suggests that meta-declarative knowledge is important in

terms of guiding knowledge creation and that meta-procedural knowledge is important in terms of simplifying the process of knowledge creation.

Chapter Six presents the conclusions of the study and its contribution to theory and to practice. The chapter presents a high level analysis of the study's contributions to research on virtual worlds and on knowledge creation. In addition, the chapter explores the study's contributions to theory at a more granular level by means of articulating and discussing a revised and empirically based theoretical framework of knowledge creation in virtual worlds. At the same time, to articulate the study's contributions to practice by leveraging a theoretically based typology of knowledge creator archetypes (the sage, the lore master, the artisan, and the apprentice) in order to develop an actionable presentation of the study's findings and implications for practice. This guide constitutes an analytical tool that can be used to stimulate knowledge creation in virtual worlds. Finally, the chapter also explores the limitations of the study and identifies a number of distinct directions for further research.

2 INTRODUCING VIRTUAL WORLDS

2.1 Introduction

Virtual worlds are online, immersive, interactive environments (O Riordan *et al.,* 2009; O Riordan and O'Reilly, 2011) with "critical implications for business, education, social sciences, and our society at large" (Messinger *et al.,* 2009, p. 204). The growing importance of virtual worlds can be illustrated by considering the following:

- There are hundreds of publically accessible virtual worlds in existence (Mennecke *et al.,* 2008). De Freitas and Veletsianos (2010) estimate that over 180 virtual worlds are either available or are under development.
- Whilst it is difficult to accurately measure how many people use virtual worlds, scholars (e.g. Jackson and Favier, 2008; Castronova, 2007, pp. 33-34; Noveck, 2004) suggest a figure in the region of nineteen to twenty million people.
- Virtual world users spend significant amounts of time and money in virtual worlds. In Second Life alone, users spent a total of 435,000,000 hours inworld in 2010[1]. At the same time, CNET predicts that the international market for virtual goods will reach US$5.5 billion in 2012[2].
- The importance of virtual worlds looks set to increase. As broadband Internet access expands, virtual worlds and three-dimensional avatars are becoming more pervasive and widely adopted (Tampieri *et al.,* 2009). In fact, analysts have predicted that by 2020, virtual worlds will be as widespread as the World Wide Web is now (Wyld, 2010). Indeed, recent developments in the creation of web-based and tablet interfaces for virtual worlds support Wyld's (2010) argument that virtual worlds can augment or even replace the web browser as the way we interface with the Internet.

These observations, together with the breath, scope, transparency and accessibility of virtual worlds have driven multidisciplinary interest in virtual worlds (Fetscherin *et al.,* 2008; Mennecke *et al.,* 2008).

[1] http://community.secondlife.com/t5/Featured-News/The-Second-Life-Economy-in-Q4-2010/bc-p/674619 Accessed 17 March 2011
[2] http://news.cnet.com/8301-13846_3-10440920-62.html Accessed 17 March 2011

Fundamentally, virtual worlds "mirror, model and extend the myriad interactions available in the physical world" (Wasko et al, 2011). As this chapter argues, virtual worlds therefore extend the possibilities for:

(i) Communication and interaction (de Freitas and Veletsianos, 2010; Mueller *et al.,* 2010; Messinger *et al.,* 2009; Noveck, 2004, p. 4; Fetscherin *et al.,* 2008)

(ii) Co-operation and collaboration (de Freitas and Veletsianos, 2010; Giovacchini *et al.,* 2009; Fetscherin *et al.,* 2008; Kahai *et al.,* 2007)

(iii) Innovation and creativity (Kohler *et al.,* 2011a and 2011b; de Freitas and Veletsianos, 2010; Giovacchini *et al.,* 2009; Ondrejka, 2007).

Thus, virtual worlds are seen to represent a compelling research target in the context of this study. The structure and main thread of the arguments presented in this chapter are summarised in Table 2.1. Specifically, the table summarises the main purpose and outcome of the argument and also pinpoints the (i) major thread, (ii) key arguments, and (iii) primary contributions of the chapter.

TABLE 2.1 MAPPING THE THREAD AND ARGUMENT OF CHAPTER TWO

PURPOSE:	Articulate a research agenda for this study		
OUTCOME:	Future research should focus on the key areas of research identified in this review		
SECTIONS:	*MAJOR THREAD:*	*KEY ARGUMENT(S):*	*CONTRIBUTION:*
2.2 Virtual worlds: origins, classifications and definitions	✦ Virtual worlds first began to emerge in the late 1970s and it is important to recognise that virtual worlds (i) have been created using a wide variety of technologies and (ii) have been used for a wide variety of purposes	✦ It is important to clearly define and classify virtual worlds ✦ It is appropriate to distinguish virtual worlds according to usage differences ✦ Non-game-oriented virtual worlds are an appropriate target for this study	✦ Characterises virtual worlds as online, immersive, interactive environments
2.3 Establishing a research agenda for investigating virtual worlds	✦ Existing virtual worlds research looks at the (i) business aspects, (ii) educational aspects , and (iii) social & technical aspects of virtual worlds ✦ These four research streams have a common focus on the impact of virtual worlds on communication and collaboration; innovation and creativity; knowledge & processes of knowing	✦ There is a substantial level of academic interest in virtual worlds. However, existing research is fragmented and there is a dearth of empirical virtual world studies ✦It is important to identify common areas of interest in extant virtual world research and focus on these areas	✦ A systematic review of extant peer-reviewed virtual worlds research to date

2.2 Virtual worlds: origins, classifications and definitions

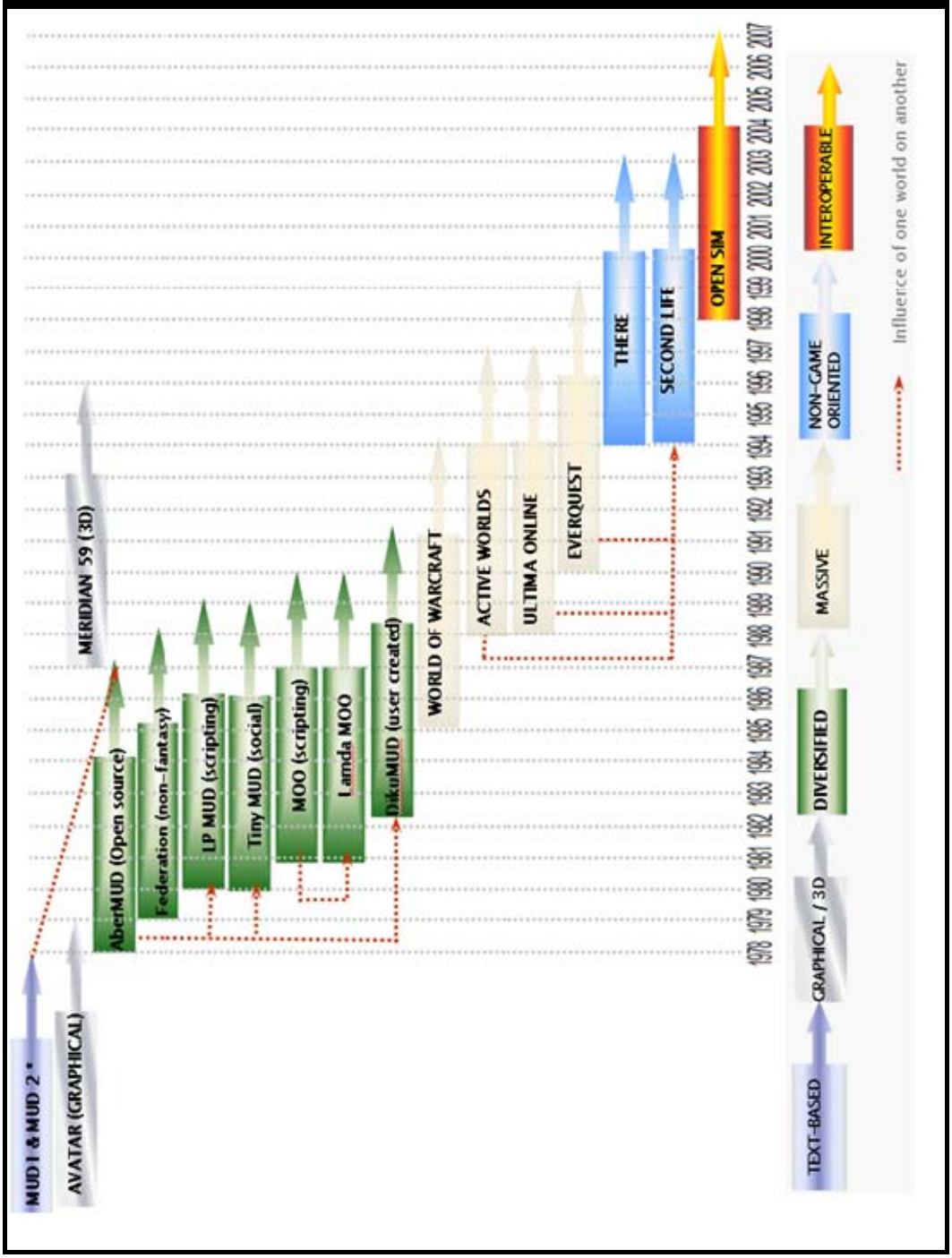
The purpose of this section is to establish a strong conceptual understanding of virtual worlds upon which to identify and articulate this study's research objective. Numerous definitions and classifications of virtual worlds have been proposed in order to help individuals and organisations evaluate virtual worlds in terms of their own needs (Messinger *et al.,* 2009). However, existing conceptualisations of virtual worlds are imprecise (Boellstorff, 2008, p. 17). Further, many of these definitions fail to provide insight into the processes or effects of using these systems or to provide a conceptual framework from which to make regulatory decisions (Steuer, 1992). Part of the problem relates to the diverse origins and complex evolution of virtual worlds (Warburton, 2009; Boellstorff, 2008, p. 17). In addition, there are now literally hundreds of virtual worlds in existence (De Freitas and Veletsianos, 2010; Mennecke *et al.,* 2008). These virtual worlds are diverse in nature and are used for a plurality of purposes (Grimes, 2009, p. 80). This section therefore begins by examining the origins of virtual worlds (Section 2.2.1) and then extends a definition (Section 2.2.3) and classification (Section 2.2.2) of virtual worlds from extant literature.

2.2.1 The origins of virtual worlds

Virtual worlds are the "end product of a long tradition of interactive representational environments" (Lastowka and Hunter 2004, p. 29). Therefore, this section presents an analysis of the diverse and complex origins of virtual worlds as a first step in conceptualising virtual worlds for this study. To that end, Figure 2.1 presents a chronologically-structured summary of some of the key virtual worlds to emerge between 1978 and 2011. Each of the worlds identified in the figure demonstrates an original and unique feature that sets it apart from other worlds. For example, TinyMUD is seen as the first purely social virtual world. At the same time, Figure 2.1 captures some of the ways that particular virtual worlds influenced the designs of subsequent virtual worlds. For example, the table shows that AberMUD had a formative influence on at least three other virtual worlds listed in the table. In this way, the figure illustrates the *genealogical complexities of virtual world histories*. Finally, the figure loosely classifies (rather than

formally classified) each virtual world into one of six 'families' to facilitate the discussion which accompanies the figure. The analysis presented herein extends the work of Bartle (2004) and Messinger *et al.*, 2009)

Figure 2.1 The Origins and Evolution of Virtual Worlds



Text-based virtual worlds

Virtual worlds can be traced back to, 1978, when Roy Trubshaw released MUD1 - the first multiplayer or shared game (Bartle, 2004). Virtual worlds were initially referred to as **MUDs**, which stands for multi-user dungeon (cf. Curtis, 1992; Reid, 1999). These virtual worlds (MUDs) were typically defined as text-based, networked, virtual environments (Schiano, 1999) or as shared, persistent, navigable text-based virtual environments (Curtis, 1992). These worlds were usually represented to users as a series of richly described rooms that could be spatially navigated (Schiano, 1999; Krikorian *et al.,* 2000); and they enabled real time (public or private) communication (Schiano, 1999). However, the only fixed representation of a user was a name, which persisted from session to session (Cagnina and Poian, 2007). These virtual worlds were multi-player games that combined role-playing with social chat rooms (Curtis, 1992). Curtis (1992) explains that in text-based virtual worlds, user-created characters and scriptable objects could interact with each other in rich and compelling ways.

Graphical and 3D virtual worlds

Graphical virtual worlds are rendered from a variety of perspectives including:

- first person view (the environment is viewed from the perspective of what the player's character 'sees')
- third person view (the environment is viewed from the perspective of what the player's character 'sees' but the character is visible to the player)
- a "roaming camera" (the user is free to determine the point from which an environment is viewed)

Most early virtual worlds were text-based but the first graphical virtual worlds actually began to emerge in the 1960s. Nevertheless, the first fully fledged graphical world ('Avatar') was not released until 1979 and it was 1996 when the first three dimensional virtual world ("Meridian 59") was released. Since then, virtual worlds have become more graphically sophisticated over time (Sivan *et al.,* 2008) and continue to incorporate media of increasing richness.

Diversified virtual worlds

Over time, the emphasis on role-playing in virtual worlds began to diminish. Gradually, a diverse range of virtual worlds emerged that allowed users to pursue various interests within them. This discussion distinguishes between social and content creation virtual worlds (including scripted virtual worlds). *Social virtual worlds* facilitated user interaction. TinyMUD (1989), for example, is regarded as the first influential social virtual world. TinyMUD also allowed users to 'extend' the environment. This means that users were able to modify the environment and to introduce new objects into it. *Content creation virtual worlds* were developed for users with a more explicit interest in shaping virtual environments (Au, 2008, p. 6). In particular, scripted virtual worlds gave users the ability to control the virtual world's functionality. For example, LPMUD (1989) incorporated a scripting language which users could use to control inworld functionality. In 1990, MOO was released. MOO combined elements of social virtual worlds (such as TinyMUD) with elements of scripted virtual worlds (such as LPMUD).

Massive virtual worlds

In 1997, Ultima Online was released. Ultima Online became the first truly massive virtual world (Bartle, 2004, pp. 20-23). For the first time, thousands of players could share a single virtual world. Massive virtual worlds have been described as **MMORPG** (Massively Multiplayer Online Role Playing Game) ever since. Ultima Online was also one of the first 'classless' games. That is to say, in Ultima Online, players were not forced to assign their characters to particular 'classes' (e.g. warrior, healer, and druid).

Non-game-oriented virtual worlds

A new class of virtual world emerged in 2003. Like previous content creation virtual worlds, these environments facilitated and encouraged user-created content (Ondrejka, 2004). Like previous virtual worlds, these environments also emphasised the social aspects of participation in virtual worlds (Messinger *et al.,* 2009). However, these environments represented a new departure in the sense that they represented a stronger commercial orientation than had hitherto been found

in virtual worlds. For this reason, Sivan *et al.,* (2008) refer to these virtual worlds as "3D3C" virtual worlds where "3D" refers to the fact that these worlds are three dimensional and "3C" refers to the fact that these worlds are primarily concerned with "community, (content) creation and commerce".

'There' and "Second Life" are the best known examples of this generation of virtual worlds. Both 'There' and "Second Life" incorporate real world monetary systems and novel IP policies. The infrastructure in Second Life in particular was purposely designed to facilitate the development of a virtual economy, incorporating a Linden Dollar currency system and supporting the ability to set objects as "for sale" or as "replicable on demand" (Jennings *et al.,* 2007). It was the steadily increasing volume of virtual goods and services sold in Second Life specifically that drove mainstream media coverage of virtual worlds and prompted the entry of a number of real world businesses into virtual worlds in 2006 (Jennings *et al.,* 2007).

The next step: interoperable virtual worlds

At present, most of the well-established virtual worlds are proprietary and closed in nature. This means, for example, that virtual world users cannot easily export their avatars, their contact lists or their (own) virtual goods from one virtual world into another. It also means, for example, that virtual world users cannot export their contact lists from one virtual world into another. This has been recognised as a barrier preventing the adoption of virtual worlds for corporate users in particular and as a barrier preventing the development of a 3D Internet in general (Mennecke *et al.,* 2008). Thus, concerted efforts are underway to develop interoperable virtual worlds, which would allow for the "seamless flow of goods and people (avatars) across virtual worlds" (Kametsu, 2007, p. 122). For example, Linden Labs and IBM successfully demonstrated virtual world interoperability for Second Life in 2008 by teleporting avatars between the Second Life Preview Grid and an OpenSim virtual world server[3]. Open Simulator (commonly known as

[3] http://www-03.ibm.com/press/us/en/pressrelease/24589.wss Accessed 24th January 2011

"OpenSim") is the most well known virtual world platform that offers a degree of virtual world interoperability. OpenSim allows individuals and organisations to use their own servers to create their own virtual worlds and to connect their virtual worlds to other virtual worlds (Childers, 2009). This concept is analogous to the idea of hyper linking for the World Wide Web and is therefore referred to as 'hypergridding' (Childers, 2009).

In summary, the analysis presented in this section illustrates the complex evolution of virtual worlds thus far. As such, the analysis reveals the diverse range of virtual worlds that exist today and therefore underscores the need to develop a clear conceptualisation of virtual worlds to guide this study. To that end, Section 2.2.2 presents an analysis of existing classifications of virtual worlds.

2.2.2 Classifying virtual worlds: technical and usage-based differences

As Section 2.2.1 illustrates, contemporary virtual worlds are diverse in nature and have evolved in a complex manner. Lastowka and Hunter (2004) argue that as each virtual world is different, "categorical statements about virtual worlds [are] suspect" (p. 28). This section analyses existing (technical and usage-based) virtual world classifications and argues in favour of distinguishing between game-oriented and non-game oriented virtual worlds. The section also presents a rationale in favour of investigating non-game oriented virtual worlds in this study.

Scholars classify virtual worlds using technical and usage-based classifications. *Technical classifications* of virtual worlds primarily reflect the evolution of virtual worlds over time. Thus, typical technical classifications distinguish between text-based virtual worlds, graphical virtual worlds, immersive virtual worlds and 3D virtual worlds. *Usage-based classifications* of virtual worlds are fundamentally based on the distinction between game-oriented and non-game-oriented virtual worlds.

There are a number of reasons in favour of a usage-based classification in the context of this study: usage-based classifications

(i) can adequately capture the diverse nature of virtual worlds,

(ii) are less likely to be made redundant by frequent changes in the technologies used to create virtual worlds (cf. Boellstorff, 2008, p. 17),

(iii) may allow for the emergence of richer insights into the processes or effects of using these systems (cf. Steuer, 1992).

In summary, this section has argued in favour of using a usage-based classification of virtual worlds in this study. The next section therefore focuses specifically on usage-based virtual world classifications.

2.2.2.1 Focusing on usage-based classifications: examining game orientation

This section focuses on usage-based classifications of virtual worlds. These classifications are fundamentally based on the game orientation of virtual worlds. The analysis suggests that non-game-oriented virtual worlds are an appropriate research target for this study.

The majority of virtual worlds are game-oriented (Jung and Kang, 2010). *Game-oriented virtual worlds* are typically referred to as MMOGs (Massively multiplayer online games) or as games. These virtual worlds typically have a pre-defined theme or plot which is used to structure and evaluate users' performances (Jung and Kang, 2010). Whilst game-oriented virtual worlds remain the dominant type of virtual world, there has been a dramatic increase in the number of *non-game-oriented virtual worlds* (Jung and Kang, 2010). Non-game-oriented virtual worlds are generally referred to as MUVEs (multi-user virtual environment). These worlds are often conceptualised with reference to game-oriented virtual worlds. So, for example, they are described as 'unstructured' or 'unscripted' (e.g. Mennecke *et al.*, 2008) or 'serious' (e.g. Bellotti *et al.*, 2010) virtual worlds. However, as the analysis in Section 2.2.1 suggests, there are many types of non-game-oriented virtual worlds. Therefore, it is more useful to view non-game-oriented virtual worlds in terms of what they *are,* instead of what they are not.

For this reason, Sivan *et al.*'s (2008) observation that non-game-oriented virtual worlds are primarily concerned with community, (content) creation and commerce is particularly helpful. Indeed, a review of extant literature reveals that a number of scholars have deliberately concentrated their research efforts on virtual worlds that are primarily oriented toward:

(i) *community* (e.g. Noveck, 2004; Hendaoui and Limayem, 2008; Jung and Kang, 2010; Merikivi, 2009; Mäntymäki and Merikivi, 2010),

(ii) *content creation* (e.g. Arakji and Land, 2007; Goel and Mousavidin, 2007; Ondrejka, 2004), and

(iii) *commerce* (e.g. Mueller *et al.,* 2010; Papagiannidis and Bourlakis, 2008; Cagnina and Poian, 2009; O Riordan *et al.,* 2009; Lui *et al.,* 2007).

This analysis illustrates the view that non-game-oriented virtual worlds are seen be particularly important for social interaction (Chesney *et al.,* 2009b; Mäntymäki and Merikivi, 2010) in general and for commercial interaction (Chesney *et al.,* 2009b) in particular. At the same time, it illustrates the fact that non-game-oriented virtual worlds that have attracted the majority of academic attention in the recent past. For these reasons, non-game-oriented virtual worlds are of primary concern in the context of this study.

In summary, this section has argued in favour of (i) classifying virtual worlds according to usage-based differences and (ii) focusing on non-game-oriented virtual worlds in the context of this study. The next section therefore presents a systematic review of extant literature carried out to ensure that virtual worlds are clearly defined for the purposes of this study.

2.2.3 Defining virtual worlds

As indicated at the outset of this chapter, existing conceptualisations of virtual worlds are imprecise (Warburton, 2009; Boellstorff, 2008, p. 17). This imprecision is well illustrated by examining the variety of terms that is used to describe virtual worlds. Virtual worlds are described in extant research as:

- metaverses (Ondrejka, 2004, 2006; Kemp, 2006; Papagiannidis and Bourlakis, 2008)
- synthetic worlds (Castronova, 2006, 2007; Shelton, 2010)
- mirror worlds (Gelertner, 1992)
- persistent worlds (Day, 2002)
- artificial worlds (Rheingold, 1992)
- digital worlds (Ondrejka, 2007)
- virtual or graphical environments (Yee, 2006; Hendrix, 1996).

Therefore, the purpose of this section is to deliver a means of effectively defining virtual worlds as a third and final step in conceptualising virtual worlds for the purposes of this study. The analysis suggests that three key themes permeate existing definitions of virtual worlds and that these themes can be used to define virtual worlds. The discussion concludes by defining (non-game-oriented) virtual worlds as o*nline, immersive, interactive environments that are based on community, content creation, and commerce* and presents the rationale in favour of the adoption of this definition in this study.

2.2.3.1 Virtual worlds are online environments

This section explores the view that virtual worlds are environments. This is the first of three key themes permeating existing definitions of virtual worlds.

Virtual worlds are defined as places (e.g. Curtis, 1992; Bartle, 2004; Boellstorff, 2008), spaces (e.g. Thomas and Seely Brown, 2009), and environments (e.g. Bartle, 2004; Mennecke *et al.,* 2007) that *simulate* real or imaginary environments (Hagsand, 1996). More specifically, virtual worlds are online environments that are simulated by computers (Jung and Kang, 2010; Castronova, 2007, p.223; Boellstorff, 2008; Holmstrom and Jakobsson, 2001) through the Internet

(Boellstorff, 2008, p. 17; Menneke *et al.,* 2007). For this reason, virtual worlds *persist* after their users log out (Holmstrom and Jakobsson, 2001; Jung and Kang, 2010; Hagsand, 1996).

Taken together, these definitions underscore the *spatial* nature of virtual worlds. Virtual worlds are 'inhabited' locations (Boellstorff, 2008, p. 17): "people go to places, do things there, and then they go home" (Bartle, 2004, p. 475). Fundamentally, it is this *navigable* (Hagsand, 1996) property of virtual worlds that distinguishes them from related phenomena such as virtual communities and online forums. (Text-based virtual worlds also rely on textual descriptions of imagined 'rooms' and are therefore considered navigable). Thus, whereas the Internet and online media in general can be seen to facilitate electronically mediated communication, virtual worlds are effectively shared, electronically engendered environments.

One important (but frequently overlooked) implication of this analysis is that *virtual worlds are not media per se*. A medium is "a channel [that is] open for communication with a (large) number of individuals" (Bartle, 2004, p. 475). Virtual worlds *contain* communication channels (Bartle, 2004, p. 475). For example, virtual worlds may contain (i) public and/or private, (i) synchronous and/or asynchronous, (ii) text-based and/or voice-based media. However, this does not mean that virtual worlds are communication channels (Bartle, 2004, p. 475). The danger is that scholars who view virtual worlds as media or as channels rather than as environments run the risk of over-simplifying the communicative affordances of virtual worlds. This observation may have important implications for virtual world researchers interested in exploring virtual worlds from the perspective of theories like the theory of media richness or the theory of media synchronicity.

2.2.3.2 Virtual worlds are interactive

This section explores the view that virtual worlds are interactive. This is the second of three key themes permeating existing definitions of virtual worlds.

Virtual worlds are shared (Hagsand, 1996), multi-user (Hagsand, 1996; Bartle, 2004), massively multiplayer (Mennecke, Roche *et al.,* 2007) or distributed (Hagsand, 1996) environments. Thus, virtual worlds offer users the ability to communicate and collaborate with others in a shared virtual space that is created by users (Eschenbrenner *et al.,* 2008).

More specifically, all communication and interactivity in virtual worlds is mediated by the avatar (Petrakou *et al.,* 2010). Scholars use the term 'avatar' to describe either (i) the "embodied persona" adopted by the user (e.g. Schultze, 2008) or (ii) the "virtual embodiments of persons" (e.g. Boellstorff, 2008, p. 128). Users' avatars can interact (i) with other avatars, (ii) with the environment and objects within it, and (iii) with 'bots' (robots) - avatars which are controlled by machines, rather than by humans[4]. The discussion considers each type of interaction in turn.

In the first instance, scholars are primarily focused on the nature of *interaction between avatars* in virtual worlds. This reflects substantial level of interest in what it means for the individual to be represented as, and interact through an avatar (cf. Suh *et al.,* 2011; Yee *et al.,* 2009; Adrian, 2008; Goh and Paradice, 2008; Blodgett *et al.,* 2007; Yee *et al.,* 2007; Bailenson, 2006). In particular, scholars are interested in how interaction between avatars leads to social presence, which is defined as "the degree of salience of another person in an interaction and the consequent salience of the interpersonal relationship" (Short, Williams *et al.,* 1976. p. 65).

Second, scholars are interested in the manner in which avatars interact with the environment (Hagsand, 1996; Bartle, 2004; Cagnina and Poian, 2007; Mennecke,

Roche *et al.,* 2007); building objects and embedding new functionalities. This functionality has enabled a new departure in user-generated content and has evolved to varying degrees in different virtual worlds.

Finally, users increasingly interact with 'bots' that have been built by other virtual world users. Bots, or robots, are avatars which are controlled by machines, rather than by humans. Virtual worlds support interactivity between virtual world users and bots (cf. Veletsianos *et al.,* 2010); including embodied AI (cf. Burden, 2009).

2.2.3.3 Virtual worlds are immersive

The purpose of this section is to explore the view that virtual worlds are immersive. This is the third of three key themes that permeate existing definitions of virtual worlds.

Scholars emphasise the immersive nature of virtual worlds (e.g. Childs, 2010; de Freitas *et al.,* 2010; Hew and Cheung, 2010; Schultze and Orlikowski, 2010; Davis *et al.,* 2009; Tampieri, 2009; Warburton, 2009; Kemp and Haycock, 2008; Savin Baden *et al.,* 2008; Carey, 2007). Immersion is defined as that sense of "being there" or, more formally, as "a psychological state in which the individual perceives himself or herself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli" (Blascovich *et al.,* 2002, p. 105). However, in asserting that virtual worlds are immersive, it is important to emphasise that immersion in a virtual world is a qualitatively different experience from immersion in virtual reality.

Immersion in virtual reality technologies is based on perceptual subterfuge or sensory realism leading to a "perceptually based illusion of non-mediation" within simulated environments (Lombard and Ditton, 1997, p. 0). Thus, the focus of virtual reality research has traditionally been the actual technology and in increasing its "immersive and involving properties" (Steuer, 1992, p. 33) by means of focusing on the mechanisms by which human beings interact with

[4] http://wiki.secondlife.com/wiki/Bot - Accessed 21 June 2011

computer simulations (Boellstorff, 2008, p. 5). For example, Brooks (1999) describes virtual reality in terms of "the visual (and aural and haptic) *displays* that *immerse* the user *in the virtual world* and that block out contradictory sensory impressions from the real world" (p. 16, italics added). In this light, virtual worlds are seen as the outcome or result of virtual reality technology usage.

Unlike virtual reality, the emphasis in virtual worlds is less on the technologies used to create a sense of immersion and more on the worlds themselves (Bartle, 2004; Boellstorff, 2008, p. 5) and the experiences that are created by virtual world technologies (Steuer, 1992, p. 33). That is to say, virtual worlds seek to "approximate aspects of reality – enough for the purposes of immersion" (Bartle, 2004, p. 475). Therefore, the technologies used to create virtual worlds are inexpensive and typically rely on desktop interfaces.

2.2.3.4 Synthesising a new definition of virtual worlds

The preceding analysis has indicated that three key themes permeate extant definitions of virtual worlds. Specifically, existing definitions of virtual worlds emphasise the fact that virtual worlds are online, immersive, interactive environments. In addition, the analysis presented in Section 2.2.2.3 supports the view of Sivan *et al.,* (2008), who suggest that non-game-oriented virtual worlds are primarily concerned with community, (content) creation and commerce. Therefore, non-game-oriented virtual worlds are defined in the context of this study as:

> *Online, immersive, interactive environments that are based on community, content creation, and commerce*

Game-oriented virtual worlds, which are not the primary focus of this study, may also be defined (according to the analysis presented in this section) as online, immersive, interactive, game-oriented environments.

There is much to recommend the adoption of these definitions of virtual worlds. The definitions are largely commensurate with extant conceptualisations of virtual worlds (reviewed above) and capture the salient characteristics of virtual worlds. At the same time, the definitions are broad enough to encompass a diverse range of non-game-oriented virtual worlds (irrespective of ongoing and often turbulent changes in the technical aspects of virtual worlds) but can still be used to effectively distinguish between non-game-oriented virtual worlds from related phenomena such as virtual communities. In addition, the definitions avoid any suggestion that virtual worlds are in some way "not real". This is considered to be an advantage because research has shown that what happens in virtual worlds is often just real to participants and that virtual worlds have increasingly real ramifications (Boellstorff, 2008, p. 21). Thus, it is more meaningful to distinguish between the virtual and the actual than to distinguish between the virtual and the real (Boellstorff, 2008, p. 21; cf. Levy, 1998).

In summary, Section 2.2 has established a clear understanding of virtual worlds. The analysis has traced the emergence and evolution of virtual worlds and explored a range of definitions and classifications of virtual worlds that permeate extant literature. Usage-based classifications of virtual worlds are seen to be comparatively more useful in this study than technologically based classification. The analysis has further argued in favour of investigating non-game-oriented virtual worlds in the context of this study. Non-game-oriented virtual worlds are hereafter referred to as virtual worlds. Finally, the analysis defined non-game-oriented virtual worlds for the purpose of this study. The next step in articulating a suitable research agenda for this study is to leverage this understanding in carrying out a systematic review of extant virtual world research.

2.3 Establishing a research agenda for the investigation of virtual worlds

An effective literature review uncovers areas where research is needed, creates a firm foundation for advancing knowledge, and also facilitates theory development (Webster and Watson, 2002, p. xiii). Therefore, the purpose of this section is to establish a research agenda for the investigation of (non-game-oriented) virtual worlds. An initial analysis (Section 2.3.1) illustrates a significant level of scholarly interest in virtual worlds and highlights the multi-disciplinary nature of extant virtual world research. This is followed by a more detailed analysis (Section 2.3.2) which uncovers three distinct avenues of research being pursued across these disciplines.

2.3.1 Virtual worlds research: an overview

This section presents an overview of extant virtual world research. The analysis reveals substantial levels of academic interest in virtual worlds. It shows that virtual world research is varied and multi-disciplinary. However, the analysis points to a dearth of empirical (Jung and Kang, 2010) and suggests that virtual world research remains "dangerously fragmented" (Goh and Paradice, 2008). In light of these observations, this analysis can help to guide future research.

The discussion presented herein is based upon Table 2.2. The table presents an inter-disciplinary overview of peer-reviewed virtual world research. The table incorporates papers published in A and B rated journals and conferences using the 2010 ERA rankings[5]. The table categorises existing research according to primary research focus. Four primary research foci are identified:

(i) introductory studies,
(ii) business-oriented studies,
(iii) studies focused on using virtual worlds for education, and
(iv) studies focused on social and technical aspects of using virtual worlds.

Within each domain, key research topics for research are distinguished. Individual studies are organised by date and then name.

TABLE 2.2 CLASSIFICATION OF EXTANT VIRTUAL WORLD RESEARCH		
FOCUS	**KEY TOPICS FOR RESEARCH**	**AUTHOR(S)**
INTERDISCIPLINARY	Introductory studies; focused on identifying suitable research directions and developing literature reviews to underpin further research	Bray and Konsynski (2007); Jakala (2007); Junglas and Steel (2007); Mennecke *et al.,* (2008); Schultze *et al.,* (2008); Meredith *et al.,* (2009); Schultze and Orlikowski (2010)
BUSINESS FOCUS	Commercial opportunities in virtual worlds	Hemp (2006); Bourlakis *et al.,* (2009) ; Driver and Jackson (2008); Hendaoui and Limayem (2008) ; Jackson and Favier (2008)
	Business models in virtual worlds	MacInnes (2006); Cagnina and Poian (2007) ; Kim, Lyons *et al.,* (2008); Noam (2007)
	Consumer behaviour and v-CRM	Lui *et al.,* (2007); Guo and Barnes (2007); Hendaoui and Limayem (2008); Bourlakis *et al.,* (2009); Guo and Barnes (2009a); Guo and Barnes (2009b); Hooker *et al.,* (2009); Lehdonvirta (2009); Shen and Eder (2009); Animesh *et al.,* (2011); Goel and Mousavidin (2007)
	Virtual team collaboration	Kahai *et al.,* (2007); Davis *et al.,* (2009); Cahalane *et al.,* (2010); Schouten *et al.,* (2010); Schultze (2010)
	Decision making	Suh *et al.,* (2011)
	Innovation	Arakji and Land (2007); Mackenzie *et al.,* (2009); O Riordan *et al.,* (2009); Kohler *et al.,* (2009); Kohler *et al.,* (2011a); Kohler *et al.,* (2011b)
	Knowledge management	Mueller *et al.,* (2010)
	Legal aspects	Novek and Balkin (2006); Duranske (2008); Roquilly (2011)
	Economic aspects	Castronova (2001;, 2006;, 2007)
EDUCATION FOCUS	Empirical reports of educational projects carried out in virtual worlds	Holmes (2007); Prasolova-Førland (2008); Ip *et al.,* (2008); Jarmon *et al.,* (2009); Oliver and Carr (2009); Twining (2009); Herold (2010); Merchant (2010); Petrakou *et al.,* (2010); Veletsianos *et al.,* (2010); Traphagan *et al.,* (2010)
	Design of pedagogical frameworks	De Freitas and Neumann (2009); Bellotti *et al.,* (2010); De Freitas *et al.,* (2010)
	Evaluation of educational designs employed in virtual world settings	Dickey (2005); Andreas *et al.,* (2010); Burgess *et al.,* (2010); Chen *et al.,* (2010); Cheong (2010); Girvan *et al.,* (2010); Ketelhut *et al.,* (2010); Salmon *et al.,* (2010); Traphagan *et al.,* (2010)
	Literature reviews of education in virtual worlds	Franceschi *et al.,* (2009); Warburton (2009); Childs (2010); Dalgarno and Lee (2010); Falloon (2010); Hew and Cheung (2010); Savin Baden *et al.,* (2010)
SOCIAL AND TECHNICAL ASPECTS	Acceptance and usage of virtual worlds	Chen *et al.,* (2008); Fuller *et al.,* (2007); Holsapple and Wu (2007); Barnes (2009); Saeed *et al.,* (2009); Verhagen *et al.,* (2009); Mäntymäki and Merikivi (2010); Spann *et al.,* (2010); Fui-Hoon Nah *et al.,* (2011); Goel *et al.,* (2011);
	Attitudinal beliefs about virtual worlds	Tampieri (2009); Merikivi (2009)
	Communication in virtual worlds	Schroeder (2002); Nayar (2004); Carey (2007); Moore *et al.,* (2007); Goh and Paradice (2008); Davis *et al.,* (2009)
	Other	Gender (Guadagno *et al.,* 2011); Griefing (Chesney *et al.,* 2007 i; Chesney *et al.,* 2009 ii); Human behaviour (Junglas *et al.,* 2007); Identity and trust (Blodgett *et al.,* 2007); Psychosocial wellbeing (Mennecke *et al.,* 2007); Racial prejudice (Gong, 2008); Sense making (Berente *et al.,* 2011); Trust and conflict (Campbell *et al.,* 2007); User goals (Jung Kang, 2010); Virtual communities (Cajvaneanu, 2007)

[5] cf. http://www.arc.gov.au/era/era_journal_list.htm Last accessed 23 May 2011

The first category of studies included in the table is described as *interdisciplinary*. These studies appear in a wide variety of research fields and are largely introductory in nature. The purpose of these studies is typically to present reviews of literature in specific fields in order to facilitate the identification of suitable directions for virtual world research in those fields. The fact that there are so many of these studies and the fact that these studies are being published on an ongoing basis supports the view that (non-game-oriented) virtual world research remains in its infancy (Kohler *et al.,* 2011a).

The second category of studies is primarily focused on the *business aspects* of virtual worlds. These studies are fundamentally focused on developing an understanding of (i) the commercial opportunities and constraints afforded by virtual worlds, and (ii) the potential impact of virtual worlds on organisations (especially on organisational innovation, knowledge management, decision making, communication, and collaboration). A closer inspection reveals that these studies are typically theoretical (and often speculative) rather than empirical in nature. The relative immaturity of research in this area in comparison to other areas of interest reflects the fact that the use of virtual worlds by real world businesses is a relatively recent development in terms of the history of virtual worlds (cf. Section 2.2.1).

The third category of studies is focused on the educational aspects of virtual worlds in *education*. Research on education is more mature than research on business in virtual worlds: education scholars draw on (and test) well established pedagogical theories about the use of virtual environments for education. Nevertheless, there remains a dearth of empirical studies in this area of virtual world scholarship. This problem is illustrated in a recent introduction to a British Journal of Educational Technology (BJET) special issue on virtual worlds in education where Salmon and Hawkridge (2009) acknowledge that most of the papers included in the special issue are "promotional or even speculative, writing about what might happen in SL (Second Life) rather than what happened" (p. 408).

The final category of studies in the table is focused on the *social and technical aspects* of virtual world usage. A closer inspection of this stream of research reveals that it is typically qualitative in nature and addresses a wider variety of topics than research in the other categories of the table. Further, the analysis suggests that scholars in this category are also fundamentally interested in communication and collaboration in virtual worlds. However, these scholars are also fundamentally interested in aspects of identity (including gender and racial issues; the self; representation; and culture) and human behaviour in virtual worlds.

In summary, the analysis presented in this section highlights the level of academic interest in virtual world research. At the same time, the analysis draws attention to the dearth of empirical research in support of the propositions found in the literature and underscores the fragmentary nature of extant virtual world research. There is therefore a need to probe extant research more deeply in order to discover the underlying features of virtual worlds that have caused such widespread interest in them.

2.3.2 Exploring the potential of virtual worlds

As illustrated in Section 2.3.1, virtual world research is varied, multi-disciplinary and fragmented. This section therefore presents a deeper analysis of extant literature that uncovers three of the key features of virtual worlds that have thus far captured the scholarly imagination. These features relate to the capacity of virtual worlds to affect:

(i) communication and collaboration.
(ii) creativity and innovation, and
(iii) knowledge creation.

This analysis informs the articulation of a suitable research agenda in the context of this study but can therefore also be used to guide future studies.

2.3.2.1 Virtual worlds affect communication and collaboration

Scholars have consistently conceptualised virtual worlds as new media. Scholars in this research stream are focused on the extent to which *virtual worlds can enable new forms of communication and collaboration* with unique spatial, temporal, sensory and social properties. Specifically, virtual worlds are described in literature as communications media (Moore *et al.,* 2007; Carey, 2007), social media (e.g. Messinger *et al.,* 2009) and immersive media (e.g. Carey, 2007).

Where attention is focused on virtual worlds as *communications media*, the emphasis is placed on communication modalities within virtual worlds. Here, the avatar is seen as a "digital manifestation of [the] individual within [the] virtual worlds (Goh and Paradice, 2008, p. 1) and it is argued that "as we interact with each other and with our own sense of self and personal identity using screens and images, the mediated face-to-face encounter is coming to extend and augment—and even to replace—the physical face-to-face encounter" (Cleland, 2008, p.4).

Communication in virtual worlds is complex and multimodal: avatars may communicate one-on-one or one-to-many with other avatars. More specifically, avatars can communicate using multiple, simultaneous personalised communication channels including both voice and text chat (Goh and Paradice,

2008). In addition, avatars can express themselves using nonverbal signs like body language and gestures (Carey, 2007). These non-verbal communication methods have significant impact on the quality of communications (Goh and Paradice, 2008; cf. Moore *et al.,* 2007; Carey, 2007) and suggest that virtual worlds have a number of unique characteristics that make them distinct from other media (Dalgarno and Lee, 2010).

Where attention is focused on virtual worlds as *immersive media*, scholars explore the immersive properties of virtual worlds. In particular scholars are interested in the extent to which users feel immersed or 'present' in the virtual world and in understanding the factors that affect immersion in virtual worlds. For example, researchers are interested in the effect of active participation and representational fidelity (the degree of realism of objects in a virtual world) on immersion in a virtual world (cf. Hedberg and Alexander, 1994; Whitelock *et al, 1994*).

Finally, where attention is focused on virtual worlds as *social media*, scholars explore the social aspects of virtual worlds use. For example, scholars have investigated social presence (Brna, 1999) or co-presence in virtual worlds. This refers to a sense of being there together with other geographically dispersed users (Dalgarno and Lee, 2010). In particular, scholars who view virtual worlds as social media are focused on interactivity between

(i) avatars,
(ii) avatars and objects, and
(iii) avatars and the environment

(Giovacchini, Kohler *et al.,* 2009). In particular, communications within a virtual world can be enhanced by the ability to shape the environment to add context (Goh and Paradice, 2008).

Despite this level of interest in the potential of virtual worlds for richer and more engaging communication and collaboration, their capabilities have yet to be examined in depth (Davis *et al.,* 2009, p. 90). Thus, research is needed to

investigate communication and collaboration issues arising from virtual world usage (Hendaoui *et al.,* 2006).

2.3.2.2 Virtual worlds affect creativity and innovation

A second stream of research on virtual worlds is focused on exploring the implications of virtual worlds for creativity and innovation (cf. Kohler *et al.,* 2011a, pp. 160-161; Giovacchini *et al.,* 2009; cf. Ondrejka, 2007). Researchers in this area are focused on how the experience of being in a virtual world differs from the experience of being in other environments and on these differences affect the innovation process (Kohler *et al.,* 2011a, 2011b). Though these is a dearth of studies addressing avatar-based innovation in virtual worlds (Kohler *et al.,* 2011a), a number of arguments can be made to suggest that virtual worlds can affect creativity and innovation. The discussion considers four arguments.

First, it can be argued that virtual world users are creative and innovative by definition. This argument is based on the view that until virtual worlds become widely diffused, those who use them are innovative by definition. In other words, they are early adopters of a technological innovation (cf. Rogers, 2003). It is also based on the view that user-created virtual worlds attract individuals who wish to be creative in those worlds.

Second, virtual worlds have the potential to alter the diffusion of information, knowledge and other innovations. Virtual worlds "alter the social structures in which their users are embedded and the manner in which they communicate, both of which are thought to influence the diffusion of technical innovations amongst individuals" (O Riordan *et al.,* 2009, p. 2). In particular, virtual worlds "facilitate the emergence of purposeful communities which support the (often real-world) activities of their members including the development and adoption of innovations" (O Riordan *et al.,* 2009, p. 2). For this reason, virtual worlds can be used as sites for open innovation (cf. Kohler *et al.,* 2011a; Kohler *et al.,* 2011b; Mackenzie *et al.,* 2009), where customers are involved in innovation as a source of ideas, technical solutions, designs and even prototypes (Kohler *et al.*, 2011b).

Third, content creation tools embedded in virtual worlds encourage users to interactively create anything they can imagine and to share that act of creation with other users (Kohler *et al.,* 2011a). In addition, virtual worlds provide an opportunity to ask traditional questions about creativity in a new context and introduce a range of new questions that can lead to new insights and understandings about creativity in general (Ward and Sonneborn, 2009). Therefore, virtual worlds such as Second Life can support the creative functioning of both individuals *and* groups (Ward and Sonneborn, 2009). In this regard, user-created virtual worlds resemble "engines of creation" that "provide the freedom to experiment", "unrestrained consumer freedom and empowerment", and can lead to "unprecedented rates of innovation" (Kohler *et al.,* 2011a, pp. 160-161; cf. Ondrejka, 2007, Giovacchini *et al.,* 2009).

Finally, though the concept of user-driven innovation is not new (cf. von Hippel, 2002), customers are increasingly seen as useful sources of creativity (Benkler, 2006). Lead users in particular are seen as an important source of ideas (Benkler, 2006). Indeed, the traditional role of the R&D department as an isolated but dynamic powerhouse of idea generation is giving way to innovative business practices that emphasise the intersection of the organisation with its environment. Emerging virtual worlds offer unprecedented opportunities for companies to collaborate with co-creating consumers (Kohler *et al.,* 2011b) and therefore "herald the next leap of evolution for open innovation" (Kohler *et al.,* 2011a, p. 160). Open innovation is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, 2006, p.1). Virtual worlds provide companies opportunities for valuable co-creation and co-production with their customers (Goel and Mousavidin, 2009). Specifically, innovation processes are enabled by collaboration in virtual worlds where companies are free to access customers' innovative potential and where users are empowered to experience and modify innovative products and product features long before they really exist (Mueller *et al.,* 2010). Thus, companies have started to explore how they might apply the interactive technology of virtual worlds for an open innovation process

where customers and manufacturers may jointly work on new products (Giovacchini *et al.,* 2009).

2.3.2.3 Virtual worlds affect knowledge creation

Computer-mediated communication, in general, can "increase the quality of knowledge creation" by "enabling a forum for constructing and sharing beliefs, for confirming consensual interpretation, and for allowing the expression of new ideas" (Alavi and Leidner, 2001, p. 118). Virtual worlds, in particular, overcome barriers in existing technologies and "offer new opportunities of knowledge as part of the action" (Mueller *et al.*, 2010, pp. 13-17). Because virtual worlds immerse users in shared, immersive, interactive space, they can be "applied for dynamic, practice-based and experience-rich knowledge generation far above the pure collection of knowledge in databases" (Mueller *et al.,* 2010, p 13). This section presents three arguments in favour of the assertion that *virtual worlds have the potential to impact knowledge creation* in extant virtual world research.

First, virtual worlds are a type of environment; they can alter the conditions within which knowledge creation takes place. In the cognitive sciences, the concept of situatedness has been used extensively (Lindblom and Ziemke 2003, p. 79). In this view, an agent's "behaviour and cognitive processes first and foremost are the outcome of a close coupling between agent and environment" (Lindblom and Ziemke 2003, p. 79). Further, it is known that dramatically altered information environments are known to be the locus of knowledge structure changes (Walsh, 1995). Virtual worlds alter the "ambient social and physical circumstances" within which knowledge creation takes place (cf. Seely Brown and Duguid, 1991, p. 47). In particular, the experience of navigating a user-generated virtual world or the experience of communicating and interacting by means of avatars are specifically unique to virtual worlds (Kohler *et al.,* 2011a).

Thus, Chittaro and Ranon (2007) argue that in many cases, interaction in a virtual environment can allow for a spontaneous knowledge acquisition that is typically associated with first-person experience. Specifically, Chittaro and Ranon (2007)

argue that virtual environments allow users to recreate the real world or to create entirely new worlds, thereby "providing experiences that can help people in understanding concepts as well as learning to perform specific tasks, where the task can be repeated as often as required and in a safe environment" (p.7). Virtual worlds therefore afford new opportunities for the delivery of perceptual experience, which is at the heart of cognitive mental processes.

Second, virtual worlds are a type of medium; they have the potential to influence knowledge creation. In fact, media richness is traditionally defined specifically as the "capacity to change mental representations" (Huber, 1991, p. 103). Virtual worlds present information in a way which mimics reality and has the ability to attract and retain a participant's attention and excite his/her imagination (Hooker *et al.,* 2009). Thus, virtual world users "can explore the context, acquire information and manipulate objects, practicing skills and constructing knowledge in a natural way" (Bellotti *et al.,* 2010, p. 87).

Third, virtual worlds contain social networks within them; they have the potential to alter personal social networks. These networks, in turn, influence information access and knowledge flows and thereby influence knowledge creation (Yang *et al.,* 2009). Virtual worlds exhibit affordances that effectively extend the field of interaction amongst individuals. Social software in general can "help students to build their own mental models and enrich knowledge resources" resulting "in the construction of new knowledge" (Ip *et al.,* 2008, p. 1). Virtual worlds in particular allow people to "implement their thinking into actual actions, which helps them to evaluate the success of their ideas, at minimum cost" (Ip *et al.,* 2008, p. 1). Research carried out by Schultze (2010) indicates that virtual worlds offer potential for team collaboration over more traditional text-based collaboration technologies. Schouten (2010) suggests that the shared environment and avatar-based interaction enabled by 3D virtual worlds "aid convergence processes in teams working on a decision making task, leading to increased shared understanding between team members" (p. 1). Thus, virtual worlds have the potential to allow individuals to arrive at new insights and interpretations and to

engage in new forms of dialogue and thereby improve the quality and frequency of knowledge creation. Therefore, it can be seen that virtual worlds, as social networks, have the potential to influence knowledge creation.

Against a backdrop of disillusionment with the traditional information processing paradigm, the assertion that virtual worlds have the potential to affect knowledge creation takes on an added significance. It is recognised that we live in a world of "more and more information and less and less meaning" (Baudrillard, 1995, p. 79). The information processing paradigm has resulted in the development of mechanistic and rigid organisational routines which are "incapable of keeping pace with dynamic knowledge-creation needs" (Malhotra, 2000, p. 121). Thus, scholarly attention has begun to move away from the pervasive information processing paradigm of the past and toward a focus on the *creation* (rather than the diffusion) of information, knowledge and innovation rather than their diffusion. Therefore, it would seem clear that research is needed to investigate knowledge creation in virtual worlds.

2.4 Conclusion

This chapter has introduced virtual worlds and has presented an analysis of extant virtual world research that can be used in order to develop an appropriate research agenda for an investigation of virtual worlds. The chapter highlights the "conceptual imprecision" (Boellstorff, 2008, p. 17) surrounding extant conceptualisations of virtual worlds. Based upon this analysis, the chapter contributes a new definition of (non-game-oriented) virtual worlds: virtual worlds are defined as online, immersive, interactive environments that are based on community, creation and commerce.

The analysis suggests that this ambiguity stems from virtual worlds' rich and varied histories. In addition, virtual worlds are now used for increasingly diverse purposes. Therefore, virtual worlds are increasingly classified according to usage differences. The analysis also reveals a marked increase in the number of published virtual world studies since the early 2000s. This increase reflects an increasing interest in virtual worlds in both research and in practice. In particular, interest is firmly focused on non-game-oriented virtual worlds, such as Second Life.

The chapter therefore reviews extant (non-game-oriented) virtual world research in order to identify some key areas for future research. In particular, the analysis reveals that virtual world research is fundamentally driven by the desire to understand the potential of virtual worlds to support communication and collaboration; and the attendant implications for knowledge and knowledge creation, for innovation and creativity. This is an area that is of fundamental interest in the IS field given that the very idea and true value of information systems lie in their potential to support human communication and collaboration (Ågerfalk, 2010, p. 252; Lyytinen, 1985, p. 61). These themes are used to focus the analysis presented in the next chapter, which focuses on extant research in the areas of innovation and knowledge management.

3 KNOWLEDGE CREATION IN VIRTUAL WORLDS

3.1 Introduction

As illustrated in Chapter Two, (non-game-oriented) virtual world research is fundamentally concerned with the nature of communication and collaboration in virtual worlds and the attendant implications for knowledge and knowledge creation; for innovation and creativity. Therefore, this chapter provides a review of extant research in the fields of innovation (Section 3.2 and Section 3.3) and knowledge management (Section 3.4). The analysis reveals that these fields have much in common. Specifically, the analysis suggests that scholars in each field increasingly recognise the role of knowledge in innovation. Furthermore, the analysis suggests the adoption of an integrated approach for the investigation of innovation and knowledge and demonstrates how this might be accomplished by means of focusing specifically on knowledge creation (Section 3.6). The structure and main thread of the arguments presented in this chapter are summarised in Table 3.1. Specifically, the figure summarises the main purpose and outcome of the argument and also pinpoints the (i) major thread, (ii) key arguments, and (iii) primary contributions of the chapter.

TABLE 3.1 MAPPING THE ARGUMENT DEVELOPED IN CHAPTER THREE	
PURPOSE:	Further articulate a research agenda for this study by focusing on research on (i) innovation and (ii) knowledge management
INNOVATION:	
SECTION 3.2 Defining and classifying innovation	✦Traditional views of innovation are based on the idea of innovation-as-newness or innovation-versus-invention ✦These views distract researchers from the creation of ideas – which is central to innovation ✦Innovation scholars increasingly recognise that knowledge is at the core of innovation
SECTION 3.3 Managing innovation	✦ Scholars are increasingly focused on - early stages of innovation (fuzzy front end) - generation of 'new' ideas - recombination /reapplication of existing ideas ✦ Scholars increasingly view innovation as a communicative process and highlight the role of social networks in the generation and development of ideas
KNOWLEDGE MANAGEMENT:	
SECTION 3.4 Knowledge through the ages	✦ Philosophical perspectives on knowledge focus on knowledge as (i) justified belief or (ii) that which is experientially based ✦ Knowledge is increasingly recognised as a key organisational resource and driver of competitive advantage
SECTION 3.5 Creating knowledge: getting to the core of innovation and knowledge	✦ The dominance of the information-processing view and the data-information-knowledge hierarchy have led to a focus on the storage, retrieval and transfer of knowledge instead of knowledge creation ✦ Scholars recognise the importance of knowledge for innovation and the role of knowledge creation in innovation ✦ Existing research on knowledge creation is primarily focused on the distinction between tacit and explicit knowledge ✦ But it may be useful to distinguish between declarative and procedural knowledge. In particular, this classification can be used to identify four knowledge creator archetypes
OUTCOME:	✦ Scholars in both fields of research recognise the role of knowledge in innovation ✦ Conceptualisations of knowledge and innovation have changed over time ✦ By focusing on knowledge creation in particular and by distinguishing between declarative and procedural knowledge creation, it is possible to develop an integrated approach to the investigation of innovation and knowledge in virtual worlds

3.2 Defining and classifying innovation

Innovation is a topic of enduring and increasing importance for organisations (Drucker, 1998): innovation capability is "the most important determinant of firm performance" (Crossan and Apaydin, 2010, p. 1154). Yet after years of research on the concept, considerable uncertainty surrounds both the meaning and operationalisation of the term (Garcia and Calantone, 2002). At the same time, scholars (e.g. Downs and Mohr, 1976; Kline and Rosenberg, 1986; Dewar and Dutton, 1986; King 1990; Damanpour, 1990; Rowley *et al.,* 2011) argue that the failure to effectively utilise innovation classifications is responsible for the instability of empirical findings in innovation research (Downs and Mohr, 1976). Therefore, this section presents an analysis of existing definitions and classifications of innovation. The analysis identifies and explores two key themes that permeate existing definitions and classifications of innovation: (i) innovation as newness (Section 3.2.1) and (ii) innovation versus invention (Section 3.2.2). In addition, the analysis reveals that at a definitional level, scholars in the innovation field increasingly define innovation in terms of knowledge (Section 3.2.3). Based upon these insights, innovation is defined for the purposes of this study (Section 3.2.4).

3.2.1 Defining and classifying innovation as newness

This section explores the (pervasive) theme of innovation-as-newness in existing definitions (Section 3.2.1.1) and classifications (Section 3.2.1.2) of innovation. The analysis problematises efforts to define innovation in terms of newness and shows that scholars are dissatisfied with classifications of innovation (e.g. incremental vs. radical innovation) based on the concept of 'newness'. Finally, the analysis reveals that scholars have attempted to address these problems by defining innovation in terms of creativity and value but suggests that these approaches are also problematic (Section 3.2.1.3).

3.2.1.1 Defining innovation in terms of newness

Innovation is often defined in terms of newness. For example, Schumpeter (1939) argues that innovation "combines factors in a new way" (pp. 87-88). Specifically,

innovation is often defined in terms of new ideas. Thus, Van de Ven (1986) suggests that "an innovation is a new idea" (p.591). Similarly, innovation is defined as a new idea (which may be a recombination of old ideas), a scheme that challenges the present order, a formula, or a unique approach that is perceived as new by the individuals involved (Zaltman *et al.,* 1973; Van de Ven *et al.,* 1986).

Nevertheless, conceptualisations of innovation in terms of newness are problematic. Rogers (2003) suggests that it "matters little, as far as human behaviour is concerned, whether or not an idea is "objectively" new as measured by the lapse of time since its first use or discovery" (p. 12). Fagerberg (2006) explains that defining innovation as "the first attempt to carry [an invention] out in practice" is problematic because there are instances of people conceiving of the same idea (for example, writing) independently (p. 4). Thus, many authors (e.g. Rogers, 2003, p. 12; Damanpour and Gopalakrishnan, 2001; Nelson and Rosenberg, 1993; Damanpour, 1990; Daft, 1982; Aiken and Hage, 1971) define innovation in terms of newness to a particular unit of adoption. Others (Zaltman *et al.,* 1973, p. 2; Rogers, 2003, p. 12) define innovation in terms of being *perceived* as new by a unit of adoption. These approaches are in turn problematic because there is little continuity within the literature in terms of whose perspective is being used to evaluate perceived newness (Garcia and Calantone, 2002).

3.2.1.2 Classifying innovation in terms of newness

In addition to *defining* innovation in terms of newness, scholars have also *classified* innovation in terms of newness (Massa and Testa, 2008). Here too, the conceptualisation of innovation in terms of newness is problematic. In this section, the analysis considers the distinction between incremental and radical innovation. This classification is based on the degree of newness of an innovation and is one of the central concepts in the existing literature (Mansfield, 1968; Moch and Morse, 1977; Henderson and Clark, 1990). The analysis reveals that there are a number of problems associated with using this classification in practice.

The distinction between incremental and radical innovation is based on delineating those ideas that refine and improve existing designs and those that introduce new concepts that depart in significant ways from past practice (Massa and Testa, 2008). *Incremental innovation* (also termed competence enhancing, continuous or routine innovation) introduces relatively minor changes to existing products and exploits the potential of established designs (Henderson and Clark, 1990; Tushman and Anderson, 1986). Thus, incremental innovation typically reinforces the dominance of established firms (Henderson and Clark, 1990; Tushman and Anderson, 1986). *Radical innovation* (also described as competence destroying, discontinuous or breakthrough innovation), on the other hand, is concerned with "foundational inventions that serve as the basis for many subsequent technological developments" (Ahuja and Lambert, 2001, p. 523). Radical innovations are therefore based on a different set of engineering and scientific principles and often open up whole new markets and potential applications (Henderson and Clark, 1990). Thus, radical innovations typically emerge from small, entrepreneurial firms (Abernathy and Utterback, 1978; Henderson and Clark, 1990; Tushman and Anderson, 1986; Rosenbloom and Christensen, 1994).

Scholars question the merit of distinguishing between incremental and radical innovation. Brown and Eisenhardt (1997) find that the classification discourages scholars from examining organisations who compete by changing continuously and by constantly reinventing themselves. Scholars also suggest that the two forms of innovation are fundamentally related. For example, Thirtle and Ruttan (2002) argue that the former contributes to the latter (p.2). Similarly, Da Silveira (2001) suggests that the technological change life cycle passes though different stages of radical and incremental development starting with a technological transformation (*substitution*), leading to incremental improvements and standardisation (*dominant design*), until further efforts bring diminishing returns, leading to a new transformation. Finally, Usher suggests that major inventions emerge "from the cumulative synthesis of relatively simple inventions, each of which requires an individual 'act of insight'" (Thirtle and Ruttan, 2002 p. 2).

In fact, scholars have made similar arguments in relation to the distinction between product and process innovation. (*Product innovation* is the introduction of new elements in an organisation's production or service operations whereas *process innovation* is the introduction of new elements into an organisation's production or service operations to produce a product or render a service (Damanpour and Evan, 1984, p. 394; Damanpour and Gopalakrishnan, 2001). Here, it is observed that there are important connections between each type of innovation (Van de Ven, 1999, p. 9) and that most innovations involve technical and administrative components (Leavitt, 1965; Van de Ven, 1999, p.9).

3.2.1.3 Innovation-as-creativity: a possible solution?

As a way of circumventing the problems associated with defining innovation in terms of newness, a number of authors (e.g. Sethi *et al.,* 2001; Amabile *et al.,* 1996; Dewar and Dutton, 1986) suggest that innovative ideas are 'creative' rather than novel. For example, Amabile *et al.,* (1996) define innovation as the "successful implementation of creative ideas within an organisation" (p. 25). The analysis presented in this section reveals that this strategy is also problematic.

Creativity is typically defined in innovation research in one of two ways. First, creativity is defined in terms of the development of novel ideas (e.g. Litchfield, 2008). This view of creativity is clearly of little use in avoiding the conceptualisation of innovation as newness. Creativity also is defined in terms of the development of ideas that are useful or influential (e.g. Paulus and Nijstad, 2003, p. 3). The remainder of this section is focused on this view.

There are two main problems associated with defining creativity in terms of usefulness. First, this view is only useful *after* the fact (Amabile *et al.,* 1996; Shalley and Gibson, 2004) and therefore does little to help with the structuring of efforts in advance (Litchfield, 2008; Ford and Gioia, 2000; Diehl and Stroebe, 1987; Mumford and Gustafson, 1988). Second, it must be possible to evaluate the usefulness or influence of ideas. However, the question of how to distinguish useful (or valuable) ideas remains problematic. It is recognised that creative ideas

can generate (economic) value both directly and indirectly (Yayavaram and Ahuja, 2008). Implicit in the view that creative ideas can create value indirectly is the belief that creative idea may come into being at a particular time and place but may create value at another time or place. Indeed, the research carried out by Van de Ven (1986) found that innovations can take *decades* to incubate and mature.

3.2.2 Defining innovation in terms of invention

The origins of the distinction between innovation and invention can be traced back to the arguments set forth by Schumpeter in the 1930s. This section explores this distinction and shows how it has led to an interest as innovation as a process. However, the analysis concludes by problematising the distinction on the basis that it has distracted researchers from an activity that is central to innovation: the creation of ideas.

Schumpeter's rationale for distinguishing between invention and innovation is that invention neither produces any economically relevant effects; nor does it necessarily induce innovation (Schumpeter cited in Thirtle and Ruttan, 2002, p.2). At the same time, innovation is possible without anything that should be identified as invention (Schumpeter cited in Thirtle and Ruttan, 2002, p.2). Based on this argumentation, the distinction between the creation of ideas and the implementation of ideas has traditionally been seen as both necessary and valuable (Ruttan, 1959).

In this view, innovation is defined in terms of how it relates to invention. Invention, in this view is seen as:

(i) "the creation of a new idea" (Van de Ven *et al.,* 1999, p. 9),

(ii) "the development of a new idea or an act of creation" (Ahuja and Lampert, 2001, p. 523), or

(iii) "the first occurrence of an idea for a new product or process" (Fagerberg, 2006, p. 4).

Innovation, on the other hand, is seen to be more encompassing than invention. More specifically, it is seen to include the process of developing and

implementing a new idea (Van de Ven *et al.,* 1999, p. 9). Thus, Mohr (1969) asserts that "invention implies bringing something new into being; innovation implies bringing something new into use" (p.112). In effect, scholars are distinguishing between the creation of ideas (invention) and the implementation of ideas (innovation).

As a result of this distinction, several definitions of innovation emphasise that innovation is a process rather than a product (King and Anderson, 1990, p. 82). For example, innovation is defined as:

(i) "a process involving both the generation and implementation of ideas" (Scott and Bruce, 1994, p. 606),

(ii) "the temporal sequence of activities that occur in developing and implementing new ideas" (Schroeder *et al.,* 1986, p. 1),

(iii) "the development and implementation of new ideas by people who over time engage in transactions with others within an institutional order" (Van de Ven, 1986, p. 590),

(iv) "all of the decisions, activities and their impacts that occur from recognition of a need or a problem, through research, development and commercialisation of an innovation, through diffusion and adoption of the innovation by users, to its consequences" (Rogers, 2003, pp. 136-137).

A common thread running through these definitions of innovation is a concern for the role of activities and behaviours and their impacts on the development of innovative ideas. Thus, whilst these definitions underline the central role of ideas in innovation, they have led to the development of a substantial body of research focused on the implementation of ideas as opposed to the creation of ideas.

Nevertheless, a number of scholars have suggested that the distinction is problematic. On the one hand, the distinction has distracted researchers from focusing on the actual creation of inventions (i.e. invention) (Rosenberg cited in Thirtle and Ruttan, 2002, p. 2). On the other hand, defining innovation in terms of invention obscures the fact that innovation is most often the result of borrowing or

imitation, rather than 'pure' invention (cf. March and Simon, 1958, p. 188). Further, it obscures the fact that both invention and innovation may involve the novel recombination or reformation of extant (and therefore, not in any sense *new*) componential knowledge. In this perspective, innovation is seen to represent a form of reinvention rather than invention. Thus, in the sociological literature, the term "reinvention" is often used to characterise improvements that occur to a product or service while it is spreading in a population of adopters (Fagerberg, 2006, p.22).

3.2.3 Defining innovation in terms of knowledge

As illustrated in Sections 3.2.1 and 3.2.2, innovation is commonly defined and classified in terms of invention and in terms of newness or creativity. However, there are a number of significant problems associated with conceptualising innovation in this manner – not least of which is the fact that it tends to distract researchers from a core element of innovation: the creation of ideas (Rosenberg cited in Thirtle and Ruttan, 2002, p. 2). The analysis presented in this section suggests that innovation is (i) increasingly defined in terms of innovation and (ii) a central element in extant theorisations about innovation.

In terms of defining innovation, Heffner and Sharif (2008) observe that most innovation initiatives define innovation in a manner that combines knowledge and ideas with entrepreneurship to generate new products, services, processes, capabilities or competencies in competitive markets and social contexts. So, for example, innovation is defined as:

(i) the use of new knowledge to offer a new product or service that customers want (Shea, 2005; Afuah, 2003, p. 13; Albers and Brewer, 2003)

(ii) the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services (Beesley and Cooper, 2008; Luecke and Katz, 2003, p. 2)

(iii) the process of turning knowledge and ideas into value (Dvir and Pashar, 2004).

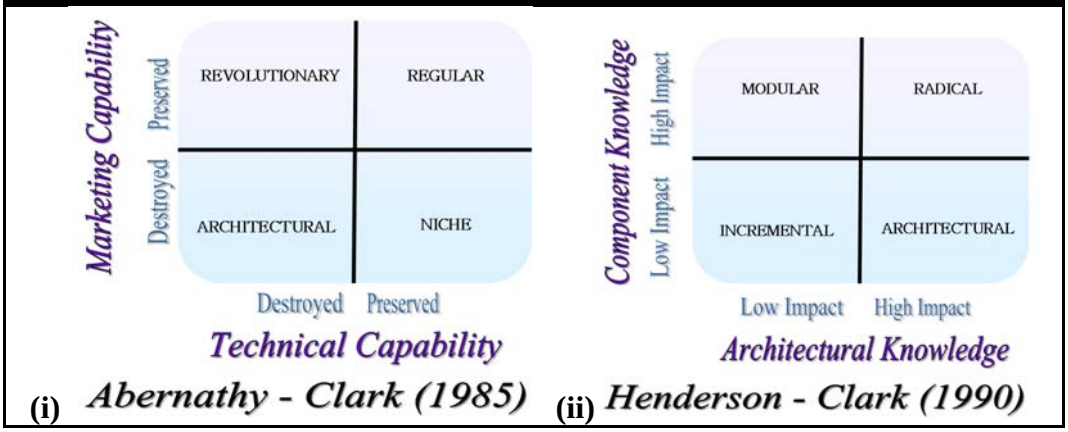
Furthermore, a closer inspection of the literature reveals that knowledge (conceptualised as a form of capability or skill) is a central element of extant theorising about innovation. The pervasive use of the terms "competence enhancing" and "competence destroying", for example, provides an indication of the extent to which knowledge (as skill) is central to extant conceptualisations of innovation. The remainder of this section underscores this observation by showing how incremental and radical innovations are explicitly dichotomised using a knowledge based perspective.

Using a knowledge-based perspective, it is possible to distinguish between incremental and radical innovation in terms of (organisational) capability. From this perspective, one is concerned with the question of "how new the new knowledge and the new product" are (Afuah, 2003, p. 14). In this view, *incremental innovations* reinforce the dominance of established firms (Henderson and Clark, 1990; Tushman and Anderson, 1986), whose innovative capabilities better suit the production of innovations along existing technological trajectories (Sørensen, 2000). Radical innovations, on the other hand, are competence destroying as they involve new core concepts or relations among core concepts and are likely to be more difficult for organisations (Tushman and Anderson, 1986; Afuah, 2003, p. 16).

To further illustrate the extent to which knowledge is at the core of extant theorising about innovation, Figure 3.1 illustrates two innovation classifications that extend the distinction between incremental and radical innovation along knowledge-based lines. The Abernathy-Clark model (1985) is an example of a more sophisticated version of the incremental/radical dichotomy. This model augments the incremental/radical dichotomy with a subdivision of firm capabilities into technical and marketing capabilities (Afuah, 2001, p. 17). The model suggests that each type of capability can be destroyed or preserved resulting in four different kinds of innovation: regular, niche, architectural, and revolutionary innovation. The Henderson Clark Model (1990) also extends the distinction between incremental and radical innovation. The model was developed

to explain why incumbents failed to implement incremental innovations. This model distinguishes innovations in terms of their impact on architectural and component knowledge. The model suggests that different combinations of component and architectural knowledge result in different kinds of innovation: incremental, modular, radical, and architectural innovation.

FIGURE 3.1 CLASSIFICATIONS OF INNOVATION BASED ON KNOWLEDGE



3.2.4 Defining innovation for the purposes of this study

The need to synthesise a new definition of innovation is suggested by the discussion presented above which highlights a number of issues associated with extant conceptualisations of innovation. The purpose of this section is therefore to bring together the themes that permeate extant literature on innovation in order to synthesise and present a definition of innovation for the purpose of this study.

The discussion has illustrated that innovation is commonly conceptualised in literature in terms of the creation and implementation of ideas (this is what distinguishes innovation from invention) and that these ideas are distinguished in terms of being novel and useful (or valuable). At the same time, and reflecting these key themes, innovations are commonly classified in terms of their newness (e.g. incremental versus radical innovation) or in terms of the output (e.g. product versus process innovation). More formally, innovation can be defined for the purposes of this study as:

The development and implementation of ideas that are perceived to be (i) novel and (ii) useful or valuable by those within a particular unit of adoption

This definition effectively integrates key themes permeating conceptualisations of innovation. The definition is, on the one hand, commensurate with existing definitions of innovation (as it is derived from them) and also allows for classifying innovation using existing schemes. At the same time, the definition circumvents a number of problems with existing definitions and classifications of innovation. First, the definition addresses the problems associated with defining innovation in terms of newness by focusing on perceived innovativeness relative to the unit of adoption. The definition avoids the ambiguity associated with defining innovation in terms of creativity by explicitly defining innovation in terms of novelty and usefulness (or value). Further, the definition resolves the challenge of attempting to distinguish between ideas that are valuable from those that are not (given that this value may be generated both directly and indirectly) by once again focusing on perceived usefulness or value. For these reasons, this definition is considered to be appropriate in the context of this study.

3.3 Managing innovation

The purpose of this section is to present an overview of this research that can be used to construct an understanding of innovation in virtual worlds. Research investigating innovation is a vast field that spans eight decades. Thus, the field of innovation is very broad (Damanpour, 1991). In fact, the field offers a variety of insights into the nature of innovation that are leveraged in this study. In accordance with Staw (1984) and King (1990), the analysis deconstructs existing research according to level of analysis. In particular, the section analyses research on (i) individual innovation (Section 3.3.1), (ii) group innovation (Section 3.3.2), (iii) organisational innovation (Section 3.3.3), and the diffusion of innovations (Section 3.3.4).

3.3.1 Individuals and innovation

The central role of the individual has long been recognised in innovation research: (Rothwell, 1994). This section reviews innovation research at the individual level; variable-oriented and process-oriented studies are considered in turn.

In terms of *variable-oriented innovation research,* Table 3.2 provides an overview of some of the main factors that have been investigated at the individual level. In accordance with King (1990), the table distinguishes between trait based and situational factors that are perceived to influence individual level innovation. Trait based factors are focused primarily on aspects of personality. Situational factors are focused primarily on the work setting and include both social and organisational factors.

TABLE 3.2 VARIABLE-ORIENTED INNOVATION RESEARCH (INDIVIDUAL LEVEL)		
FACTOR TYPE	**FACTOR**	**AUTHORS**
Traits of the individual	Intrinsic motivation	Amabile (1983); Amabile (1996); Amabile *et al.,* (1996); Deci and Ryan (1985); Deci and Ryan (2010)
	Ability and skills	Lovelace (1984); Amabile (1983)
	Cognitive differences	Mika (2007; cf. pp.188-190)
	Creative problem solving	Basadur *et al.,* (1982); Scott and Bruce (1994)
	Creative thinking	Wallas (1926)
	Goal orientation	Dweck and Leggett, (1988); Vandewalle (1997)
	Social independence	Kaplan (1963); Coopey (1987)
	Participative leadership style	Kanter *et al.,* (1983)
	Positive affect	Isen *et al.,* (1987); Isen (1996)
	Propensities	*Risk taking* (Michael, 1979; Abbey and Dickson, 1983; Glassman, 1986); *anxiety* (Wallach and Kogan, 1965; Nicholson and West, 1988); *tolerance for ambiguity* (Child, 1973)
Situational factors perceived to influence individual innovation	Role of change agent	Rogers (2003)
	Role of lead user	Von Hippel (1986); Urban and von Hippel (1998)
	Role of champion	Chakrabarti (1974); Howell and Boeis (2004);
	Role of ideator (prolific idea generators)	Rosenfeld and Servo (1990)
	Feedback and recognition	Glassman (1986)
	Autonomy	Thompson (1965); Hage and Aiken (1970); Kimberly and Evanisko (1981); Abrunhosa and Moura (2008)
	Job scope	Stone (1976)
	Discretion	Amabile (1984); Lovelace (1986);
	Hierarchical organisational structure	Jansen *et al.,* (2009)

In the first instance, the table reveals that many of the factors that are known to affect innovation at the individual level are knowledge-based factors. For example, both Amabile (1983, 1996) explicitly investigate ability and skill. Amabile (1983), in fact, explicitly argues that innovation at the individual level is affected by domain relevant *skills* and creativity relevant *skills* (as well as intrinsic task motivation). In addition, many other factors are based on an individual's (cognitive) *capability* to innovate. These observations indicate that research at this level of analysis acknowledges the role of knowledge in innovation. In the second instance, the table reveals that a number of studies suggest that creative performance is a function of both ability and motivation (cf. Amabile, 1983, 1996; Lovelace, 1984). These observations are used to inform the selection of variables

in constructing the preliminary framework. Finally, Table 3.2 illustrates the number of studies that highlight the role of (influential) other people in stimulating innovation at the individual level.

Whilst variable-oriented research is commonplace, *process-oriented models of innovation* are rare at this level of analysis (King, 1990). These models are typically normative, stage-based models of individual level innovation. For example, Wallas (1926) identifies four stages of creative thinking: preparation, incubation, illumination and verification. Usher (cited in Ruttan, 1959, pp. 601-602) identifies four stages of individual invention: perception of the problem; setting the stage; the act of insight; critical revision. Basadur *et al.,* (1982) propose a model of creative problem solving for work contexts with three stages (problem finding, problem solving and solution implementation) and suggest that each step involves ideation and evaluation steps. In addition, these models are highly cognitive in nature (King, 1990) and therefore emphasise the role of ideation in innovation. Specifically, the models conceptualise individual innovation as an exercise in problem solving (e.g. Usher cited in Ruttan, 1959, pp. 601-602; Basadur *et al.,* 1982) or in idea generating and creative thinking (e.g. Wallas, 1926; Amabile, 1983). One exception to this general rule is Amabile's (1983) process model which contains five tasks: task presentation, preparation, idea generation, idea validation and outcome assessment.

3.3.2 Groups and innovation

This section reviews innovation research at the group level; variable-oriented and process-oriented studies are considered in turn. The analysis demonstrates that innovation at the group level has traditionally been an under-researched phenomenon. However, it also highlights the fact that scholars increasingly recognise both (i) the significance of group level innovation in general and (ii) the importance of communication and collaboration within the group for innovation.

In terms of *variable-oriented innovation research* at the *group* level*,* Table 3.3 presents a summary of some of the main factors that impact upon innovation.

Whereas individual level research is focused primarily on the role of individual cognition in innovation, research at the group level is more focused on traits of groups that are likely to influence communication and collaboration within it (e.g. group dispersion, group cohesiveness, group composition, group longevity). This emphasis on communication and collaboration (leading to the creation of new ideas) is reflected in the manner in which group level innovation is defined. For example, Anderson (1989) defines group innovation as "the emergence, import, or imposition of new ideas which are pursued towards implementation by the group through inter-personal discussions and successive re-mouldings of the original proposal over time" (p. 4).

TABLE 3.3 VARIABLE-ORIENTED INNOVATION RESEARCH (GROUP LEVEL)

FACTOR	AUTHORS
Ability and skills	Lovelace (1984); Amabile (1983)
Climate for excellence	West (1990)
Group cohesiveness	Rogers, 1954; Nystrom, 1979; Keller, 1986; West & Wallace, 1991; Scott & Bruce, 1994
Group longevity	Lovelace, 1986; Nystrom, 1979)
Group composition	Torrance, 1972
Group structure	Meadows, 1980
Group dispersion	Gibson and Gibbs, 2006 (considers geographic and temporal dispersion)
Innovation orientation	Keller, 1986
Leadership style	Nystrom, 1979; Mumford *et al.,* 2002
Norms of innovation	West (1990)
Participative safety	West (1990)
Vision	West (1990)

King and Anderson (1990) observe that *process-oriented models of innovation* are "virtually non-existent" at the group level of analysis (p. 85). One exception is West (1990) who proposes four stages of group innovation: (i) Recognition (vision mapping is necessary during this stage to ensure innovation quality); (ii) Initiation (participative safety is necessary during this stage to ensure innovation quality); (iii) Implementation (norms are necessary during this stage to ensure innovation quantity); and (iv) Stabilization (a climate of excellence is necessary

during this stage to ensure innovation quantity). Amabile (1983) also suggests that her process model of innovation is applicable at the individual and group level.

This apparent gap in existing research is actually due to the profound influence of Osborn's (1957) brainstorming techniques on the field. According to Litchfield (2008), "virtually all brainstorming research conducted in the last thirty years confounds this intervention with the task of idea generation by providing Osborn's (1957) set of four rules to all idea generators" (p. 649). These techniques are: (i) generate as many ideas as possible, (ii) avoid criticizing any of the ideas, (iii) attempt to combine and improve on previously articulated ideas, and (iv) encourage the generation of 'wild' ideas. Inspired by Osborn's ideas, a range of idea generating techniques have been proposed by various scholars including the use of bug lists, stepladder techniques, synectics, nominal group techniques and electronic brainstorming (Forsyth, 2006, pp. 319-320). Like innovation research at the individual level, the primary focus of this stream of research is not developing an understanding of the process of group innovation *per se*. Instead, its focus is to develop an understanding of techniques that can be used to develop the capacity (a form of knowledge) for the creation of innovative ideas.

3.3.3 Organisations and innovation

Organisational innovation has been "consistently defined as the adoption of an idea or behavior that is new to the organisation" (Hage, 1999, p. 599). This section reviews innovation research at the organisational level. The analysis reveals that organisational innovation research is increasingly concerned with the impact of communication and collaboration in organisational innovation. There is substantial interest in (i) the "fuzzy front end" of innovation and (ii) how innovative organisations balance exploratory and exploitative activities.

In terms of *variable-oriented innovation research,* Table 3.4 provides an overview of some of the main factors that impact upon organisational innovation. Mohr (1969) indicates, for example, that organisational size and wealth are among the strongest predictors of innovation. Most organisational innovativeness research

has concentrated on organisational structure (Wolfe, 2004). In particular, authors have indicated that particular structural interventions may be used to encourage innovation. For example, organisations create 'skunkworks' (defined by Brown (in Brown and Ulijn, 2004, p. 134) as isolated and skilled team designed to accelerate the development of innovative products or services) in order to protect innovative projects from corporate bureaucracy (McCosh, 1998).

TABLE 3.4 VARIABLE-ORIENTED INNOVATION RESEARCH (ORGANISATIONAL LVL)

FACTOR	AUTHORS
Organisational size	Rosenfeld and Servo, 1990; Mohr, 1969
Resources (slackness)	Rogers, 2003; Mohr, 1969
Organisational structure	Centralization, formalisation, complexity (Zaltman, 1973); modular structures (Sanchez and Mahoney, 1996); formal and informal internal structures (Teece, 1998); organic structures (March, 1981; Peters, 1994)
Organisational boundaries	Firm boundary and external linkages (Teece, 1998)
Liquidity and diversification	Cohen and Levin, 1989
Diversified product ranges	Nelson, 1969
Strategy	West and Farr, 1989; Cooper, 1984
Leadership characteristics	Mohr, 1969; Kimberly and Evanisko, 1981
Management style	Van de Ven, 1986; Bouwen and Fry, 1988
Organisational culture	Teece, 1998
Organisational age	Kimberly and Evanisko, 1981

The importance of communication and collaboration within and between organisations is also increasingly recognised. Thus, recent theoretical enquiry has moved away from purely formal structures to organisational processes, relationships and boundaries (Lam, 2006). For example, Rosenfeld and Servo (1990) suggest that the implications of organisational size on lateral and vertical communication within the organisation mean that organisations face a dilemma in seeking to allow for change whilst maintaining a high degree of organisational integrity. In particular, the importance of informal organisational structures is increasingly recognised (Ibarra, 1993). Recognising the importance of communication and knowledge sharing for innovation, Yayavaram and Ahuja (2008) argue that skunkworks may actually prevent the coupling of knowledge elements across research units.

The *process of innovation at an organisational level* has received considerable attention. Thus, numerous authors (e.g. Usher, 1954; Hage and Aiken, 1970; Zaltman *et al.,* 1973; Utterback and Abernathy, 1975; Kimberly, 1981; Rogers, 2003; Meyer and Goes, 1988; Bernstein and Singh, 2006) propose models of stages and sequences of events that take place. In particular, a number of authors (e.g. McFarlan and McKenney, 1982; Kwon and Zmud, 1987; Cooper and Zmud, 1990) focus on the adoption of IT-based innovations in organisations. Innovation process models at this level of analysis typically describe nonlinear series of episodes, stages or phases (Van de Ven et al., 1999; Drazin and Schoonhoven, 1996; Rogers, 2003; Van de Ven, 1986). In particular, innovation process models often explicitly include idea generation and idea selection stages (Montoya-Weiss and O'Driscoll, 2000).

Researchers are increasingly focused on the earliest stages of the innovation process in organisations. Thus, there is particular interest in the so-called "fuzzy front end" (Montoya-Weiss and O'Driscoll, 2000) of innovation, where ideas are created and selected (e.g. e.g. Reinertsen, 1999; Smith *et al.,* 1999; Koen *et al.,* 2002; Reid and de Brentani, 2004; Börjesson *et al.,* 2006; Backman *et al.,* 2007; Kim *et al.,* 2010). This interest is paralleled by a growing interest in the earliest phases of the decision making process (O Riordan and O'Reilly, 2011) where it is argued that the manner in which problems are initially 'framed' fundamentally conditions all subsequent decision making outcomes (Adam, 2008; Daly *et al.,* 2008). Thus, Koen (*et al.,* 2002) argue that the "fuzzy front end is generally regarded as one of the greatest opportunities for improvement in the overall innovation process" (p. 5).

One of the key questions arising from research in this area relates to balancing exploratory and exploitative behaviours. This debate stems from March (1991) who argues that organisations should seek to develop structural ambidexterity by means of separating exploitative and exploratory tasks into different organisational subunits (Schulze, 2009, p. 48). Scholars are particularly focused on whether organisations:

(i) move from periods of exploration to periods of exploitation over time (by means of processes of punctuated equilibrium), or

(ii) maintain a balance between these activities (by means of "organisational ambidexterity") over time

(cf. Schultze, 2009; Gupta *et al.* 2006). Therefore, a number of theories have been proposed in relation to exploratory and exploitative activities in organisations (e.g. Fang *et al.,* 2010; Gupta *et al.,* 2006; Tushman and O'Reilly, 2006). For example, Fang *et al.,* (2010) argue that an organisation should be divided into semi-isolated subgroups may help strike the proper balance of exploration and exploitation. Similarly, Tushman and O'Reilly (2006) cite a number of examples of organisations who have handled the tension between exploitation and exploration by means of becoming structurally ambidextrous. These observations are used to inform the selection of variables in constructing the preliminary framework used to guide this study.

3.3.4 The diffusion of innovations

Theories of innovation diffusion seek to explain the process by which innovations spread through populations of potential adopters (Newell *et al.,* 2000; Fichman, 1993). The analysis presented in this section therefore serves to highlight the role of communication and collaboration on innovation.

Traditional innovation diffusion research has contended that adoption is driven by the characteristics of the innovation and characteristics of the potential adopter (Ford *et al.,* 2008). In relation to *characteristics of the innovation*, Rogers (2003) proposes that relative advantage, compatibility, trialability, observability are generally positively correlated with rate of adoption and that complexity is generally negatively correlated with rate of adoption. In relation to *characteristics of potential adopters*, Rogers (2003, pp. 288-289) indicates that socioeconomic status indicated by variables such as income, level of living, possession of wealth, occupational prestige, and self-perceived identification with a class) and innovativeness go hand in hand and that earlier adopters tend to be upwardly mobile in terms of social status. Research is inconsistent in terms of evidence

about the relationship between age and innovativeness. Rogers (2003, pp, 289-290) does suggest that early adopters tend to have greater empathy than later adopters, that they may be less dogmatic, that they may have a greater ability to deal with abstractions, that they may have better change and risk tolerance and that early adopters may be more rational and intelligent than later adopters. However, Rogers acknowledges that personality variables have not received substantial research attention. In addition, a number of scholars (e.g. Ryan and Gross, 1943; Rogers, 2003, pp. 282-292) have classified adopters as innovators, early adopters, early majority, late majority and laggards. These classifications are based upon the time element of adoption and are used to plot diffusion curves for particular innovations (cf. Ryan and Gross, 1943; Rogers, 2003).

3.4 Innovation: the emergence of a knowledge-based view

The analysis presented above well illustrates the argument in favour of classifying innovation research according to (i) research approach (i.e. variable-oriented and process-based approaches) and (ii) level of analysis. It shows how this approach allows the researcher to systematically review this body of research (Staw, 1984). This approach also accurately reflects existing divisions in the field (King, 1990; King and Anderson, 1990). However, it also conceals some of the macro level changes taking place in the field over time. This section focuses on these changes.

At a high level, the analysis underscores the view that knowledge is at the heart of innovation. In particular, the analysis shows that scholars at all levels of analysis embrace the view that innovation is a kind of capability that can be developed. At the same time, the analysis reveals that researchers increasingly focus on the importance of communication (within or across groups and organisations, for example) for innovation. Thus, innovation scholars focus on

(i) how innovative ideas emerge (as equivocal outcomes) by means of active and interactive processes of social construction, and

(ii) the ways that ideas are perceived and interpreted as they spread through populations of potential adopters.

These insights help to illustrate some of the ways that virtual worlds may influence innovation and underscore the merit of investigating innovation in virtual worlds in the context of this study.

The discussion is structured as follows. Section 3.4.1 reveals that scholars are increasingly interested in the role of the Internet and related technologies in innovation. Section 3.4.2 reveals that a series of tracer studies have led to investigations of "recombinant innovation" which seek to explore the connections that exist between (created) ideas and (implemented) ideas. Section 3.4.3 suggests the emergence of new perspectives on innovation. More specifically, the analysis suggests that innovations are increasingly seen as the equivocal outcomes of electronically mediated social interaction. Finally, Section 3.4.4 argues that a result of these trends, a new knowledge-based view of innovation is beginning to take shape in the field.

3.4.1 Innovation: the role of the Internet

The emergence of the Internet and related technologies has altered the way that information about new ideas is exchanged in interpersonal networks (Rogers, 2003, p. xviii). Thus, new forms of innovation are emerging that are based on leveraging the communicative affordances of modern technologies (including virtual worlds). These forms of innovation are described in literature as:

(i) peer production (Benkler, 2006),
(ii) co-production (Schneider and Bowen, 1995; Wilkstrom, 1996),
(iii) co-creation (Ramaswamy *et al.,* 2010; Prahalad and Ramaswamy, 2004),
(iv) produsage (Bruns, 2008),
(v) open innovation (Chesbrough, 2003; Chesbrough & Vanhaverbeke, 2006),
(vi) open source innovation (von Hippel, 2001),
(vii) collective intelligence (Lévy, 1997),
(viii) crowd sourcing (Howe, 2006).

3.4.2 Recombinant innovation

At the same time, a number of influential tracer studies of innovation have revealed that inventions (created ideas) and innovations (implemented ideas) are (i) connected with but (ii) disconnected from each other. These studies show that there are important *connections* between different types of innovation (Van de Ven, 1999, p. 9). In fact, what is thought of as a single innovation is actually the outcome of a lengthy process involving interrelated innovations (Fagerberg, 2006, p. 5). Thus, different types of innovation impact upon one another (Thirtle and Ruttan, 2002; Leavitt, 1965; Van de Ven, 1999, p.9) and ideas and innovations are seen to be "functionally interdependent" (Rogers, 2003, p. 162). On the other hand, there are important *disconnects* between inventions (created ideas) and innovations (implemented ideas). For example, inventions and innovations are often separated in time and in space (Rogers, 2003, p. 162). Furthermore, there are "compositional disconnects" between inventions and innovations too (Rogers,

2003, p. 162). This refers to the idea that up to 3,000 ideas are needed to produce one commercial success (Miller and Morris, 2008, p. ix).

As a result, of these insights, a stream of research has emerged that is focused on "recombinant innovation". Recombinant innovation refers to the view that individual innovations consist of specific configurations or cognitive structures of ideas. In particular, it refers to the view that "seeming novelty of many a system is due solely to the novelty of the application or arrangement of the old elements which enter into it" (Lovejoy, 1936, p.4). Research in this area demonstrates that most important innovations undergo "drastic changes in their lifetimes – changes that may, and often do, totally transform their economic significance" (Kline and Rosenberg, 1986, p. 283). Further, this research suggests that these changes are brought about as a result of

(i) knowledge spillovers (Cohen and Levin, 1989)
(ii) borrowing and imitation (cf. March and Simon, 1958) and
(iii) reinvention and recombination (cf. Yayavaram and Ahuja, 2008).

Thus, Usher argues that major inventions emerge from a "cumulative synthesis of relatively simple inventions, each of which requires an individual 'act of insight'" (Thirtle and Ruttan, 2002 p. 2). Similarly, Bandura (2002) argues that innovation takes place when pre-existing innovations are refined and synthesised into new procedures (p. 131).

3.4.3 The emergence of new perspectives on innovation

As a result of these developments, scholars are increasingly focused on *innovations as the equivocal outcomes of electronically mediated social interaction*. This section considers each point in turn.

First, innovations are increasingly seen as the *equivocal outcomes* of innovation processes. That is to say, the characteristics of innovations are seen to be perceived rather than given (Rogers, 2003, p. xxi) and to emerge as participants strive to create mutual understandings (Rogers, 2003, p. 18). In this view, innovations and changes are conversations, discourses and texts, the merits of

which are seldom self-evident (Ford *et al.,* 2008). Thus, the meaning of an innovation is "gradually worked out through a process of social construction" (Rogers, 2003, p. xxi) and "it is a serious mistake to treat an innovation as if it were a well-defined, homogeneous thing" (Kline and Rosenberg, 1986, p. 283).

As a result, scholars are increasingly focused on innovation as a *social* phenomenon. For example, Rogers (2003) defines innovation as "a social process… in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 5). Thus, there is increased emphasis on the role of (i) groups and (ii) social networks in innovation. In terms of *groups*, innovation is increasingly seen as the outcome of collaboration within and across groups and teams (Hevner and Chatterjee, 2010, p. 147). Thus, there is increased interest in the role of groups in innovation (West, 2002; Paulus and Nijstad, 2003; Osborn, 1957) and in the ways that group phenomena may influence creative or free thinking. Examples of these phenomena include:

(i) conformism (cf. Van de Ven, 1986)
(ii) group think (cf. Janis, 1982)
(iii) evaluation apprehension (Diehl and Stroebe, 1987
(iv) production blocking (Diehl and Stroebe, 1987)[6].

In terms of *social networks*, scholars now recognise the importance of social networks for innovation diffusion (Newell, Snow and Galliers, 2000). In particular, it is recognised that the social networks of early adopters differ from the social networks of others (Rogers, 2003, pp. 290-292).

In particular, scholars increasingly focus on innovation as an *electronically mediated* phenomenon. Thus, scholars (e.g. Dennis and Valacich, 1993; McGrath, 1984) have attempted to evaluate the performance of different kinds of groups in

[6] Conformism refers to the tendency to yield to group pressure. Group think refers to the idea that groups may arrive at premature consensus leading to suboptimal and noncreative solutions. Evaluation apprehension refers to the concept that individuals' ideas may not be communicated in groups due to apprehension or fear about the group's evaluations of those ideas. Production blocking refers to the idea that individuals' ideas are not communicated in groups due to the dynamics of group interaction

idea generating (or brainstorming) activities. These findings underline the significance of groups and of interaction (communication and collaboration) in groups in terms of creating and shaping ideas. In particular, these scholars have tended to focus their investigations on three kinds of groups:

(i) non-interacting individuals whose ideas are pooled (nominal groups)

(ii) interacting individuals whose ideas are pooled (interacting groups)

(iii) computer-based groups (who interact online).

These studies suggest that non-interacting groups outperform interacting groups (Schneider *et al.,* 2008). At the same time, large computer-based groups may in turn outperform nominal groups for brainstorming activities (Dennis and Valacich, 1993). Scholars (e.g. Schneider *et al.,* 2008; Connolly, Jessup, and Valacich, 1990) have suggested that the superior performance of groups in idea generation may be attributable to group memory and to parallel communication and anonymity in groups.

3.4.4 The knowledge-based view of innovation

In response to the developments outlined above (Sections 3.4.1, 3.4.2 and 3.4.3), a knowledge-based view of innovation as slowly emerged in the field. This knowledge-based view of innovation is well illustrated in the views of Van de Ven *et al.* (1999, p. 84) who argue that

> during the early highly ambiguous period of innovation development, broad macro goals galvanise action and promote learning by discovery… Through learning by discovery, innovation teams identify and transform tacit understandings into explicit understandings of alternative conditions in which to pursue possible actions and outcomes in the development of their innovations

Thus, innovation process models from the 1990s often visualise innovation as the accumulation of know-how (Rothwell, 1994). In fact, several studies (Agarwala-Rogers, 1976; Tushman, 1977; Senker, 1995a; Senker, 1995b; Senker, 2008; Verona, 1999; Gopalakrishnan and Bierly, 2001; Brockman and Morgan, 2003) utilise a knowledge perspective in order to investigate organisational innovation. For example, Rogers and Agarwala-Rogers (1976) and Tushman (1977) explore

the impact of knowledge of innovations on organisational innovation. Senker (1995a, 1995b, 2008) investigates the contribution of tacit knowledge to innovation. Verona (1999) provides a resource based view of product development. Gopalakrishnan and Bierly (2001) analyse innovation adoption using a knowledge-based approach. Finally, Brockman and Morgan (2003) explore the role of existing knowledge in new product innovativeness.

Thus, scholars increasingly see innovative organisations as those that are:

(i) intelligent and creative (Glynn, 1996; Woodman *et al.,* 1993)

(ii) capable of learning effectively (Senge, 1990; Argyris and Schön, 1978)

(iii) capable of creating new knowledge (Nonaka, 1994; Nonaka and Takeuchi, 1995; Lam, 2006, p. 123).

One study in particular explicitly argues that the innovation process should be seen as "a complex stream of communication linking the structural functions of the organisation and knowledge creation" (Bernstein and Singh, 2006, p. 563).

Taken together, these insights serve to underscore the merit of investigating innovation and knowledge using a new integrated approach. First, this kind of approach is well suited to the emerging recombinant view of innovation (cf. Section 3.4.2) as it would allow for the use of techniques from the cognitive sciences to investigate the development and flow of ideas by means of examining configurations and changes in mental models (cf. Walsh, 1995). Second, the utilization of a knowledge perspective would allow for the incorporation of insights from knowledge management in relation to the role of social networks in determining the flow of information, knowledge and ideas (Prusak, 2001). Third, there is much to be gained from using theories of the social construction of knowledge to understand innovations as socially and discursively constructed artifacts (cf. Berger and Luckmann, 1966; Barrett, 1994; Mizruchi, 1999; Engeström, 2000; De Wever et al., 2009; Simpson, 2010). Based on these insights, the next section of the chapter presents a review of extant research in the area of knowledge management.

3.5 Knowledge through the ages

Accelerated by rapid growth in ICT capabilities, the emergence of the knowledge economy was first observed over forty years ago (Heffner and Sharif, 2008). This led to a renewal of interest in the question of knowledge (Kakabadse, 2003). This trend first started in the fields of economics (cf. Hayek, 1945; Arrow, 1962); organisational theory (cf. March and Simon, 1958) and philosophy (cf. Polanyi, 1966) (Kakabadse, 2003). Contemporary organisations are increasingly knowledge intensive (Boland and Tenkasi, 1995, p. 350) and knowledge focused (Alavi and Leidner, 2001, p. 108). Knowledge is identified as the key resource for individual firms (Gao *et al.,* 2008) and the key driver of competitive advantage (Porter and Millar, 1985; Winter, 1987; Quinn, 1992; Blackler, 1995; Nonaka and Takeuchi, 1995; Dunford, 2000; Gao *et al.,* 2008; Taminiau *et al.,* 2009). Thus, the main concern is for the generation, management and utilization of knowledge in such a way that produces long-term advantages (Quinn, 1992, p. 241; Soo *et al.,* 2002). In addition, the analysis presented in Section 3.5 attempts to show that the role of knowledge in innovation is increasingly recognised and that there is merit in using an integrated approach to investigate innovation and knowledge.

Therefore, the purpose of this section is to review extant knowledge-based research. The analysis considers knowledge through the lens of Western Philosophy (Section 3.5.1) and the lens of knowledge management (Section 3.5.2). The discussion illustrates that contemporary perspectives on knowledge bear the indelible tint of their forbears in western philosophy. In addition, the discussion illustrates that *scholars investigating knowledge also recognise that knowledge is at the core innovation.*

3.5.1 Knowledge through the lens of Western philosophy

This section explores knowledge through the lens of Western philosophy. The rationale for the consideration of this material is twofold. First, knowledge has defined epistemological debate in western philosophy since the classical Greek era (Alavi and Leidner, 2001). It would be wasteful to cast aside the insights that western philosophy can offer. Second, despite of (or perhaps because of) a long

standing intellectual fascination with the concept of knowledge, profound definitional ambiguity continues to surround the term. Knowledge is "a highly contentious concept" (Spender, 1996, p. 48); "one of those 'vague words' one is at times compelled to use… a 'loose name'" (Dewey and Bentley, 1949, pp. 48, 87); "a broad and abstract notion" (Alavi and Leidner, 2001, p. 107); and "a loose, ambiguous, and rich concept that precludes reduction to simple sets of distinctions" (Alvesson and Kärreman, 2001, pp. 997–1012). Knowledge is "far too problematic to bear the weight of a useful theory of the firm without a clear statement of the epistemology which gives it meaning" (Spender, 1996, p. 48).

Therefore, the discussion explores knowledge (i) for the ancient Greeks (Section 3.5.1.1), (ii) in Renaissance and Enlightenment thought (Section 3.5.1.2), and (iii) in twentieth century Philosophy (Section 3.5.1.3) in turn. The discussion demonstrates that contemporary perspectives on knowledge do, in fact, bear the indelible tint of their forbears in western philosophy.

3.5.1.1 Knowledge for the ancient Greeks

The earliest recorded writing about the relationships between sensory experience, truth, and knowledge dates back to the ancient Greeks (cf. Hirschheim, 1985; Alavi and Leidner, 2001). The ancient Greeks classified knowledge into *doxa* (that which is believed to be true) and *episteme* (that which is known to be true) and held that the purpose of science was to transform the former into the latter (Hirschheim, 1985). Table 3.5 provides an overview of conceptualisations of knowledge by ancient Greek writers.

TABLE 3.5 ANCIENT GREEK VIEWS ON KNOWLEDGE	
PHILOSOPHER	**VIEW OF KNOWLEDGE**
Plato (c. 428 – 348 BC)	Knowledge as "justified true belief"; the objects of knowledge of the rational soul (the 'Forms') have a real existence that is separate from the things our senses perceive (Cornford, 2003, p. 2); knowledge is not acquired through the senses or as information conveyed from one mind to another but is acquired through recollection (Cornford, 2003, pp.3-4)
Aristotle (384-322 BC)	Concepts are abstracted from sense experience and connected by logical inferences to provide knowledge (Popkin, 1988); the objects of knowledge and knowledge itself are hierarchically structured (Kenny, 1998, pp. 73-74); formal logic can be used to evaluate inferences (Kenny, 1998, pp. 58-60)
Stoics (led by Zeno of Citium)	Appearances presented to the senses can be misleading so criteria should be used to evaluate cognitive appearances (Kenny, 1998, p. 89)
Sceptics (led by Pyrrho of Elis)	Axioms can not be used to guide science but without axioms "all lines of reasoning must be either circular or endless" (Kenny, 1998, p. 89)

It has been traditional to regard Plato's Academy and Aristotle's Lyceum "as two opposite poles of philosophy (Kenny, 1998, p. 57). Plato (c. 428 – 348 BC) is credited with defining knowledge as justified true belief. Plato held that the objects of knowledge of the rational soul (the 'Forms') had a real existence that was separate from the things our senses perceive (Cornford, 2003, p. 2). Conceptualisations of knowledge as justified true belief and of truth as correspondence with facts (the correspondence theory) have appeared consistently since.

In Aristotle's (384-322 BC) view, we notice things in the course of our lives by means of our senses and we build up a body of experience. Thus, our concepts are drawn from our experience; observation has primacy over theory; and science is a search for causes or explanations (Kenny, 1998, p. 71). Further, Aristotle held that concepts are abstracted from sense experience and connected by logical inferences to provide knowledge (Popkin, 1988). Aristotle conceived of the objects of knowledge and knowledge itself and as being hierarchically structured; and saw definition as largely a process of division (Kenny, 1998, pp. 73-74). Aristotle also founded logic as a 'tool' for science ('Organon' is the Greek for 'tool') and classed inferences into 'all', 'some', and 'not'; specifying rules to evaluate inferences as valid or false (Kenny, 1998, pp. 58-60).

After Aristotle, the primacy of empiricism came to be challenged by both the 'stoics' and the 'sceptics'. Nevertheless, Aristotle's arguments remained largely acceptable until the Renaissance (Popkin, 1988). The 'stoics' held that the appearances which things present to our senses are the foundation of all science but that appearances may mislead (Kenny, 1998, p. 89). Therefore, knowledge should be based on 'cognitive appearance' (*phantasia kataleptike*) and that a test or 'criterion' could be used to decide which appearances are reliable (Kenny, 1998, p. 89). The 'sceptics' subsequently argued that there is no way to distinguish cognitive appearances from any other kind. This was because they denied the possibility that self evident principles could be used as the basis of science. Without such axioms, "all lines of reasoning must be either circular or endless" (Kenny, 1998, p. 89). The sceptics also held that if it were possible to use criteria to evaluate cognitive appearances, it would not be possible to know whether they had been identified or not (Kenny, 1998, p. 90). Whilst sceptical arguments have manifested in philosophical works ever since (e.g. the work of Hume), philosophers in later periods (e.g. Kant; Hegel; Spinoza) have been concerned with defending philosophy from sceptical arguments.

3.5.1.2 Knowledge in Renaissance and Enlightenment thought

Philosophy during the *Renaissance* (c.1300-c.1600) was primarily metaphysical and rationalistic. However, it was during the Renaissance that epistemology, the theory of knowledge, began to develop (Popkin, 1988). Renaissance thinkers were primarily concerned with problems in logic and less concerned with epistemology (Popkin, 1988). Renaissance scholars criticised Aristotle's theory of concept abstraction and his theory of the logical connections of concepts and thereby raised important epistemological issues. These issues led to the identification of a number of central problems with the concept of knowledge that are still grappled with today (Popkin, 1988).

During the *Enlightenment* (c.1637-1789), the dominance of metaphysical and rationalistic philosophy began to give way to an epistemological and empiricist philosophy. Freedom, mastery and progress were at the core of Enlightenment

thought, which held that through the development of scientific knowledge, man would be able to give an "ever more concrete expression to the ideal of being free" (Schouls, 1989, p. 3). Enlightenment philosophers focused on the sensory and experiential components of knowledge rather than on the merely mathematical, emphasizing the use of reason in the development of philosophical, social, political, and scientific knowledge (Duignan, 2010, p. 109). Enlightenment philosophy is broadly divisible into British empiricist and Continental rationalist camps. These are discussed in turn. Table 3.6 provides an overview of conceptualisations of knowledge in modern philosophy.

The school of British empiricism dominated the perspective of Enlightenment philosophy until the time of Kant. *Bacon* (1561-1626) argued in favour of induction: a "carefully schematised procedure, mounting gradually from particular instances to axioms of gradually increasing generality" (Kenny, 1998, p. 186). Specifically, Bacon advocated the use of tables of discovery to order facts in such a way that the true causes of phenomena and the true forms of things could be inductively established. *Locke* (1632-1704) held that mental operations are a combining and compounding of simple sensory materials into complex conceptual entities. Locke (1993) defined ideas as mental entities (whatever is the object of the understanding when a man thinks) and distinguished simple and complex ideas in terms of the number of senses observed in their detection. Locke's theory of knowledge was based upon a kind of sensory atomism, in which the mind is an agent of discovery rather than of creation. *Hume* (1711 – 1776) argued that impressions (sensations, passions and emotions, as they make their first appearance in the soul) are responsible for ideas (faint images of these in thinking and reasoning); and that relations of ideas were *a priori* knowledge and divided knowledge into relations of ideas and (falsifiable) matters of fact (Norton, 1993, pp. 65-66).

TABLE 3.6 CONCEPTUALISATIONS OF KNOWLEDGE IN MODERN PHILOSOPHY		
SCHOOL	**AUTHOR**	**VIEW OF KNOWLEDGE**
British empiricism[7]	Bacon (1561-1626)	Experience is the only source of valid knowledge; syllogisms cannot produce new concepts or extend knowledge; induction should be used to advance knowledge by means of tables of discovery
	Locke (1632-1704)	The ultimate source of human ideas is sense experience; all mental operations are a combining and compounding of simple sensory materials into complex conceptual entities
	Hume (1711–1776)	The scope, limits and justification of our knowledge is given by experience; impressions are responsible for ideas; knowledge can be divided into (falsifiable) matters of fact and relations of ideas (*a priori* knowledge)
Kant (1724-1804)		There are true, synthetic *a priori* judgements that have not been derived from experience but it is important to be able to determine the validity of knowledge and guard against metaphysical claims
Continental rationalism	Descartes (1596–1650)	The senses can be deceived but scepticism must be avoided; "I am thinking, therefore I exist"; there is a fundamental division between the mind and the body
	Spinoza (1632-1677)	Everything is ultimately intelligible; there are different levels of knowledge; ideas that come from outside the mind are confused, inadequate and uncertain but ideas are adequate, unconfused and certain to the extent that they manifest our power
	Leibniz (1646-1716)	The mind is an immaterial substance and is causally independent of all bodies; both ideas and knowledge are innate

Kant (1781) argued, against the empiricists, that there are true synthetic *a priori* judgements; in other words, that there are judgements which are not tautologies, yet which are not derived from experience ('Kant', A Dictionary of Sociology). Kant held that the aims of science were both constructive and critical - "to expose the illusions of a reason that forgets its limits" (Crawford in Guyer, 2003, p. 148). Therefore, the philosopher must be able to determine the source, the extent, and the validity of human knowledge and the ultimate limits of reason. Thus, whilst rejecting a central doctrine of empiricism, Kant sought to defend the cognitive status of empirical science against metaphysical claims to knowledge of 'things-in-themselves' that are beyond experience ('Kant', A Dictionary of Sociology).

Continental rationalism was epitomised by the work of Descartes, Spinoza, and Leibniz. *Descartes* (1596 – 1650) called into question the deliverances of the

senses, which are susceptible to sense-deception but held that the second task of philosophy is to prevent these doubts from leading to scepticism (Kenny, 1998, p., 192). Descartes attempted to bring these doubts to an end with the argument that *Cogito, ergo sum*: "I am thinking, therefore I exist" (Kenny, 1998, p., 193). *Spinoza's* philosophy is perhaps the "most thoroughgoing commitment in the history of philosophy to the intelligibility of everything"; Spinoza held that each thing is intelligible and that there are no facts that are impervious to explanation (Della Rocca, 2008, pp. 1-2). Spinoza held that ideas are "confused, inadequate and uncertain to the extent that they are caused from outside our mind"; ideas are unconfused, adequate, and certain "to the extent that our ideas are a manifestation of our power" (Della Rocca, 2008, p. 186). Spinoza (1632-1677) distinguished three kinds of knowledge or cognition: (i) opinion or imagination (which includes random or indeterminate experience and hearsay or knowledge from mere signs), (ii) reason (which depends on common notions and on adequate knowledge of the properties rather than essence of things) and (iii) intuitive knowledge (Garret, 1996, p. 5). Leibniz (1646-1716) was committed to the thesis that the human mind is an immaterial substance (Jolley, 2005, p. 93) which is causally independent of its body and of all bodies (Jolley, 2005, p. 103). Leibniz therefore attempted to revive the Platonic doctrine of innate ideas on the basis that the human mind is causally independent of all other substances except God (Jolley, 2005, p. 103) and also argued in favour of the innateness of knowledge based on our capacity for knowing necessary truths in geometry (Jolley, 2005, p. 109).

3.5.1.3 Knowledge in twentieth century philosophy

Philosophy in the twentieth century has been divided into analytic and continental traditions. The development of analytic philosophy was influenced by the creation of symbolic (or mathematical) logic at the beginning of the century. Philosophers in the analytic tradition are generally agreed that the purpose of analysis is the clarification of thought. From its inception, the methods of analytic philosophy have included the development of symbolic languages as well as the close

[7] Cf. www.britannica.com/EBchecked/topic/1350843/Western-philosophy/60957/Classical-British-empiricism, accessed 14 August, 2009

examination of ordinary speech; the objects to be clarified have ranged from concepts to natural laws to ordinary terms. Continental philosophy is a largely twentieth century phenomenon in opposition to more mainstream analytic philosophy. At a very general level, it can be said that knowledge in the continental tradition is seen to consist of those constructions about which there is a relative consensus (or at least some movement towards consensus) among those competent (and in the case of more arcane material, trusted) to interpret the substance of the construction. Multiple 'knowledges' can coexist when equally competent (or trusted) interpreters disagree (Guba and Lincoln, 1994, p. 113).

This section has explored the various conceptualisations of knowledge that have permeated western philosophical thought since the time of the ancient Greeks. The discussion illustrates that the means whereby knowledge can be justified, can be considered 'true' or at the very least adequate, has been a central theme permeating these discourses. In the next section, contemporary conceptualisations of knowledge in the field of knowledge management are reviewed.

3.5.2 Knowledge through the lens of knowledge management

The purpose of this section is to analyse conceptualisations of knowledge within the realm of knowledge management. Knowledge management is a practitioner-based, substantive response to real social and economic trends including globalization, ubiquitous computing, and the knowledge-centric view of the firm whose intellectual antecedents are found in economics and sociology (cf. Prusak, 2001). Knowledge Management (KM) arose in the mid 1990s to address the issue of knowledge in organisations because the enthusiasm for the idea that knowledge has become the most strategic of corporate assets had "not been matched by an understanding of how to operationalise knowledge" (Marr and Spender, 2004, p. 183). Whilst it has been argued that conceptualisations of knowledge in this field have not influenced the development of knowledge-based theories of the firm (cf. Alavi and Leidner, 2001), the analysis reveals that conceptualisations of knowledge in the field of knowledge management bear the indelible tint of their forbears in western philosophy. The analysis is structured as follows: Section 3.5.2.1 derives a characterisation of knowledge from existing research and Section 3.5.2.2 and considers existing classifications of knowledge.

3.5.2.1 Characterising knowledge

A review of existing literature reveals that several characterisations of knowledge are manifest in knowledge management research. Table 3.7 summarises six common characterisations of knowledge that are found in knowledge management literature. The table is structured using a series of headings initially proposed by Alavi and Leidner (2001) but is populated using specific examples from literature. Specifically, the table indicates that knowledge is characterised (i) vis-à-vis data and knowledge; (ii) as a state of mind; (iii) as an object, (iv) as a process; (v) as access to information; and (vi) as capability.

TABLE 3.7 CLASSIFICATION OF KNOWLEDGE DEFINITIONS	
TYPE	**EXAMPLES FROM LITERATURE**
Knowledge vis-à-vis data and information	⌘ Data is raw numbers and facts; information is processed data; knowledge is *authenticated information* (Dreske, 1981; Machlup, 1980) ⌘ Knowledge is information possessed in the mind of individuals: it is *personalised information* (which may or may not be new, unique, useful, or accurate) related to facts, procedures, concepts, interpretations, ideas, observations, and judgments. Information is converted to knowledge once it is processed in the mind of individuals and *knowledge becomes information once it is articulated* and presented in the form of text, graphics, words, or other symbolic forms (Alavi and Leidner, 2001) ⌘ Knowledge is the addition of human interpretations to information source or the reformulation or *interpretation of information* in a personalised way. Information is the systematic arrangement of data for a specific purpose (Robert, 2009) ⌘ Knowledge does not exist outside of an agent or knower: it is *indelibly shaped by one's needs as well as one's initial stock of knowledge*; knowledge becomes information when articulated, verbalised, and structured; this information becomes data when assigned a fixed representation and standard interpretation (Tuomi, 1999)
Knowledge as state of mind (a state of knowing or understanding)	⌘ Knowledge is a condition of *understanding gained through experience or study;* the sum or range of what has been perceived, discovered, or learned (Schubert *et al.,* 1998) ⌘ Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides *a framework* for evaluating and incorporating new experiences and information. It originates and is applied *in the minds* of knowers. In organisations, it often becomes *embedded* not only in documents and repositories but also in organisational routines, processes, practices and norms (Davenport and Prusak, 1998, p.3) ⌘ Organisation knowledge is the collective sum of individual knowledge assets which is embedded in people, product, process and structure (Shankar *et al.,* 2009)
Knowledge as object (to be stored or manipulated)	⌘ Knowledge is that which is objectively known, an intellectual property, attached to a name and a group of names and certified by copyright or some other form of social recognition or more specifically, a set of *organised statements of facts or ideas,* presenting a *reasoned judgment* or an *experimental result*, which is transmitted to others through some communication medium in some systematic form (Bell, 1976) ⌘ Knowledge is a complex and variegated good which can be tacit or codified, localised (context-specific) or abstract (generic) (Grimaldi and Torrisi, 2001)
Knowledge as process (of applying expertise)	⌘ Knowledge *cannot 'be divorced from context* and transmitted either as abstract data or as universally applicable approaches to problem solving; learning is not a passive process... but an active one' (Heffner and Sharif, 2008) ⌘ Knowledge is a dynamic human *process of justifying personal belief* toward the truth at the organisational level (Nonaka and Takeuchi, 1995) ⌘ Knowledge is defined as four sets of *socially enacted* knowledge processes: (i) creation (also referred to as construction), (ii) storage/retrieval, (iii) transfer, and (iv) application (Alavi and Leidner's, 2001) ⌘ Knowledge is conceptualised as knowing in practice; human action plays an essential role in knowing how to get things done in organisations; knowing is not a static embedded capability or stable disposition of actors, but rather an *ongoing social accomplishment, constituted and reconstituted* as actors engage the world in practice (Orlikowski, 2002)
Knowledge as condition of having access to information	⌘ Knowledge is information that is relevant, actionable, and based at least partially on experience. Knowledge is a subset of information; it is subjective; is linked to meaningful behavior; and it has tacit elements born of experience (Leonard-Barton and Sensiper, 1998)
Knowledge as capability (the potential to influence action)	⌘ Knowledge is not so much a capability for specific action, but *the capacity to use information*; learning and experience result in *an ability to interpret information* and to ascertain what information is necessary in decision making (Watson, 1999) ⌘ Knowledge is the capacity (potential or actual) to take effective action in varied and uncertain situations. Knowledge consists of comprehension, understanding, insights, meaning and the ability to anticipate the effect of our actions. Knowledge is neither true nor false. Its value is difficult to measure other than by the results of its actions (Bennet and Bennet, 2008) ⌘ Knowledge is a justified belief that increases an entity's capacity for effective action (Huber, 1991; Nonaka, 1994) ⌘ Knowledge is a *capacity* that builds on information extracted from data or the set of expectations that an observer hold with respect to an event (Boisot, 1998)

Table 3.7 illustrates that conceptualisations of knowledge within knowledge management bear the indelible tint of western philosophical arguments. For example, a number of these definitions emphasise the relationships between knowledge, truth and belief and underline the manner in which knowledge is in some way organised, systematic or justified by some means. The table also supports the view that scholars investigating knowledge recognise the importance of knowledge for innovation. A number of scholars investigating innovation suggest that innovations 'embody' organisational knowledge (Subramaniam and Youndt, 2005; Heffner and Sharif, 2008) and focus on the adoption of ideas in adopting units (e.g. organisations). These conceptualisations are commensurate with characterisations of knowledge-as-object in the table. Further, definitions of innovation are especially commensurate with characterisations of knowledge-as-capability. Scholars (e.g. Kandampully, 2002; Ahuja and Lampert, 2001) describe innovation as a core competency. Scholars (e.g. Kogut and Zander, 1992; Collinson, 2003; Pitt and MacVaugh, 2008) also argue that knowledge management competencies or capabilities are fundamental to innovation, enabling it to survive competitively and grow. For example, Leonard-Barton and Sensiper (1998) argue that innovation depends upon the individual and collective expertise of employees: in their words, "the marvellous capacity of the human mind to make sense of a lifetime's collection of experience and to connect patterns from the past to the present and future is, by its very nature, hard to capture" but it is "essential to the innovation process" (p. 112).

In addition, Table 3.7 is used to derive a characterisation of knowledge for the study. To that end, key components of existing characterisations of knowledge are highlighted in the table using italicised text. These elements show that knowledge is grounded in experience (reflecting the beliefs espoused by British empiricists, for example) and at the same time is derived by means of cognitive processes in the mind (reflecting the beliefs espoused by continental rationalists, for example). Further, these characterisations are explicitly pragmatic in their orientation: they are focused on the instrumental nature of knowledge or its practical use value. In addition, the social nature of knowledge is increasingly emphasised. This is

especially clear in characterisations of knowledge as process. Berger and Luckmann (1966) argue that all knowledge is derived from and maintained by social interactions. From this perspective, knowledge is contextual in nature but also widely distributed throughout communities and societies. Thus, the relationship between individual and collective knowledge is problematised and the need to ensure that knowledge can be effectively shared is emphasised. Based on these insights, knowledge is characterised in this study as:

> *A capacity for action or ability to interpret, authenticate, or personalise information and experience; a framework for evaluating and incorporating new experiences and information; this framework is developed through experience or study by means of ongoing, socially enacted processes; it cannot be divorced from context and is shaped by one's needs, initial knowledge frameworks, and experiences.*

This view that knowledge can be seen as a kind of framework is drawn from existing literature and is consistent with conceptualisations of knowledge structures that are found in modern psychology and clinical neurology (cf. Walsh, 1995). Knowledge structures are defined as mental templates that individuals "impose on an information environment to give it form and meaning" (Walsh, 1995, p. 281) or as "organised knowledge about a given concept or type of stimulus" (Fiske and Taylor, 1984, p.149).

The extraction and synthesis of this conceptualisation of knowledge from extant literature sheds light on why it may be useful to investigate innovation and knowledge using an integrated approach. The emphasis placed in literature on the practical or instrumental nature of knowledge explains why Albers and Brewer (2003) argue that innovation is one of the objectives of an effective knowledge management program and that organisations need to have innovation mechanisms that support knowledge creation, sharing, and integration if they are to stimulate the invention part of innovation. Thus, Suh *et al.,* (2004) develop an integrated knowledge management model for enabling innovation in R&D organisations. In

fact, numerous authors have investigated how specific aspects of organisational knowledge relate to organisational innovation. For example, Schiuma and Lerro (2008) investigate the role and the relevance of knowledge-based capital as a strategic resource and a source of regional innovation capacity. Harlow (2008) assesses the level of tacit knowledge within firms and finds significant relationships between a firm's level of tacit knowledge and its innovative performance. Chang and Lee (2008) investigate the linkage between knowledge accumulation capability and organisational innovation. The results indicate that the capability to obtain knowledge can positively and significantly affect technical innovation. Researchers have found that the role of outside sources of knowledge in the innovation process is often critical (Cohen and Levinthal, 1990). This observation is supported by Chang and Lee (2008) whose results indicate that the external environment and organisational culture both have significant interaction effects with knowledge accumulation capability on organisational innovation.

These findings illustrate that knowledge management scholars are united with innovation scholars in recognizing the central role of knowledge in innovation. In addition, these findings show that knowledge management scholars have succeeded in demonstrating that there is practical value to be gained from acknowledging the central role of knowledge in innovation. Subramaniam and Youndt (2005) acknowledge that "so close are the ties between research on knowledge and research on innovation, in fact that in recent years scholars have seen a blurring of the boundaries between these areas" (p. 450). The authors explain that it is now "quite common" for "studies examining innovation to use knowledge or intellectual capital as antecedents, and studies investigating knowledge and intellectual capital frequently use innovation as outcomes" (Subramaniam and Youndt, 2005, p. 450). Further, this characterisation of knowledge is commensurate with the definition of innovation as "the development and implementation of ideas that are perceived to be (i) novel and (ii) useful or valuable by those within a particular unit of adoption" adopted in Section 3.2.

In summary, this section has presented a series of conceptualisations of knowledge that permeate knowledge management research. This analysis was used to derive a characterisation of knowledge in the context of this study and to articulate a series of arguments in favour of developing an integrated approach for the investigation of innovation and knowledge in the context of this study. In the next section, existing classifications of knowledge are analysed.

3.5.2.2 Classifying knowledge

The purpose of this section is to extend the conceptualisation of knowledge presented above by means of analysing existing classifications of knowledge. This task is necessary in the context of this study for several reasons. First, the proposition that there are different types of knowledge is possibly the most pervasive theme in writing about the nature of knowledge (Nahapiet and Ghoshal, 1998). Second,

> a good classification functions in much the same way that a theory does, connecting concepts in a useful structure. If successful, it is, like a theory, descriptive, explanatory, heuristic, fruitful, and perhaps also elegant, parsimonious, and robust
>
> Kwasnik, 1999, p. 24

Thus, theoretical developments in knowledge management are likely to be influenced by the distinctions that are made between different types of knowledge (Alavi and Leidner, 2001). Finally, Alavi and Leidner (2001) observe that knowledge taxonomies in particular are important for designing knowledge systems because they focus attention on the kinds of knowledge to be supported.

In the knowledge management literature, distinctions are commonly drawn between different kinds of knowledge (Faucher *et al.,* 2008). Many knowledge classifications have been proposed. Alavi and Leidner (2001) identify ten commonly used knowledge types (i) tacit (tacit cognitive, tacit technical), (ii) explicit, (iii) individual, (iv) social, (v) declarative, (vi) procedural, (vii) causal, (viii) conditional, (ix) relational, (x) and pragmatic. Authors have also proposed knowledge traits including appropriability, imitability, adaptability and intensity.

Similarly, authors have posited the existence of knowledge processes including: acquisition; adaptation; adoption; aggregation; application; articulation; assimilation; building; codification; dissemination; diffusion; generation; imitation; recombination; representation; retrieval; storage; and transfer (or transmission). Whilst many classifications of knowledge have been proposed, this section considers two of the most commonly used classifications of knowledge: the tacit/explicit and the declarative/procedural distinctions. The analysis reveals that knowledge is classifiable in terms of being declarative or procedural but is not classifiable in terms of being tacit or explicit. Therefore, the analysis concludes in favour of recognizing the tacit and explicit dimensions of knowledge but classifying knowledge in terms of declarative and procedural knowledge.

Tacit and explicit dimensions of knowledge

The distinction between tacit and explicit knowledge is widely cited (Alavi and Leidner, 2001; Martín de Castro *et al.,* 2008). According to Polanyi (1966), explicit knowledge can be coded in writing or symbols, but only a small part of our knowledge is explicit; in his words, "we can know more than we can tell" (p. 4). Polanyi (1966) illustrates his argument with the following example: "you can identify one face out of thousands, but it is nearly impossible to give an adequate description of this face to another person, so that she is able to identify the face" (p.4). Thus, tacit knowledge forms the background necessary for assigning the structure to develop and interpret explicit knowledge (Alavi and Leidner, 2001). Polanyi does not fully define tacit knowledge but distinguishes two types of tacit knowledge: the proximal and the distal. Proximal knowledge is fully tacit whilst distal knowledge is 'specifiably known' and the functional relation between the two terms of tacit knowing is such that "*we know the first term only by relying on our awareness of it for attending to the second*" (Polanyi, 1966, pp. 9-10, italics in original). Further, Polanyi explains that given adequate means of expression, we can after all communicate what perhaps cannot be put in words. For instance, ostensive definitions ('naming-cum-pointing' definitions) conceal "a gap to be bridged by an intelligent effort on the part of the person to whom we want to tell what the word means" (Polanyi, 1966, p. 6).

Polanyi (1966) recognised that "formalising all knowledge to the exclusion of any tacit knowing is self-defeating" (p.4) because not all tacit knowledge can be made explicit. Similarly, Alavi and Leidner (2001) assert that the assumption that tacit knowledge is more valuable than explicit knowledge "is tantamount to equating an inability to articulate knowledge with its worth" (p.111). Nevertheless, knowledge management has traditionally been concerned with trying to eliminate tacit knowledge rather than finding ways to cope with tacit knowledge (Faucher *et al.,* 2008).

Osterloh and Frey (2000) suggest that the distinction between tacit and explicit dimensions of knowledge is important because it sheds light on the transferability and appropriability of explicit knowledge, as opposed to tacit knowledge. Whilst explicit knowledge has the character of a public good (with the exception of patents or copyrights), tacit knowledge is acquired by and stored within individuals and cannot be transferred or traded as a separate entity (Osterloh and Frey, 2000). Thus, scholars explain the distinction in these terms. For example, Zack (1999) argues that tacit knowledge is "subconsciously understood and applied, difficult to articulate, developed from direct experience and action, and usually shared through highly interactive conversation, story-telling and shared experience" (p. 46). In contrast, explicit knowledge "can be more precisely and formally articulated… [and] more easily codified, documented, transferred or shared" (Zack, 1999, p. 46).

Similarly, Nonaka (1994) draws on Polanyi to attempt to explicate the tacit and explicit dimensions of organisational knowledge in particular. Nonaka (1994) argues that the explicit dimension of knowledge is articulated, codified, and communicated in symbolic form and/or natural language and that the tacit dimension of knowledge is rooted in action, experience, and involvement in a specific context. Like Polanyi, Nonaka distinguishes two kinds of tacit knowledge. According to Nonaka (1994), the cognitive elements of tacit knowledge "refers to an individual's images of reality and visions for the future, that is to say, what is and what ought to be"; the concept is centred on "what

Johnson-Laird (1983) called ‘mental models’ in which human beings form working models of the world by creating and manipulating analogies in their minds” (Nonaka, 1994, p. 16). These models include declarative, paradigms, beliefs, and viewpoints that provide perspectives which help individuals perceive and define their world (Nonaka, 1994). The technical element of tacit knowledge “covers concrete know-how, crafts, and skills that apply to specific contexts” (Nonaka, 1994, p. 16).

However, the distinction has proven problematic at both theoretical and methodological levels. Faucher *et al.,* (2008) argue that the perspective has been commonly distorted to hold that data and information are explicit, and knowledge and wisdom are tacit. Further, empirical problems have arisen due to issues associated with attempts to define and operationalise variables relating to the distinction (Rice and Rice, 2005). In particular, there are difficulties associated with investigating tacit knowledge specifically, which is considered difficult to express at a definition level. The key (but often overlooked) element of Polanyi’s conceptualisation of the tacit and explicit dimensions of knowledge is that the two are not dichotomous states of knowledge; but are instead viewed as mutually dependent and reinforcing qualities of knowledge (cf. Polanyi, 1975). Thus, Tsoukas (2005, p. 410) indicates that Polanyi’s original arguments have been misinterpreted. Further, a number of authors (e.g. Leonard-Barton and Sensiper, 1998; Zander and Kogut, 1995) propose that the distinction between tacit and explicit knowledge should be understood as a continuum rather than as a dichotomy. In addition, it is noted that Polanyi himself acknowledged that knowing what (declarative knowledge) and knowing how (procedural knowledge) are distinct. Specifically, Polanyi argues that “the ‘*wissen*’ and ‘*können*’, the ‘knowing what’ and ‘knowing how’, have a similar structure and neither is ever present without the other” (p. 7, italics in original). Thus, the development of a skill tends to be accompanied by the development of a deeper understanding of the skill that defies articulation (Polanyi, 1958).

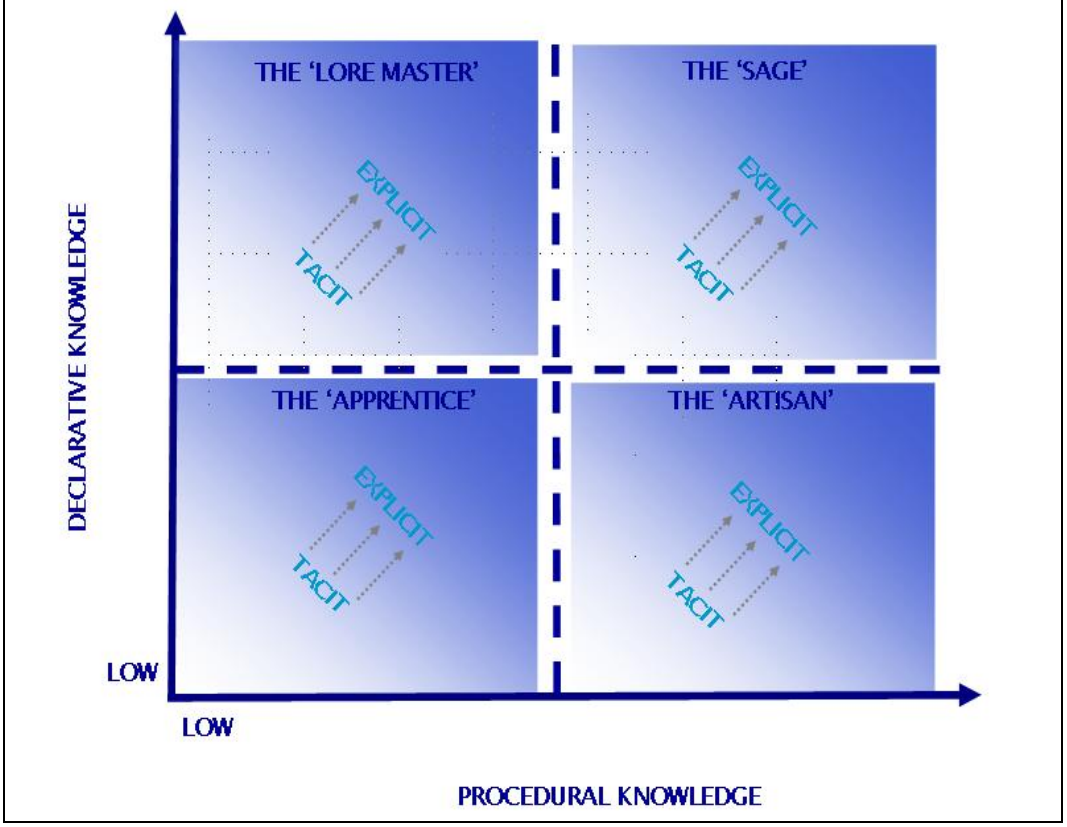
Declarative and procedural knowledge

Scholars frequently make a distinction between declarative and procedural knowledge (Nahapiet and Ghoshal, 1998). This distinction was first proposed by Ryle (1945), who distinguished between know-*what* and know-*how*. Ryle indicated that know-*what* consists of learning that something is the case whilst know-*how* consists of things like learning to play the piano or to prune trees (Ryle, 2002, p. 28). Declarative knowledge is defined as actual knowledge, expressed in propositions (Andersen, 1983); as knowing about something (Zack, 1999); and is said to concern the development of facts and propositions (Nahapiet and Ghoshal, 1998). Procedural knowledge is defined as methodological knowledge which is used for activities such as remembering how to ride a bicycle or play the piano (Andersen, 1983); as knowledge about something (Zack, 1999); and is said to concern well-practiced skills and routines (Nahapiet and Ghoshal, 1998). The distinction between know-what and know-how was also developed by Anderson (1976, 1983). Anderson (1976) indicates that there are three essential differences between the two types of knowledge. Declarative knowledge is verbally communicable, is acquired suddenly by means of instruction and is possessed entirely or not at all. Procedural knowledge is not verbally communicable, is gradually acquired by means of performance of a skill and may be partially possessed. According to Chia (2003), the art of doing (procedural knowledge) has been overshadowed by the art of reasoning, justification and the mastery of language (declarative knowledge). However, research on implicit learning and cognitive neuroscience evidence indicates that "these two types of knowledge are implemented neurally in fundamentally different ways" (Anderson and Lebiere, 1998, p. 21). This suggests that the distinction between declarative and procedural knowledge is of merit. This suggests that the distinction between declarative and procedural knowledge is of merit in the context of this study.

Based on these arguments, *knowledge is seen* in the context of this study, *to exist in declarative and procedural forms even as it is recognised to have tacit and explicit dimensions.* The merit of this conceptualisation of knowledge is best illustrated by means of an example. If one were to classify existing declarative

and procedural knowledge for a particular unit (e.g. individual, group or organisation) in a particular domain (e.g. knowledge of a particular market or technology) as either high or low, one could then classify that particular unit into one of four theoretical knowledge scenarios (see Figure 3.2) and make decisions accordingly. So for example, if one were to find that a particular unit's knowledge levels were low, that unit would be classified as an 'apprentice' for that knowledge domain. Similarly, if one were to find that a particular unit's declarative knowledge (of a particular domain) was high but its procedural knowledge was low, that unit would be classified as a 'lore master'. The merit of an analytical tool like this can easily be seen: it can be used to assess existing knowledge levels in a variety of contexts and can be used at multiple levels of analysis. In addition, it could be used to compare and contrast levels of knowledge across individuals and teams. However, the literature review process has not uncovered any such model in literature nor has it found any empirical support for the merit of such a tool.

FIGURE 3.2 PROPOSING A SET OF KNOWLEDGE CREATOR ARCHETYPES



In summary, this section explored conceptualisations of knowledge that permeate knowledge management research. In addition, the section analysed existing classifications of knowledge. This analysis supports the utilization of the classification of declarative and procedural knowledge as it is commensurate with the classification of product and process innovation adopted in this study. The analysis also illustrated a series of arguments in favour of developing an integrated approach for the investigation of innovation and knowledge in this study. In the next section, the analysis begins to focus more specifically on developing that approach for the purposes of this study.

3.6 Creating knowledge: getting to the core of innovation and knowledge

The analysis presented in Sections 3.4 indicates that it is increasingly recognised that knowledge is at the heart of innovation. The purpose of this section is therefore to develop an integrated approach for investigating innovation and knowledge. To that end, the analysis presented in Section 3.6.1 proposes that specifically focusing on knowledge creation constitutes an effective means of accomplishing this aim. Section 3.6.2 is therefore concerned with exploring the concept of knowledge creation. The discussion problematises extant conceptualisations of knowledge creation and knowledge creation processes in particular. Therefore, a new characterisation of knowledge creation is developed for the purposes of this study (Section 3.6.3).

3.6.1 Recognizing the importance of knowledge creation for innovation

The purpose of this section is to argue that knowledge creation specifically is at the core of innovation. This argument is developed by leveraging and synthesising arguments set forth by knowledge management scholars that support this view. The discussion illustrates that knowledge management scholars argue that knowledge creation (i) supports innovation; (ii) is at the heart of innovation; or (iii) is the same as innovation. Further, it is indicated that the field of knowledge management is undergoing a fundamental paradigm shift as a result of these insights.

Scholars have indicated that *knowledge creation supports organisational innovation*. Popadiuk and Choo (2006) indicate that the concepts of innovation and knowledge creation "have a strong but complex relationship" (p. 302) - where "innovation depends on knowledge creation" (p. 308) - and therefore requires a "well-planned system of knowledge management that enables the firm to excel in technological, market and administrative knowledge creation" (p. 302). Popadiuk and Choo (2006) investigate the association between innovation and knowledge creation. Their analysis identifies similarities and differences between innovation and knowledge creation and concludes with a framework which differentiates types of innovation based on a knowledge creation perspective. Similarly, Nonaka *et al.,* (2000) argue that a "shift in our thinking concerning innovation in large business organisations" is required in order to increase understanding of how organisations actually create and manage knowledge dynamically in pursuit of competitive advantage (p. 4).

Scholars increasingly recognise that *knowledge creation is at the heart of innovation* (Nonaka and Takeuchi, 1995; Swan *et al.,* 1999; Nonaka *et al.,* 2000; Gold *et al.,* 2001; Popadiuk and Choo, 2006; Lam, 2006). Swan *et al.,* (1999) argue that "the creation and application of knowledge is at the core of innovation" (p. 272). Similarly, Nonaka and Takeuchi (1995) argue that when organisations innovate, they "do not simply process information… they actually create new knowledge and information, from the inside out, in order to redefine both

problems and solutions and, in the process, to re-create the environment" (p.56). The capability to create and apply new knowledge is therefore increasingly considered as one of the main sources of the competitive advantage of the firm (Almeida *et al.,* 2002; Leonard-Barton, 1990; Nonaka, 1991; Spender, 1996; Teece, 1998; Von Krogh, 1998; Zollo and Winter, 2002; Jakubik, 2008; Martin-de-Castro *et al.,* 2008).

In addition, scholars have argued that *knowledge creation is the same as innovation*. For example, Gold *et al.,* (2001) argue that innovation "is the creation of new knowledge from the application of existing knowledge" (p., 190). Lam, 2006) conceptualises innovation as "a process of organisational learning and knowledge creation" (p. 138). Nonaka (1994) also suggests that innovation "is a key form of organisational knowledge creation" and that it "can be better understood as a process in which the organisation actively develops new knowledge to solve problems" which they themselves create and define (p. 14).

Thus, scholars (e.g. Nonaka, 1994; Malhotra, 2000, pp. 2-20; Kogut and Zander, 1996) argue that a knowledge creation orientation is needed (to replace the input-output or information processing metaphor of old) to develop an ability to effectively manage knowledge in organisations. For example, Kogut and Zander (1996) propose that "a firm be understood as a social community specialising in the speed and efficiency in the creation and transfer of knowledge" (p. 503). As a result, the field of knowledge management has undergone a "paradigm shift" (e.g. Kuhlen, 2004; Hazlett *et al.,* 2005).

Knowledge management scholars who traditionally pursued a strategy of knowledge dissemination are therefore increasingly turning their attention to seeking to encourage and share the 'knowing' that arises directly from the experiences of employees (Matsuo and Easterby-Smith, 2008). Gao *et al.,* (2008) refer to these two approaches as the 'hard camp' and the 'soft camp'. The 'hard camp' is focused on capturing, abstracting, codifying, organising, storing, diffusing, reusing, transferring, and transforming knowledge. The 'soft camp', on

the other hand, focuses on cultures of knowledge creation and knowledge sharing. Thus, knowledge management has moved from a static, knowledge-warehouse approach toward a dynamic, communication-based or network approach (Kuhlen, 2004); or from a computational paradigm that was primarily focused on the explicit dimensions of knowledge (Chia, 2003) toward an organic paradigm that is primarily focused on the tacit dimension of knowledge (Hazlett *et al.,* 2005).

In summary, this section has argued that knowledge creation is at the core of innovation and that there is therefore (a recognised and practical) value associated with investigating knowledge creation in innovative contexts. Therefore, the remainder of the discussion presented in this section focuses particularly on knowledge creation.

3.6.2 Conceptualisations of knowledge creation in literature

The purpose of this section is to analyse extant conceptualisations of knowledge creation in literature. Table 3.8 indicates that knowledge creation is seen as (i) a process whereby tacit and explicit forms of knowledge are converted (Section 3.6.2.1), (ii) a process of extending (or modifying) knowledge stocks (Section 3.6.2.2); and (iii) a fundamentally social and interpretive process (Section 3.6.2.3). The section then explores the critiques that have been levelled at these perspectives (Section 3.6.2.4) and at the SECI model in particular (Section 3.6.2.5).

TABLE 3.8 CONCEPTUALISATIONS OF KNOWLEDGE CREATION		
VIEW	**DEFINITION**	**AUTHOR(S)**
Knowledge creation as (spiral) conversion process	Organisational knowledge creation: "an upward spiral process, starting at the individual level moving up to the collective (group) level, and then to the organisational level, sometimes reaching out to the interorganisational level"	Nonaka (1994, p. 20)
	Organisational knowledge creation is "a spiralling process of interactions between explicit and tacit knowledge. The interactions between these kinds of knowledge lead to the creation of new knowledge. The combination of the two categories makes it possible to conceptualise four conversion patterns... Each of the four conversion modes can be understood as processes of self-transcendence"	Nonaka and Konno (1998, p. 42)
	Organisational knowledge creation is "the capability of a company as a whole to create new knowledge, to effectively disseminate it throughout the organisation (i.e. to where it is needed) and to embody it in products, services and systems". Knowledge is created when "tacit and explicit knowledge are transformed into one another through four processes: Socialization, Externalization, Internalization, Combination"	Nonaka and Takeuchi (1995 p. viii)
Knowledge creation as extending existing knowledge stocks	Organisational knowledge creation involves developing new content or replacing existing content within the organisation's tacit and explicit knowledge	Pentland (1995); Alavi and Leidner (2001, p. 116)
	New knowledge consists of "discoveries about phenomena that were not known previously… knowledge creation is a path-dependent process... [whereby] newly acquired inputs are integrated with existing knowledge stocks"	McFayden and Cannella (2004, pp. 735-736)
Knowledge creation as social and interpretive process	"When we create new knowledge we make sense out of a new situation by holding justified beliefs, committing ourselves to this new situation, and, most importantly, by enhancing our potential to act in a new situation...	Von Krogh (1998, pp. 134-136)
	Knowledge creation "is an intensely human, messy process of imagination, invention and learning from mistakes, embedded in a web of human relationships"	Scharmer (2001, p. 247); Jakubik (2008)

3.6.2.1 Knowledge creation as spiral knowledge conversion process ('SECI')

The conceptualisation of *knowledge creation as a spiral process of conversion* is rooted in the 'SECI' model of knowledge creation. This model was first proposed by Nonaka (1991; 1994) and has been extended by a number of authors (cf. Nonaka *et al.,* 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka *et al.,* 2000; Nonaka and Toyama, 2003). The SECI model is one of the most widely cited theories in knowledge management and is the most widely cited model of the knowledge creation process in particular (Cao *et al.,* 2010; Gourlay, 2003). The remainder of this section discusses the SECI model in greater detail.

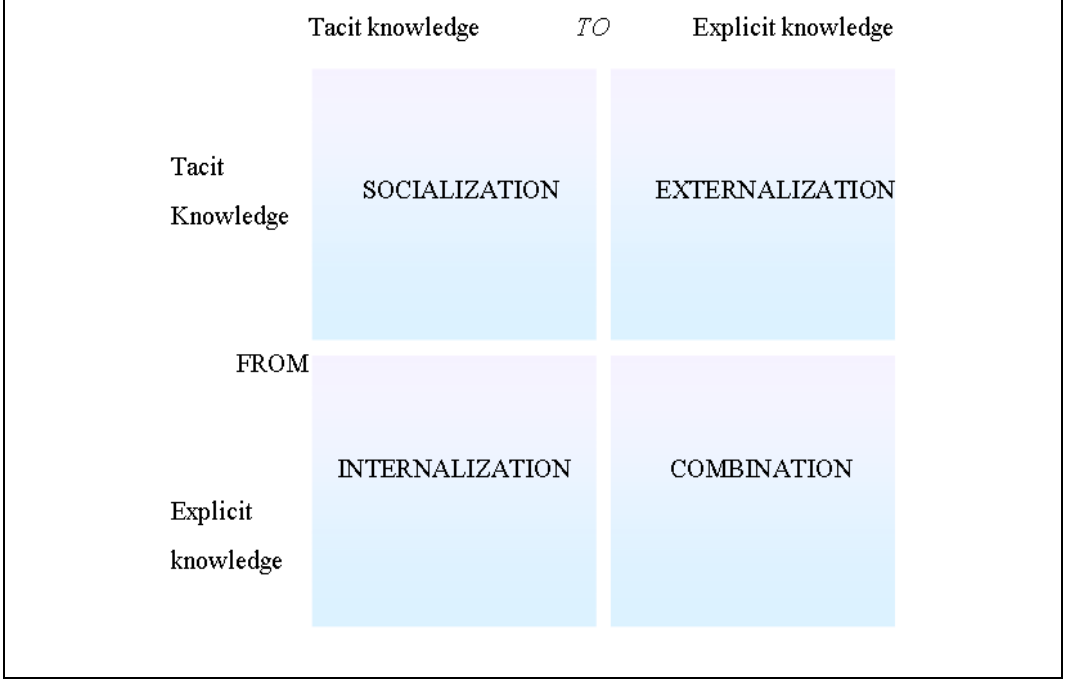
The distinction between tacit and explicit knowledge is at the heart of the SECI model. According the Nonaka (1994), tacit knowledge is "a continuous activity of knowing" and communication between individuals may be seen as "an analogue process that aims to share tacit knowledge to build mutual understanding" (pp. 16-17). In contrast, Nonaka (1994) indicates that explicit knowledge is discrete and is captured in records of the past and is accessed sequentially (Nonaka, 1994). According to Nonaka (1994, p. 18), the SECI model postulates that there are four different modes of knowledge conversion (cf. Figure 3.3):

(i) Socialization (tacit knowledge is converted to tacit knowledge)
(ii) Externalization (tacit knowledge is converted to explicit knowledge)
(iii) Combination (explicit knowledge is converted to explicit knowledge)
(iv) Internalization (explicit knowledge is converted to tacit knowledge).

During *socialization*, tacit knowledge is exchanged through joint activities rather than through written or verbal instructions. Thus, socialization involves "capturing knowledge" through "physical proximity" (Nonaka and Konno, 1998, pp. 42-43). *Externalization* "requires the expression of tacit knowledge and its translation into comprehensible forms that can be understood by others"; thus techniques such as dialogue, metaphor, analogy and narrative can support externalization (Nonaka and Konno, 1998, pp. 43-44). *Combination* involves the conversion of explicit knowledge into more complex sets of explicit knowledge and the key issues at this stage are systematising knowledge and knowledge communication and diffusion processes (Nonaka and Konno, 1998, pp. 44-45). In practice, the combination mode relies on three processes: (i) capturing and integrating new explicit knowledge, (ii) the direct dissemination of explicit knowledge by means of presentations and meetings, and (iii) the editing or processing of explicit knowledge to make it more usable (Nonaka and Konno, 1998, pp. 44-45). Finally, *internalization* requires individuals within the organisation to identify knowledge that is relevant to themselves within organisational knowledge (Nonaka and Konno, 1998, p. 45). Internalization is accomplished by means of learning- by-doing, training, and exercises (Nonaka and Konno, 1998, p. 45). For internalization to take place, explicit knowledge has

to be embodied in action and practice, therefore training programs and simulations or experiments are important in triggering internalization (Nonaka and Konno, 1998, p. 45).

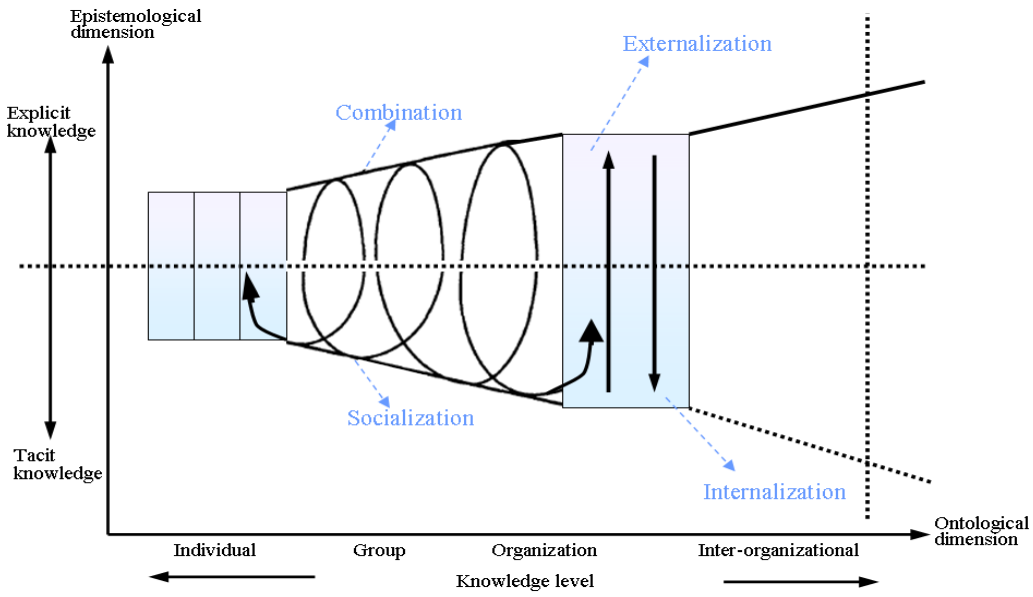
FIGURE 3.3 MODES OF KNOWLEDGE CREATION (SOURCE: NONAKA, 1994)



Nonaka (1994) explains that each of the four knowledge conversion modes can create new knowledge independently but the "central theme" of the model "hinges on a dynamic interaction between the different modes of knowledge conversion" (p. 20). In particular "the articulation of tacit perspectives in a kind of 'mobilization' process" is a key factor in the creation of new knowledge (Nonaka, 1994, p. 16). Nonaka further distinguishes between individual and organisational knowledge creation arguing that organisational knowledge creation takes place when all four modes are 'organisationally' managed to form a continual cycle. Nonaka indicates that even though individuals' tacit knowledge is at the heart of knowledge creation, organisations realise the practical benefits of knowledge through externalization and amplification (through dynamic interactions between all four modes of knowledge conversion) (Nonaka, 1994, p. 20). Thus, the interaction between individuals, groups and organisations is at the heart of the process of knowledge creation. When this happens, tacit knowledge is "mobilised

through a dynamic 'entangling' of the different modes of knowledge conversion in a process which will be referred to as a 'spiral' model of knowledge creation" (Nonaka, 1994, p. 20). This is illustrated in Figure 3.4.

FIGURE 3.4 ORGANISATIONAL KNOWLEDGE CREATION SPIRAL (cf. Nonaka,1994)



3.6.2.2 Knowledge creation as a process of extending knowledge stocks

The conceptualisation of *knowledge creation as a process of extending existing knowledge stocks or knowledge assets* is exemplified by Alavi and Leidner (2001) who argues that knowledge creation involves "developing new content or replacing existing content within the organisation's tacit and explicit knowledge" (p. 116). This perspective is informed by traditional perspectives on knowledge management. Specifically, this perspective builds upon conceptualisations of knowledge as an object; as a condition of having access to information; and as a process (cf. Table 3.7). In addition, the distinction between tacit and explicit knowledge is at the heart of this view of knowledge creation. In addition, this conceptualisation of knowledge creation extends what Compton and Jansen (1990) refer to as the "physical symbol hypothesis", whereby knowledge is seen to consist of "symbols of reality and relationships between these symbols"; and

"intelligence is the appropriate logical manipulation of the symbols and their relations" (p. 2).

This conceptualisation of knowledge creation underlines the fact that "knowledge resides within and is created by individual" (McFayden and Cannella, 2004, p. 736). This is because "the know-how and information that individuals gain over time forms their knowledge stocks" which in turn "shape the scope and direction of the search for new knowledge" (McFayden and Cannella, 2004, p. 736). Thus, Von Krogh (1998) observes that both exploration and exploitation are important in the quest to continually build knowledge but that exploration (which involves trying new processes and developing ideas that are outside an organisation's repertoire of routines) in particular is useful in stimulating knowledge creation. The view that knowledge resides within and is created by individuals and the view that exploration and exploitation are important for knowledge creation are used to inform the construction of, and selection of variables for, the preliminary framework used to guide this study.

3.6.2.3 Knowledge creation as a social and interpretive process

The conceptualisation of *knowledge creation as a social and interpretive process* is also informed by traditional perspectives on knowledge management. Specifically, this view builds upon the conceptualisation of knowledge as a state of mind (cf. Table 3.7). In addition, this perspective also underlines the centrality of the individual to the process of knowledge creation. In this perspective, it is through "an individual's cognitive processes (e.g., reflection) [that] knowledge is created, shared, amplified, enlarged, and justified in organisational settings" (Alavi and Leidner, 2001, p. 116). Thus, Von Krogh (1998) focuses on the manner in which individuals justify their own beliefs from observations of the worlds, which in turn depend on unique viewpoints and personal sensemaking that are born of individual experience. However, whilst underlining the centrality of the individual, this perspective also draws attention to the fact that individuals create knowledge as social entities engaged in collaborative processes (Alavi and Leidner, 2001). Thus, the focus of knowledge management research is

increasingly directed toward knowledge creation in human interactions (Jakubik, 2008). For example, Von Krogh (1998) argues that the first steps in knowledge creation ("sharing tacit knowledge" and "creating concepts") hinge on individuals being able to share their personal true beliefs about a situation with others (pp. 134-136). At this point, the process of creating knowledge becomes a public process of justification.

In addition to highlighting the social and collaborative nature of knowledge creation, this perspective highlights (i) the central role of the individual in knowledge creation and (ii) the importance of an individual's prior experience in shaping the creation of knowledge. These ideas inform the construction of, and the selection of variables for, the preliminary framework used to guide this study.

3.6.2.4 Critiquing extant conceptualisations of knowledge creation

Having introduced three conceptualisations of knowledge creation in literature, the purpose of this section is to explore criticisms that have been levelled at these perspectives. The discussion focuses on the distinction between tacit and explicit knowledge (which is at the heart of these views). The discussion also considers the emphasis placed on the process of knowledge creation.

Notwithstanding the fact that several authors (e.g. Hedlund, 1994; Nonaka, 1994; Vera and Crossan, 2005; Heffner and Sharif, 2008) utilise the distinction between tacit and explicit knowledge (Martín-de-Castro *et al.,* 2008), the main critiques of extant conceptualisations of knowledge creation focus on the *distinction between tacit and explicit knowledge*. All three conceptualisations of knowledge creation discussed in Section 3.5.2 are based upon the distinction between tacit and explicit knowledge. However, there are a number of conceptual problems associated with using this classification. Gourlay (2006) argues that there is "always an irreducibly tacit aspect to any explicit knowledge/knowing"; therefore any model of knowledge creation processes that begins with tacit knowledge must account in some way for inherently as well as contingently tacit knowledge (Gourlay, 2006, p. 1422). In fact, this argument stems from Polanyi's attempt to distinguish two

forms of tacit knowledge: proximal knowledge which is fully tacit and distal knowledge which is 'specifiably known'.

Extant conceptualisations of knowledge creation are also primarily focused on knowledge creation as a process. This emphasis on process based research has meant that few authors have considered the conditions that give rise to knowledge creation. Thus, there is little understanding of how knowledge is created (Nonaka *et al.,* 2000, p. 4; McFayden and Cannella, 2004; Yang *et al.,* 2010) or of how the knowledge creation process can be effectively managed (cf. Yang *et al.,* 2010) or evaluated (cf. Chen and Edgington, 2005) in organisations. This constitutes a gap in existing research.

3.6.2.5 Critiquing the SECI model of knowledge creation

The SECI model represents the dominant view of knowledge creation in literature (Cao *et al.,* 2010; Gourlay, 2003). However, whilst the SECI model is intuitively attractive (Rice and Rice, 2005), scholars have identified a number of problems with this model. Therefore, the purpose of this section is to explore these problems.

In terms of the *conceptual problems associated with the SECI model*, a number of authors have focussed on how the model views tacit and explicit knowledge. For example, Adler (1995) indicates that the contrast between tacit and explicit knowledge is conceptualised in the SECI model in too rigid a manner to facilitate the development of a dynamic model of tacit-explicit knowledge inter-relatedness (pp. 110-111). Spender (1996) argues that the four knowledge conversion modes are simply "the means of communicating the two modes of knowing around the firm" (p.51). Finally, Gourlay (2006) also problematises the distinction made between combination and internalization, arguing that they appear to be ambiguous notions that conflate knowledge creation and transfer. Thus, Nonaka *et al.,* (2006) define organisational knowledge creation without making reference to either tacit or explicit knowledge. Instead, the authors define organisational knowledge creation as "the process of making available and amplifying

knowledge created by individuals as well as crystallizing and connecting it to an organisation's knowledge system. In other words, what individuals come to know in their (work-) life benefits their colleagues and, eventually, the larger organisation" (p.1179).

In addition, scholars (e.g. Spender, 1996; Gourlay, 2006) argue that the SECI model omits important philosophers and misreads several important organisational writers. For example, Spender (1996) argues that the model deviates from the argument that organisations learn by means of acquiring better routines (cf. Nelson and Winter, 1982). In addition, Jorna argues that the model omits a discussion of earlier work on the distinctions between tacit and declarative knowledge. Furthermore, Jakubik (2008) problematises the asset view of knowledge found in the SECI model.

Empirical work on the knowledge creation is also lacking (McFayden and Cannella, 2004; Rice and Rice, 2005). In the course of this study, only three studies (Nonaka *et al.,* 1994; Chou and He, 2004; Chou and Tsai, 2004) were identified which investigated the SECI model empirically. The findings of these studies support the existence of four knowledge conversion modes (Nonaka *et al.*, 1994) and suggest that knowledge assets in organisations influence knowledge creation (Chou and He, 2004; Chou and Tsai, 2004). The empirical difficulties associated with the SECI model are believed to stem from the fact that the boundaries between explicit and tacit knowledge are indistinct in the model. This makes the statistical testing of SECI-derived propositions difficult (Rice and Rice, 2005).

3.6.3 Synthesising a new characterisation of knowledge creation

The analysis presented in Section 3.6.2 has discussed the main conceptualisations of knowledge creation in literature and has identified the main problems associated with them. Therefore, the purpose of this section is to synthesise a new conceptualisation of knowledge creation for the purposes of this study.

The analysis presented in Section 3.5.2 has carefully constructed a characterisation of knowledge for the purposes of this study. This analysis provides a solid basis upon which to construct a new characterisation of knowledge creation. Specifically, this characterisation of knowledge suggests that knowledge creation can be characterised as:

> *Changes to frameworks used for evaluating and incorporating new experiences and information; these changes affect the capability or ability to interpret, authenticate or personalise both information and experience; these changes; occur through experience or study by means of ongoing, socially enacted processes; they cannot be divorced from context and are shaped by one's needs, initial knowledge frameworks, and one's experiences.*

This characterisation of knowledge creation extends the characterisation of knowledge that is derived from existing literature in this study but effectively deviates from existing conceptualisations of knowledge creation. In particular, this characterisation of knowledge creation supports the view that knowledge can be viewed as an evolving 'framework' that provides a capacity for action and is shaped by experience, study and ongoing, socially enacted processes. This characterization is reminiscent of Kohonen's concept of the (dynamic, associative) self-organizing map, where the learning result is influenced by what already exists in the system (Honkela 2005). This view is not based on the distinction between tacit and explicit knowledge but is commensurate with the distinction between declarative and procedural knowledge (cf. Section 3.5.2.2).

This characterisation of knowledge creation is appropriate in terms of pursuing an integrated investigation of innovation and knowledge. This is in part because the conceptualisation underlines the idea that knowledge is created in a manner that relates to existing knowledge. In other words, the definition is relativistic in nature and does away with the idea that the creation of knowledge in some way involves the generation of independently or objectively new knowledge. This is also because this conceptualisation of knowledge creation reflects contemporary

perspectives in innovation research which problematise the idea that an innovation be defined in terms of objective newness to the world. In addition, the definition indicates that the creation of knowledge meaningfully affects one's capacity for action. This idea reflects contemporary perspectives in innovation research which emphasise that innovation is concerned with implemented or implementable ideas.

In order to elucidate this characterisation of knowledge creation, the remainder of the discussion compares knowledge creation with four conceptually similar constructs: (i) learning, (ii) sense making, (iii) knowledge assimilation, and (iv) knowledge acquisition. It is indicated that this conceptualisation of knowledge creation can be readily distinguished from knowledge acquisition and sensemaking but that it is conceptually more similar to the concepts of learning and knowledge assimilation.

3.6.3.1 Knowledge creation versus learning

Jakubik (2008) suggests that theories of learning and knowledge creation developed in two different disciplines (education / organisation studies and knowledge management, respectively) and that knowledge creation and learning are commonly used synonymously. However, opinion is divided in terms of how the two concepts are related. Several authors (e.g. Kolb, 1984; Vera and Crossnan, 2005) indicate that learning is the process whereby knowledge is created through the transformation of experience. At the same time, a number of authors (e.g. Nonaka, 1994; Alavi and Leidner, 2001) suggest that knowledge creation *includes* learning by indicating that learning most closely resembles a form of knowledge creation where knowledge is converted from explicit to tacit form (internalization). Meanwhile, Jakubik (2008) argues that it is learning that *includes* the process of knowledge creation as well as many other processes, such as knowledge destruction, forgetting, and re-learning. Learning is distinguished from knowledge creation on the basis of the epistemological assumptions that are brought to bear in defining the terms. For example, scholars who argue that learning is the process whereby knowledge is created (e.g. Vera and Crossan, 2005) indicate that knowledge is equivalent to content. Meanwhile, scholars who

argue that knowledge exists in tacit and explicit forms, see learning as a specific mode whereby knowledge is converted from one form to another. In the context of this study, the characterisation of knowledge simultaneously invokes the metaphor of knowledge as content and the metaphor of knowledge as processual, and grounded in action and experience. In this light, the usefulness of distinguishing between the creation of knowledge and learning is questionable as there is no attempt to distinguish between knowledge-as-content and learning-as-process.

3.6.3.2 Knowledge creation versus sense making

According to Klein *et al.,* (2006), sensemaking is the ability or attempt to make sense of an ambiguous situation; more specifically, it is "a motivated, continuous effort to understand connections in order to anticipate their trajectories and act effectively" (p. 71). Sensemaking includes a number of steps that move from (i) the recognition of a gap in existing knowledge to (ii) the formation of an initial model of the knowledge needed to complete the task and from there to (iii) a search for information and (iv) an analysis and synthesis of that information which leads to the creation of insight and understanding that are used in turn for (v) the creation of a "knowledge product" or direct action that is based on that insight or understanding (White and Roth, 2009, p. 31). The view that individuals, groups or organisations are capable of recognizing gaps in existing knowledge is problematic. This is in part because it is recognised that learning is often unintentional or unsystematic; that entities can incorrectly learn; that entities can correctly learn what is incorrect (Huber, 1991); and that the knowledge structures that are used to make complex situations tractable can blind information workers (Walsh, 1995). Therefore, the existence of a gap or problem with existing knowledge may go unrecognised. Further, the conceptualisation of sense making presented above can be seen to be unduly focused on information and the creation of a knowledge product by means of a processing (an "analysis and synthesis") of information. This view is also at odds with the conceptualisation of knowledge creation established in the context of this study. Instead, this study emphasises that information interpretation (defined as "the process through which information

is given meaning" by Daft and Weick (1984, p. 294) is a core element in the creation of knowledge but that knowledge is fundamentally created by means of contextually specific and socially enacted processes.

3.6.3.3 Knowledge creation versus knowledge assimilation

According to O'Leary (2003), assimilation means to take in and absorb as one's own; to bring into conformity with the customs of a group; or to convert to substances that are suitable for incorporation (p. 30). Thus, new knowledge needs "to be consistent with the existing knowledge" or "to be converted to a format consistent with previously existing knowledge" (p. 29). From this perspective, new knowledge can lead to "whole new ways of doing things" but for this to happen, knowledge must first be fully assimilated: knowledge "may be gathered, created or converted, but if it is not assimilated, the organisation will not be able to take action on that knowledge or actualise all of its potential value" (p.29). However, in the context of this study, the characterisation of knowledge indicates that knowledge is a capacity for action and a framework that is used to evaluate and incorporate new experiences and information. Therefore, the concept of knowledge creation is seen to encapsulate this notion of assimilation at a definitional level.

3.6.3.4 Knowledge creation versus knowledge acquisition

According to Gold *et al.,* (2001), acquisition-oriented knowledge management processes are those oriented toward obtaining knowledge; are based on the accumulation of knowledge; and are described using terms such as acquire, seek, capture, generate and create. This view suggests that the acquisition of knowledge is similar to, if not synonymous with, the creation of knowledge. However, the notion that knowledge can be 'acquired' or 'captured' has been problematised by knowledge scholars. King (1990) criticises the pervasive assumption that innovations are imported rather than internally generated (p. 54). Similarly, Compton and Jansen (1990) argue that knowledge cannot readily be captured because it varies with context and its validity is determined in contextually specific ways. In the context of this study, the view that knowledge can be

acquired or captured is at odds with the some of the key elements of the study's conceptualisation of knowledge. Specifically, it is at odds with (i) the view that knowledge cannot be divorced from context; (ii) the view that knowledge is shaped by one's needs, initial knowledge frameworks and prior experiences; and (iii) the view that knowledge is developed through experience or study by means of socially enacted processes (cf. Section 3.2.2).

3.7 Summary and Conclusion

This section summarises and concludes the analysis presented in this chapter. Based upon insights into the key areas being investigated by virtual world scholars (identified in Chapter Two), the analysis has considered extant literature in the fields of innovation and knowledge management.

Section 3.2 has deconstructed a number of key themes that permeate existing definitions and classifications of innovation in order to define innovation for the purposes of this study. Section 3.3 has provided an account of innovation research at individual, group and organisational levels of analysis and has also considered research on the diffusion of innovations. Section 3.4 reveals that the role of knowledge in innovation is increasingly recognised in the field of innovation. Scholars in this field define innovation in terms of knowledge and are focused on the creation of ideas, formulas, approaches, or schemes that challenge the present order. Further, these scholars are increasingly focused on the "fuzzy front end" of innovation (Montoya-Weiss and O'Driscoll, 2000), where ideas are generated and selected. Section 3.5 probes conceptualisations of knowledge in Western philosophy and knowledge management. The analysis reveals that knowledge management seeks to understand how knowledge can be operationalised in organisations (Marr and Spender, 2004, p. 183) and that innovation, in particular, is one of its core objectives (Albers and Brewers, 2003). Further, the analysis confirms that knowledge management researchers explicitly recognise that knowledge is at the core of innovation. Taken together, these sections make a compelling case for developing an integrated approach for the investigation of innovation and knowledge in this study. Further, the analysis makes a number of

contributions that are designed to achieve this aim. In particular, the analyses contribute new conceptualisations of innovation and knowledge. These conceptualisations are grounded in extant literature in these fields. In particular, the analysis highlights the importance of the distinction between declarative and procedural knowledge that is made in the field of knowledge management specifically and suggests how this classification might be used to identify different kinds of knowledge scenarios. The final piece of the jigsaw is presented in Section 3.6. This section highlights increased dissatisfaction with the dominant information processing view of knowledge and draws attention to the increased emphasis placed on knowledge creation in research. The chapter concludes that focusing on knowledge creation represents the key to unlocking the relationship between innovation and knowledge and presents a characterization of knowledge creation to drive future research.

4 RESEARCH METHODOLOGY

4.1 Introduction

According to Bouchard (1976), the "key to good research lies not in choosing the right method, but rather is asking the right question and picking the most powerful method for answering that particular question" (p. 402). In other words, a research strategy is chosen according to the fit between it and the purpose of the study and the nature of the research question posed (Marshall and Rossman, 2006). Fundamentally, a research strategy can therefore be seen as the logic that links the data that will be collected, and the conclusions that will be drawn, to the study's original questions (Yin, 2003). The purpose of this chapter is to present and defend the research design employed in this study.

The identification of a suitable research objective is essential when undertaking a research study (Jenkins, 1985; Mumford, 1985). Section 4.2 therefore presents the study's research objective: to investigate knowledge creation in innovative virtual world projects. Section 4.3 serves two purposes. In the first instance, the section articulates an argument in favour of using a preliminary theoretical framework to guide the study. It then leverages extant research on innovation and knowledge creation to develop a preliminary framework of knowledge creation to guide an investigation of knowledge creation in virtual worlds. Remenyi and Williams (1995) argue that the choice of research methodology must emerge from an examination of available approaches. Therefore, Section 4.4 evaluates the pros and cons of different research approaches (from the level of research paradigms right through to the level of data collection and analysis techniques) with reference to the study's research objective. Section 4.5 presents the research protocol that was used in carrying out the study. This section shows the overall timeline of the study. It also explains how particular (data collection and data analysis) techniques were used. Finally, it explains how the study's sampling strategy (which called for the selection of innovative projects in virtual worlds) was operationalised. Section 4.6 concludes the chapter. Its purpose is to provide an analysis of the techniques that were used in carrying out the study to ensure the trustworthiness of its findings.

4.2 Identifying the research objective for this study

The identification of a suitable research objective is essential when undertaking a research study (Jenkins, 1985; Mumford, 1985). Thus, an unambiguous statement of the research objective is necessary in order to facilitate the selection of a suitable research methodology (Jenkins, 1985). The purpose of this section is to present the study's research objective.

In this study, the articulation of the research objective constitutes the integration of three strands of research. The analysis presented in Chapter Two has taken virtual worlds as a starting point and has shown that existing virtual world researchers are fundamentally interested in seeking to understand the nature of communication and collaboration; innovation; and knowledge creation in virtual worlds. The analysis presented in Chapter Three has therefore primarily focused on two distinct streams of research: innovation research and knowledge management research. The analysis has shown that the central role of knowledge in innovation is increasingly recognised in the fields of innovation and knowledge management. Therefore, the analysis has argued in favour of pursuing an integrated investigation of innovation and knowledge. Further, the analysis has shown that knowledge management scholars specifically argue that knowledge creation (i) supports innovation, (ii) is at the heart of innovation, or (iii) is the same as innovation. Therefore, the analysis has argued in favour of investigating knowledge creation in virtual worlds.

Based upon these insights, the research objective for this study can be stated as follows:

To investigate knowledge creation in innovative virtual world projects

In order to achieve the research objective, a preliminary framework of knowledge creation is constructed. This framework is presented in the next section.

4.3 Developing a framework of knowledge creation

This section serves two main purposes. In the first instance, the section outlines the rationale underpinning (and merits of) the use of a preliminary framework to guide this study (Section 4.3.1). In the second instance, the section presents the framework itself and explains how it has been derived from extant research (Section 4.3.2).

4.3.1 In favour of constructing a preliminary framework

Research questions are commonly used to establishing the general boundaries of qualitative studies and are therefore useful in providing *focus* in qualitative research settings (Lincoln and Guba, 1985, p. 228). This study breaks with this convention and relies instead on the use of a preliminary framework to guide the study. This section articulates three arguments in favour of this approach. The first argument relates to the novelty of the study's research setting. The second argument relates to the role of theory in the study. The third argument relates to the transparency of the study's analysis and findings.

A number of scholars have indicated that *a preliminary framework is useful in carrying out research in novel settings.* For example, Nutt (1993) indicates that purely emergent approaches to research can be 'unwieldy' in novel research contexts, particularly where large data sets are involved. In these settings, the utilisation of preliminary theoretical frameworks may therefore be useful (Nutt, 1993). Similarly, Van Maanen (1979b) argues that "tenderly held presuppositions about the world often represent the best we can do when attempting to see, grasp, and perhaps decode empirical phenomena" (p. 539). Further, Stake (1995) also argues that in fact most researchers produce their best work by being "thoroughly prepared to concentrate on a few things yet ready for unanticipated happenings" (p. 55).

At the same time, a number of scholars (e.g. Bariff and Ginzberg, 1982; Teng and Valetta, 1991; Butler, 2002) have indicated that *a preliminary framework is useful in attempting to build theory.* This is at least partly because theories "provide the

essential guidance for determining what data need to be collected when studying or developing a new conceptualisation of phenomena" (Wheeler, 2002, p. 129).

Finally, it is "the intimate connection with empirical reality that permits the development of a testable, relevant, and valid theory" (Eisenhardt, 1989, p. 532). Therefore, the articulation and presentation of a preliminary framework serves to make the linkages between existing research, empirical data and theoretical framework explicit.

4.3.2 Constructing the preliminary framework

The purpose of this section is to construct a preliminary framework of knowledge creation to guide an investigation of knowledge creation in innovative virtual world projects. The preliminary framework conceptualises knowledge and knowledge creation in terms of the characterisations of each that are derived from (and extend) existing literature in Section 3.5 and Section 3.6.

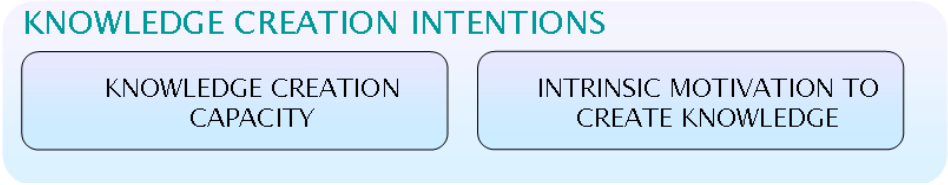
By way of recapitulation, the framework is based upon a characterisation of *knowledge* as "a capacity for action or ability to interpret, authenticate, or personalise information and experience; a framework for evaluating and incorporating new experiences and information; this framework is developed through experience or study by means of ongoing, socially enacted processes; it cannot be divorced from context and is shaped by one's needs, initial knowledge frameworks, and experiences". Further, the framework is based upon a characterisation of *knowledge creation* as "changes to frameworks used for evaluating and incorporating new experiences and information; these changes affect the capability or ability to interpret, authenticate or personalise both information and experience; these changes; occur through experience or study by means of ongoing, socially enacted processes; they cannot be divorced from context and are shaped by one's needs, initial knowledge frameworks, and one's experiences".

The framework consists of three constructs: knowledge creation intentions (cf. Section 4.3.2.1), knowledge-creating behaviours (cf. Section 4.3.2.2) and knowledge creation outcomes (cf. Section 4.3.2.3). The framework also posits that knowledge-creating behaviours affect knowledge creation outcomes (cf. Section 4.3.2.4); and that knowledge creation intentions affect knowledge creation outcomes (cf. Section 4.3.2.5). Each element of the framework is discussed in turn and Section 4.2.2.6 presents a concise statement and discussion of the preliminary framework of knowledge creation in virtual worlds.

4.3.2.1 Knowledge creation intentions

The purpose of this section is to discuss the first main construct specified in the preliminary framework: knowledge creation intentions. Knowledge creation intentions are defined in the framework as *behavioural intentions to create (declarative and/or procedural) knowledge*. The framework posits that knowledge creation intentions consist of both (i) motivation to create knowledge and (ii) capability to create knowledge (see Figure 4.1).

FIGURE 4.1
CONSTRUCTING A PRELIMINARY FRAMEWORK: KNOWLEDGE CREATION INTENTIONS



The framework indicates that *capacity to create knowledge* constitutes an element of knowledge creation intentions. Knowledge creation capacity is defined in this study as *the capability to create new knowledge that stems from prior related knowledge*. The argument that prior related knowledge influences one's capacity to create knowledge is suggested by extant research. Schema theory, for example, explains how knowledge is represented in the mind (as 'packets' or schemata) and suggests that "comprehension is the use of prior knowledge to create new knowledge" (Guterman 2003, p. 635). At the individual level, it is "well

established" that "a person's prior cognitive map (or belief structure or mental representation or frame of reference) will shape his or her interpretation of information" (Huber, 1991, p. 102). In fact, a similar approach was adopted by White (1959) who argued that competence is slowly attained through prolonged feats of learning rather than an innate trait.

By considering knowledge creation capacity, it is possible to evaluate knowledge creation intentions in a relative fashion. In other words, the knowledge creation intentions construct takes into account prior levels of knowledge and experience. This reflects the definition of knowledge creation put forth in this study. Further, this is an important feature of the framework because it means that the framework can take into account the differences between the knowledge creation intentions (and the knowledge creation outcomes) of novices and experts.

The framework also indicates that *intrinsic motivation to create knowledge* constitutes an element of knowledge creation intentions. Intrinsic motivation to create knowledge is defined in the framework as "an internal or authentic motivation to create knowledge". Intrinsic motivation is an internal or 'authentic' motivation (Ryan and Deci, 2000). Motivation is intrinsic if an activity is undertaken for the immediate satisfaction of a need (Osterloh and Frey, 2000). Intrinsic motivation "is valued for its own sake and appears to be self sustained" (Calder and Staw, 1975, p. 599; Osterloh and Frey, 2000). It is recognised that intrinsic motivation can be difficult to stimulate and that extrinsic incentives are often needed (Frey and Osterloh, 2002, p. 21). In fact, two types of motivation are commonly distinguished. Extrinsic motivations allow individuals to satisfy needs indirectly by obtaining additional resources (Ryan and Deci, 2000), especially through monetary compensation (Osterloh and Frey, 2000). For more extensive discussions of the distinction between extrinsic and intrinsic motivation see Atkinson, 1964); DeCharms (1968); Deci (1975); and Staw (1975). However, research on extrinsic motivation argues that extrinsic incentives can slow down and diminish the learning process (Frey and Osterloh, 2002, p. 21); can interfere with intrinsic motivation (Collins and Amabile, 1999); and have been found to

damage creative problem solving (Collins and Amabile, 1999). Therefore, only intrinsic motivation to create knowledge is considered in the preliminary framework.

The assertion that knowledge creation intentions consist of (i) intrinsic motivation to create knowledge, *and* (ii) capability to create knowledge (arising from prior related knowledge) is not intuitive at first glance. However, it is useful because knowledge is created in a manner that is 'indelibly' shaped both by one's needs (Tuomi, 1999) as well as by one's initial knowledge frameworks (Cohen and Levinthal, 1990; Huber, 1991; Walsh, 1995; Tuomi, 1999; Smith *et al.,* 2005) and experiences (Davenport and Prusak, 1998, p.3; Leonard-Barton and Sensiper, 1998; Schubert *et al.,* 1998). The inclusion of both (i) intrinsic motivation to create knowledge and (ii) knowledge creation capacity also means that knowledge creation intentions do not have to be evaluated in 'absolute' terms. This is seen as a strength of the framework because of the path dependent (McFayden and Cannella, 2004), personalised (Alavi and Leidner, 2001; Robert, 2009) and contextually specific (Heffner and Sharif, 2008) nature of knowledge.

4.3.2.2 Knowledge-creating behaviours

The purpose of this section is to discuss the second main construct specified in the preliminary framework: knowledge-creating behaviours. This construct is included in the preliminary framework in recognition of the view that knowledge is created in action (Orlikowski, 2002; Leonard-Barton and Sensiper, 1998; Walsh, 1995). Knowledge-creating behaviours are defined as *behaviours taken in an attempt to facilitate knowledge creation*. As indicated in Figure 4.2, the framework distinguishes between exploratory and exploitative knowledge-creating behaviours. The framework defines exploratory knowledge-creating behaviours as *behaviours taken in an attempt to create knowledge that is substantively different from existing knowledge*. The framework defines exploitative knowledge-creating behaviours are defined as *behaviours taken in an attempt to create knowledge that is not substantively different from existing knowledge*.

FIGURE 4.2
CONSTRUCTING A PRELIMINARY FRAMEWORK: KNOWLEDGE-CREATING BEHAVIOURS



The distinction between exploratory and exploitative behaviours is based on March (1991). March (1991) defines exploratory behaviours as "things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation" (p. 71) and defines exploitative behaviours as "such things as refinement, choice, production, efficiency, selection, implementation, execution" (p. 71). The preliminary framework supports the view that knowledge is created during both exploitation and exploration. This perspective is in line with existing research (Schultze, 2009, pp. 21-22) and reflects the fact that there is no such thing as perfect replication in social systems (Gupta *et al.,* 2006, p. 694).

It is recognised that knowledge-creating processes within organisations are multitudinous (Huber, 1991). However, the preliminary framework does not attempt to conceptualise knowledge-creating behaviours more precisely without empirical evidence. This is primarily because little is currently known in relation to how virtual worlds are used in practice. Therefore, it would be difficult to pre-specify knowledge-creating behaviours in the context of this particular study.

Nevertheless, there is much to recommend the use of this classification. First, the distinction has already been employed by a number of authors investigating knowledge creation (Schultze, 2009). This suggests that the concepts are well understood in literature. For example, Yang *et al.,* (2010) suggest that organisations use four knowledge creation strategies: exploration, exploitation, combination and institutional entrepreneurship. Second, scholars (cf. Schultze 2009) have probed the relationship between these behaviours and knowledge creation. For example, Von Krogh (1998) suggests that both exploration and

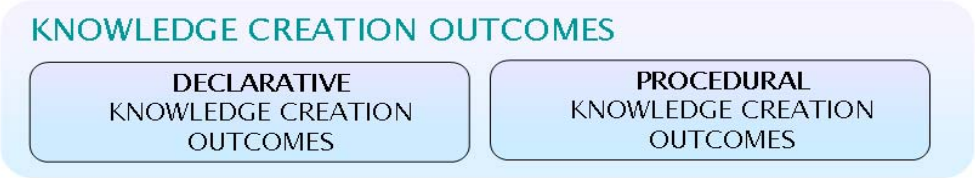
exploitation are important in order to continually build knowledge; but that exploration (trying new processes and developing ideas that are outside an organisation's repertoire of routines) is especially important for stimulating knowledge creation. Finally, scholars have developed a number of theories in relation to how these types of behaviours can be optimally balanced in organisations. According to Gupta *et al.* (2006), these theories typically focus on achieving balance synchronously (by means of "organisational ambidexterity") or asynchronously (by means of processes of punctuated equilibrium).

4.3.2.3 Knowledge creation outcomes

The purpose of this section is to discuss the third main construct specified in the preliminary framework: knowledge creation outcomes. The rationale for the inclusion of this construct relates to the need to be able to attempt to evaluate the extent to which knowledge creation occurs in virtual worlds.

Knowledge creation outcomes are conceptualised in the framework in accordance with the conceptualisation of knowledge creation presented in Section 3.6.3. Specifically, knowledge creation outcomes are defined in the framework as *changes in declarative and procedural knowledge frameworks*. Therefore, the knowledge creation outcomes construct contains two subconstructs: declarative knowledge creation outcomes and procedural knowledge creation outcomes. The framework defines declarative knowledge creation outcomes as *changes in declarative knowledge frameworks*; and defines procedural knowledge creation outcomes as *changes in procedural knowledge frameworks*. This is illustrated in Figure 4.3.

FIGURE 4.3
CONSTRUCTING A PRELIMINARY FRAMEWORK: KNOWLEDGE CREATION OUTCOMES



The conceptualisation of knowledge creation outcomes in terms of *knowledge frameworks* is commensurate with extant research on knowledge contents (Pentland, 1995; Alavi and Leidner, 2001); knowledge structures (Ausubel, 1968; Walsh, 1995); knowledge representations (Alavi *et al.,* 2002); knowledge stocks (McFayden and Cannella, 2004); and mental models (Alavi *et al.,* 2002). In effect, the framework suggests that knowledge creation outcomes can be isolated and independently investigated even as it recognises that knowledge is dynamically created on an ongoing basis.

The conceptualisation of knowledge creation outcomes as *changes in knowledge frameworks* is a key element in the conceptualisation of knowledge creation in this study. In the first instance, the framework embraces a cognitivist rather than a behavioural perspective in terms of knowledge creation. That is to say, the framework supports the view that knowledge creation outcomes may not necessarily involve behavioural change (Ausubel, 1968; Friedlander, 1983; Huber, 1991; von Krogh, 1998, pp. 134-136). Effectively, knowledge creation should be seen in terms of changes in knowledge structures rather than in actual performance because "successful performance [also] requires other abilities including perseverance, flexibility, improvisation, problem sensitivity, and tactical astuteness" (Ausubel, 1968, p. 35).

In the second instance, this conceptualisation is commensurate with March's (1991) model of mutual learning in organisations. March (1991) posits that knowledge creation takes place when (individual and organisational) beliefs are modified as a consequence of interaction within the organisations. In effect, this view directs investigative attention toward the *development* of knowledge structures rather than toward the structure or contents of knowledge structures. Thus, Walsh (1995) proposes a moratorium on research investigating the contents of knowledge structures in favour of investigating the development of knowledge structures. The investigation of the development of knowledge structures is especially relevant given the advances being made in the cognitive sciences regarding the manner in which the brain reorganises itself in response to its

environment; a phenomenon known as 'neuroplasticity' (Schwartz and Begley, 2003). Further, by focusing on changes in knowledge framework, the framework overlooks the question of whether knowledge creation results in the creation of 'new knowledge'. This is also seen to be strength of the framework in terms of using it to investigate innovation: it reflects the problematization of innovation-as-newness in literature (cf. Section 3.2.1.1).

The conceptualisation of knowledge creation outcomes *in terms of declarative and procedural knowledge* is also a key element in the conceptualisation of knowledge creation in this study. As illustrated in Section 3.5.2.2, the majority of research on knowledge creation to date (cf. Nonaka, 1994; Nonaka *et al.,* 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka *et al.,* 2000; Nonaka and Toyama, 2003 Vera and Crossan, 2005; Heffner and Sharif, 2008; Yang *et al.,* 2010) is based upon the distinction between tacit and explicit knowledge (Martín-de-Castro *et al.,* 2008). The decision to distinguish between declarative and procedural knowledge creation outcomes is based upon the fact that the distinction between tacit and explicit knowledge is problematic (Faucher *et al.,* 2008; Jakubik, 2008; Gourlay, 2006; Tsoukas, 2005; Rice and Rice, 2005; Leonard-Barton and Sensiper, 1998; Adler, 1995; Zander and Kogut, 1995). At the same time, numerous authors (e.g. Andersen, 1983; Paris *et al.,* 1983; Walsh, 1995; Kogut and Zander, 1996; Nahapiet and Ghoshal, 1998; Zack, 1999) have argued in favour of distinguishing between declarative and procedural knowledge. In particular, research on implicit learning and cognitive neuroscience evidence indicates that "these two types of knowledge are implemented neurally in fundamentally different ways" (Anderson and Lebiere, 1998, p.21). In addition, this distinction is conceptually similar to the distinction between product and process innovation that is also used in this study.

4.3.2.4 Relationship between knowledge-creating behaviours and outcomes

The purpose of this section is to explore the relationship between knowledge-creating behaviours and knowledge creation outcomes. The framework suggests that knowledge creation outcomes both influence and are influenced by

knowledge-creating behaviours (March, 1991; Leonard-Barton and Sensiper, 1998; Schubert *et al.,* 1998; Nonaka and Toyama, 2000; Orlikowski, 2002; Gupta *et al.,* 2006). Scholars recognise that human action plays an essential role in organisational knowing (Orlikowski, 2002); that knowledge "is linked to meaningful behavior" and is "born of experience" (Leonard-Barton and Sensiper, 1998, p. 113); and that the development of knowledge structures "implies a recursive relationship with use" (Walsh, 1995, p. 282).

The positing of this association is a reflection of the definition of *knowledge* adopted in this study which recognises that knowledge is fundamentally situated in action and based upon experience. This conceptualisation draws upon views espoused in literature that knowledge can be defined as (i) "understanding gained through experience or study; the sum or range of what has been perceived, discovered, or learned" (Alavi and Leidner, 2001, p. 110); (ii) "a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information" (Davenport and Prusak, 1998, p.3); and (iii) a set of "socially enacted knowledge processes" (Alavi and Leidner, 2001, p. 115). At the same time, this association reflects the definition of *knowledge creation* adopted in this study which recognises that knowledge is created in action and that the creation of knowledge is based upon experience. This view is in line with existing research which suggests that knowledge creation happens through dynamic and social interactions amongst individuals and organisations (Nonaka and Toyama, 2000).

Two propositions can be derived about the nature of the association between knowledge-creating behaviours and knowledge creation outcomes.

P1: Knowledge-creating behaviours affect knowledge creation outcomes

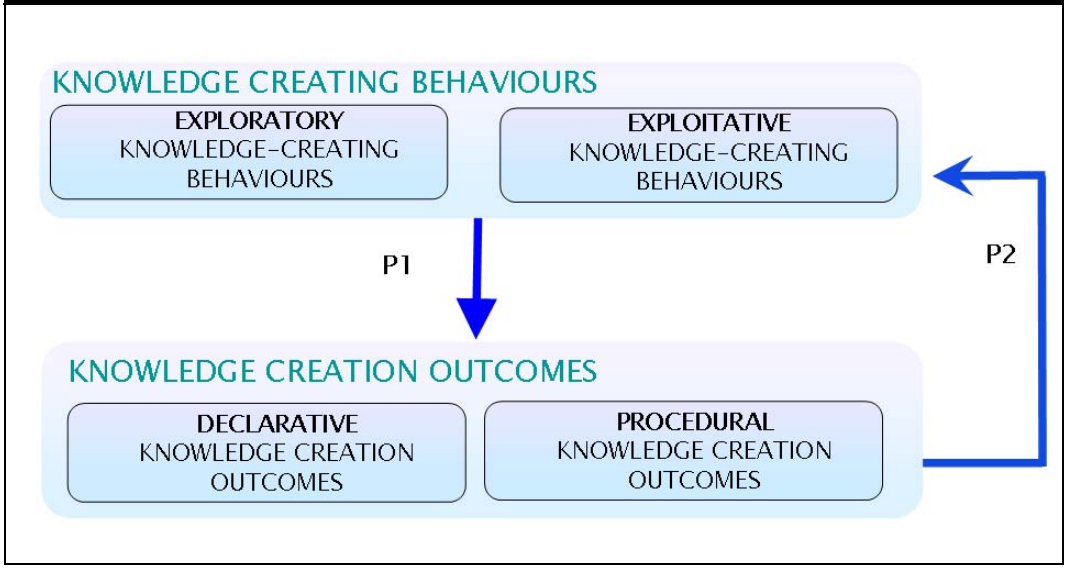
P2: Knowledge creation outcomes affect knowledge-creating behaviours

Taken together, these propositions posit the existence of an association between knowledge-creating behaviours and knowledge creation outcomes. Specifically,

these propositions recognise the existence of a two-way relationship between knowledge-creating behaviours and knowledge creation outcomes. However, it is not possible to derive specific propositions about the nature of the associations between each type of knowledge-creating behaviour (i.e. exploratory and exploitative) and each type of knowledge creation outcome (i.e. declarative and procedural) from existing research.

Figure 4.4 graphically depicts the nature of the association between knowledge-creating behaviours and knowledge creation outcomes posited by the preliminary framework. The figure shows that knowledge creation outcomes consist of declarative and procedural knowledge creation outcomes. The figure shows that knowledge-creating behaviours consist of exploitative and exploratory knowledge-creating behaviours. The figure shows that knowledge-creating behaviours affect knowledge creation outcomes and that knowledge creation outcomes affect knowledge-creating behaviours. It is important to note that the arrows connect knowledge-creating behaviours and knowledge creation outcomes at the level of the construct rather than attempting to connect the specific elements of these constructs.

FIGURE 4.4 ASSOCIATIONS PROPOSED IN THE PRELIMINARY FRAMEWORK (P1, P2)



4.3.2.5 Relationship between knowledge creation intentions and behaviours

The purpose of this section is to discuss the relationship between knowledge creation intentions and knowledge-creating behaviours. The preliminary framework is based on the premise that intentions lead to action. This premise stems from the theory of reasoned action (Fishbein and Ajzen, 1975, 1980) and the theory of planned behaviour (Ajzen, 1985). The premise is also well established in the Information Systems field; in fact, some of the field's most important theoretical contributions - i.e. the technology acceptance models (cf. Davis, 1989; Venkatesh *et al.,* 2003) - have been based upon it.

In particular, the preliminary framework posits that knowledge creation intentions (both knowledge creation capacity and intrinsic motivation to create knowledge) affect knowledge-creating behaviours. This proposition is at least in part a reflection of the definition of knowledge creation adopted in this study. The proposition also reflects the fact that intentional learning is actually the focus of organisational learning literature (Huber, 1991).

Existing research specifically points to the proposition that knowledge creation capacity (stemming from prior related knowledge) affects knowledge-creating behaviours.

P3i: Knowledge creation capacity affects knowledge-creating behaviours

For example, Smith *et al.,* (2005) argue that it takes some level of existing knowledge or know-how to develop new knowledge and find that certain aspects of existing and accessible knowledge impact a firm's knowledge creation capacity (which, in turn, impacts the level of new products and services introduced). Further, Chou and Tsai (2004) find empirical support for hypotheses that assert that the presence of knowledge assets such as organisational routines have a strong impact on certain SECI (Socialization, Externalization, Combination, Internalization) outcomes. Finally, Cohen and Levinthal (1990) argue that (organisational) absorptive capacity is both 'critical' for a firm's innovative capabilities and "largely a function of the firm's level of prior related knowledge" (p.128). Organisational absorptive capacity is "the ability of a firm to recognize

the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990, p. 128). In the cognitive sciences, it is recognised that experience provides the basis for the formation of connections and the transformation of those connections into circuits in the brain (Restak, 2001, p. xiv). Walsh (1995) indicates that the development of new knowledge structures in organisations is influenced (in a path dependent way) by original knowledge structures. Further, an individual's tenure in a company and an individual's years of work experience have been shown to result in particular knowledge structure content (Walsh, 1995). Further, constructivist views on knowledge creation indicate that "learners actively construct their own knowledge based on prior knowledge and experience brought to bear on learning tasks" (Zhang *et al.,* 2004, p. 77).

Existing research also points to the proposition that intrinsic motivation to create knowledge affects knowledge-creating behaviours.

P3ii: Intrinsic motivation to create knowledge affects knowledge-creating behaviours

James (cited in Deci and Ryan, 1985, p.11) asserted that interest plays an important role in directing attention, and thus behaviour; when intrinsically motivated, "one follows one's interests" and the "rewards are inherent in the activity" (Deci and Ryan, 1985, pp. 11-12). Numerous studies indicate that intrinsically motivated individuals have more interest, excitement, and confidence which in turn is manifest as enhanced performance, persistence, and creativity (Ryan and Deci, 2000). In particular, Osterloh and Frey (2000) argue that intrinsic motivation is a key driver of behavioural intention to use computers. Thus, scholars have pointed to the existence of an association between motivation and (i) innovation (Mohr, 1969); (ii) creativity (Mohr, 1969; Monge *et al.,* 1992; Ford, 1996; Amabile, 1996); (iii) knowledge generation (Osterloh and Frey, 2000); and (iv) knowledge sharing (Osterloh and Frey, 2000; Cabrera and Cabrera, 2002; Lam and Lambermont-Ford, 2010).

Whilst it has been possible to derive specific propositions about associations between knowledge creation capacity (P3i) and intrinsic motivation to create

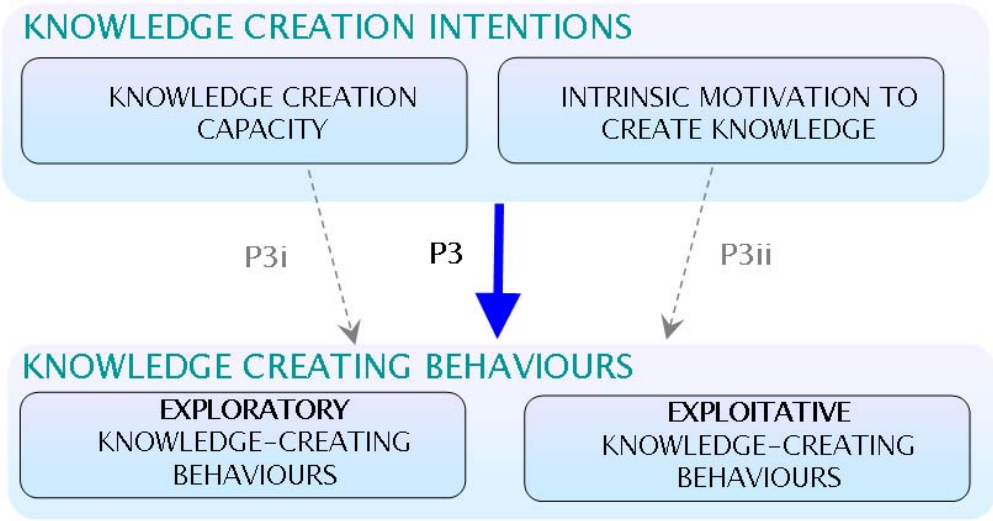
knowledge (P3ii) with knowledge-creating behaviours, it is *not* possible to specify how these constructs affect specific types of knowledge-creating behaviours (i.e. exploratory or exploitative knowledge-creating behaviours). Therefore, in this study, Proposition P3 is empirically investigated:

P3: Knowledge creation intentions affect knowledge-creating behaviours

Figure 4.5 depicts the nature of the association between knowledge creation intentions and knowledge-creating behaviours posited by the preliminary framework. The figure shows that knowledge creation intentions consist of knowledge creation capacity and intrinsic motivation to create knowledge. The figure shows that knowledge creation behaviours consist of exploitative and exploratory knowledge-creating behaviours. The figure shows that knowledge creation capacity affects knowledge-creating behaviours (P3i) and that intrinsic motivation to create knowledge affects knowledge-creating behaviours (P3ii). The figure also depicts P3 (that knowledge creation intentions influence knowledge-creating behaviours). A closer inspection of the arrows reveals that P3i and P3ii associate specific elements of the knowledge creation intentions construct with knowledge-creating behaviours. These propositions are depicted by means of a dotted arrow. This indicates that these propositions are not empirically investigated in the context of this study. Further, P3 associates knowledge creation intentions with knowledge-creating behaviours. This proposition is depicted by means of a solid arrow. This indicates that this proposition is empirically investigated in this study.

Having developed the preliminary framework and discussed each element in turn, it is now possible to present a concise statement of the preliminary framework that is used to guide this investigation of knowledge creation in virtual worlds.

FIGURE 4.5 ASSOCIATIONS PROPOSED IN THE PRELIMINARY FRAMEWORK (P3)

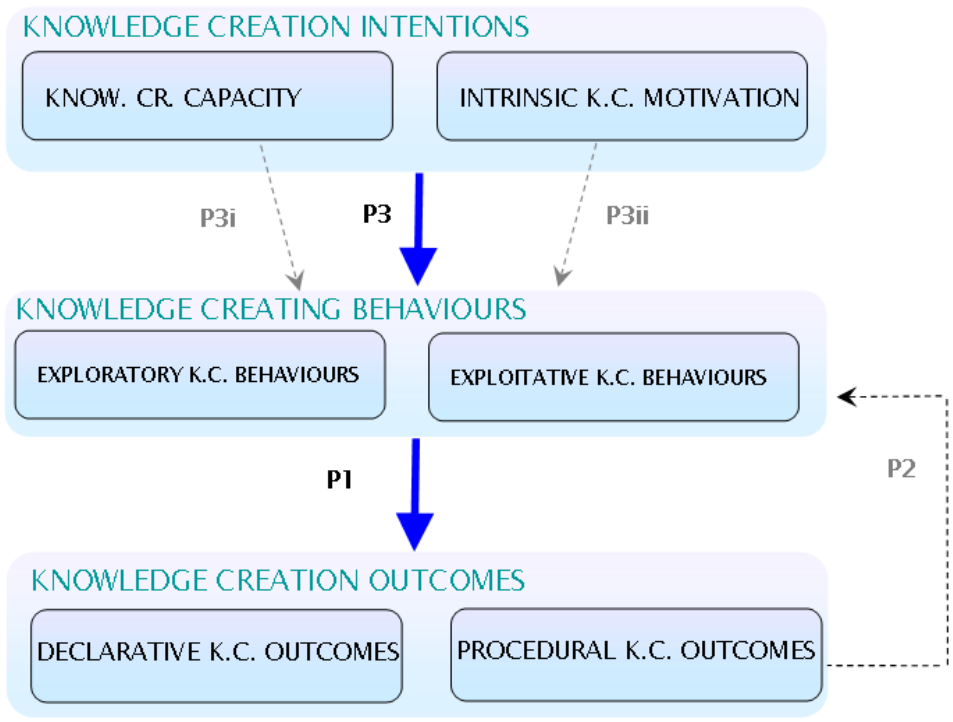


4.3.2.6 Concise statement of the preliminary framework

The purpose of this section is to provide a concise statement of the preliminary framework and to present an overall discussion of the merits of the framework in the context of this study. To that end, Figure 4.6 presents the preliminary framework that is used to guide this investigation of knowledge creation in virtual worlds. The figure indicates that the preliminary framework identifies distinguishes three main knowledge creation constructs: knowledge creation intentions; knowledge-creating behaviours; and knowledge creation outcomes.

The framework defines knowledge creation intentions as behavioural intentions to create (declarative and/or procedural) knowledge. Knowledge creation intentions consist of intrinsic motivation to create knowledge (defined as an internal or authentic motivation to create knowledge) and capacity to create knowledge (defined as the capability to create new knowledge that stems from prior related knowledge).

FIGURE 4.6 PRESENTATION OF THE PRELIMINARY FRAMEWORK



The framework defines knowledge-creating behaviours as behaviours used in an attempt to facilitate knowledge creation. Knowledge-creating behaviours consist of exploratory behaviours (defined as behaviours which are taken in an attempt to create new knowledge that is substantively different from existing knowledge) and exploitative behaviours (defined as behaviours which are taken in an attempt to create new knowledge that is not substantively different from existing knowledge).

The preliminary framework defines knowledge creation outcomes as changes in declarative and procedural knowledge frameworks. These frameworks are used to evaluate and incorporate new experiences and information. These changes affect the capability or ability to interpret, authenticate or personalise both information and experience; these changes; occur through experience or study by means of ongoing, socially enacted processes; they cannot be divorced from context and are shaped by one's needs, initial knowledge frameworks, and one's experiences.

Knowledge creation outcomes consist of declarative knowledge creation outcomes (defined as changes in declarative knowledge frameworks) and procedural knowledge creation outcomes (defined as changes in procedural knowledge frameworks).

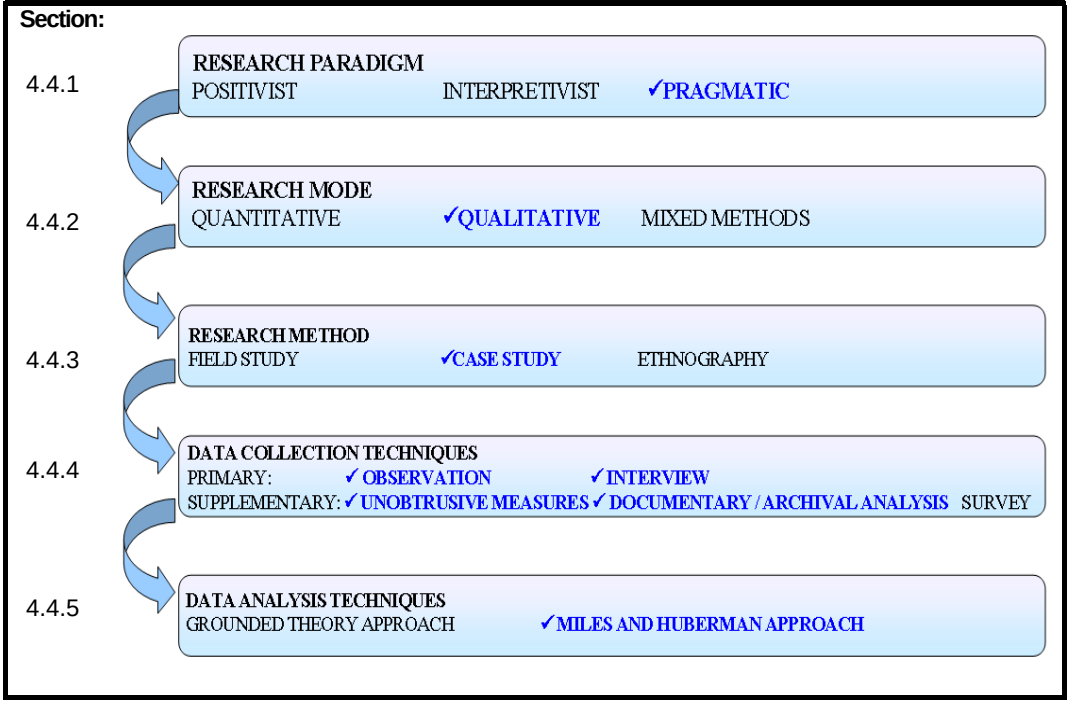
The preliminary framework also specifies a number of propositions. In terms of the relationship between knowledge-creating behaviours and knowledge creation outcomes, the preliminary framework posits that knowledge-creating behaviours affect knowledge creation outcomes (P1); and that knowledge creation outcomes affect knowledge-creating behaviours (P2). However, only the association between knowledge-creating behaviours and knowledge creation outcomes (P1) is empirically investigated. (Thus, a solid arrow depicts P1 and a dotted arrow depicts P2 in Figure 4.6). The decision to investigate only the first proposition is based upon the nature of the research design employed in this study. Specifically, in order to evaluate knowledge creation outcomes, the study's sampling strategy focuses on completed projects. One of the implications of this design decision is that the quality of the data collected with regard to interim knowledge creation outcomes and knowledge-creating behaviours is compromised. Without this data, it has not been possible to investigate the nature of the association between knowledge creation outcomes and knowledge-creating behaviours.

The preliminary framework also suggests a number of propositions regarding the nature of the association between knowledge creation intentions and knowledge-creating behaviours. Specifically, the preliminary framework posits that knowledge-creating intentions affect knowledge-creating behaviours (P3). Specifically, the framework posits that knowledge creation capacity affects knowledge-creating behaviours (P3i) and that intrinsic motivation to create knowledge affects knowledge-creating behaviours (P3ii). In the next section, the discussion centres on the development of a suitable research design for the investigation of the preliminary framework of knowledge creation in a virtual world.

4.4 Constructing the research design

The purpose of this chapter is to construct the research design for the study. Remenyi and Williams (1995) state that the prerequisite for conducting sound academic research in the IS (Information Systems) area is to understand the research process, and as a result, the choice of research methodology must emerge from an examination of available approaches. Therefore, this section consists of five subsections: each subsection addresses a particular research design decision, outlines the options that were considered, and shows why a particular option was selected in each case (with reference to the study's research objective). Figure 4.7 summarises each of the design decisions that were made in this study. Within each category, the figure lists the options that were evaluated and the chosen options are highlighted in blue text.

FIGURE 4.7 GRAPHICAL SUMMARY OF THE RESEARCH DESIGN



4.4.1 Research paradigm: adopting a pragmatic approach

A research paradigm is the "basic belief system or worldview that guides the investigator not only in choices of method but in ontologically and epistemologically fundamental ways" (Guba and Lincoln, 1994, p. 105). Further, Guba and Lincoln (1994) assert that "questions of method are secondary to questions of paradigm" (p. 105). Thus, significant scholarly attention has focused on the classification and evaluation of research paradigms (cf. Burrell and Morgan, 1979; Orlikowski and Baroudi, 1991; Guba and Lincoln, 1994; Guba and Lincoln, 2000). At the same time, IS researchers in particular have been criticised for failing to consciously examine their assumptions, which appear to have been largely taken for granted (Orlikowski and Baroudi, 1991). Therefore, the purpose of this section is to introduce the main research paradigms used in IS research and to argue in favour of the selection of a pragmatic approach for the investigation of knowledge creation in virtual worlds.

The main research paradigms in IS research are positivism and interpretivism (Chua, 1986; Orlikowski and Baroudi, 1991). In addition, Ågerfalk (2010) argues that pragmatic thinking has already inspired a lot of IS research and "has its strongest foothold in Europe" (p. 254). Ågerfalk points to the recent establishment of the AIS[8] Special Interest Group on Pragmatist IS Research and argues that both the action research methodology and the design science research paradigm are "both expressions of pragmatic ideas" (p. 251). Further, he argues that pragmatic concepts and concerns "may be of immense value to IS research" (p. 252). Therefore, this section considers positivist, interpretivist and pragmatic paradigms.

Research paradigms are "axiomatic systems": they differ from one another in terms of the axioms upon which they rest – "matters much more fundamental than the locale in which the inquiry is conducted, the format of the inquiry report, or the nature of the methods used" (Guba and Lincoln, 1982, p. 233). Therefore, the

[8] The Association for Information Systems (AIS) is an international professional society for academics specializing in Information Systems

discussion focuses on the ontological and epistemological assumptions of each of these research paradigms. Ontology refers to "the nature of the world around us; in particular, that slice of reality which the scientist chooses to address" (Hirschheim, 1985, p. 13). Thus, "the ontological question" deals with the "form and nature of reality and, therefore, what is there that can be known about it" (Guba and Lincoln, 1994, p. 108). Epistemology is defined as "…our theory of knowledge; in particular, how we acquire knowledge" (Hirschheim, 1985). In particular, epistemological "assumptions concern the criteria by which valid knowledge about a phenomenon may be constructed and evaluated" (Chua, 1986, p. 401). Thus, "the epistemological question" is focused on the relationship between the knower (or would-be knower) and what can be known (Guba and Lincoln, 1994, p. 108).

4.4.1.1 Positivism

Positivism has dominated the formal discourse in the physical and social sciences for the past four hundred years (Guba and Lincoln, 1994, p. 108). The ontological assumptions of (the original) positivism can be characterised as naïve realism: there is a 'real' reality out there and it is apprehendable by researchers. It is driven by "immutable natural laws and mechanisms" and the basic posture is reductionist and deterministic (Guba and Lincoln, 1994, p. 109). The epistemological assumptions of (the original) positivism are dualist and objectivist. That is, positivist researchers typically assume that investigator and investigated are independent entities and when the possibility that one might influence the other is recognised, strategies are employed to reduce or eliminate that influence (Guba and Lincoln, 1994). Further, positivism "seeks to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements" (Hirschheim, 1985, p. 13). In the positivist tradition, there is a belief in brute regularities rather than causation, so the possibility that science can provide deep explanation is opposed (O'Hear, 1989). Thus, positivist research is an attempt to increase predictive understanding of phenomena (Orlikowski and Baroudi, 1991; Myers, 1997). Hirschheim (1985) suggests that the four principles of positivist research are: the unity of the

scientific method, the search for human causal relationships, a belief in empiricism, and a belief that science is value-free. Similarly, Kolakowski (cited in Goles and Hirschheim, 2000) identifies a four point doctrine consisting of (i) the rule of phenomenalism which asserts that there is only experience; all abstractions, be they 'matter' or 'spirit', have to be rejected; (ii) the rule of nominalism which asserts that words, generalisations, abstractions, etc. are linguistic phenomena and do not give new insight into the world; (iii) the separation of facts from values; and (iv) the unity of the scientific method.

Both *logical positivism* and *postpositivism* emerged in the twentieth century. Logical positivism (and post empiricism) emerged from the Vienna Circle in the, 1920s. Logical positivism emphasised physicalism over phenomenalism (Hirschheim, 1985) and viewed intersubjective agreement as sufficient justification for knowledge (Hirschheim, 1985). Logical positivism was less concerned with individual explanation than with "theoretical networks of knowledge statements linked together through deductive logic and grounded in direct observation" (Hirschheim, 1985, p. 26). Postpositivism emerged as a response to the major criticisms levelled at positivism and logical positivism (Guba and Lincoln, 1994, p. 109). Post-positivist researchers are said to adopt a "critical realist" ontology: they allow for a 'real' reality but hold that it is only imperfectly and probabilistically apprehendable due to flawed human intellectual mechanisms and the "fundamentally intractable nature of phenomena" (Guba and Lincoln, 1994, p. 109).

Positivism is considered the dominant perspective in IS research today (Orlikowski and Baroudi, 1991; Chen and Hirschheim, 2004). However, neither positivism nor its successors (logical positivism and postpositivism) are considered appropriate for this study. First, there is "rational agreement about the inadequacy of the original positivist understanding of science, knowledge and meaning" (Bernstein in Mingers and Willcocks, 2004, p. 4). This is because individuals do not exist in isolation and therefore need to be understood in the context of their cultural and social life (Hirschheim, 1985). In addition, man as an

actor cannot be studied through the methods of the natural sciences, with their concern for general laws (Burrell and Morgan, 1979, p. 228). Further, logical positivism has been criticised on the basis (i) that the separation of the observable from the theoretical is problematic and (ii) that its attempts to ground scientific method in deductive reasoning (in order to overcome the problem of induction) have been unsuccessful (Hirschheim, 1985). Thus, scholars continue to question the validity of these assumptions in both the natural (Orlikowski and Baroudi, 1991) and social (Galliers and Land, 1987; Orlikowski and Baroudi, 1991) sciences. Finally, the epistemological assumptions of positivism are comparatively ill-suited to the conceptualisation of knowledge which has been adopted in this study.

4.4.1.2 Interpretivism

Whereas the aim of positivism is to be able to make predictions, the aim of interpretivism is to gain understanding (Orlikowski and Baroudi, 1991). Interpretive research therefore seeks to develop a richer understanding of

> the complex world of lived experience from the point of view of those who live it. This goal is variously spoken of as an abiding concern for the life world, for the emic point of view, for understanding meaning, for grasping the actor's definition of a situation, for *Verstehen*
>
> Schwandt 1994, p. 118

The ontological assumptions of interpretivism are relativist: realities "are apprehendable in the form of multiple, intangible mental constructions, socially and experientially based, local and specific in nature… and dependent for their form and content on the individual persons or groups holding the constructions" (Guba and Lincoln, 1994, p. 110). In turn, the epistemological assumptions of interpretivism are based on the position that our knowledge of reality is itself a social construction by human actors; and that the scientific method is a social construction (Hirschheim, 1985; Oates, 2006). Meanings are dynamic and socially constructed (Oates, 2006) so that the investigator and investigated are seen to be interactively linked and findings are literally created as the investigation proceeds

(Guba and Lincoln, 1994). In this view, "value free data cannot be obtained" (Walsham, 1995, p. 376).

The philosophical assumptions inherent in the interpretive perspective are more closely aligned with the epistemological assumptions that have been adopted for this study. Nevertheless, interpretivism is not considered appropriate in the context of this study for a number of reasons. Interpretivism has been accused of placing an over-emphasis on subjective interpretations (Goldkuhl, 2004). This is problematic because conclusions drawn entirely from participants' experiences and opinions may be skewed (Orlikowski and Baroudi, 1991). In addition, the interpretive perspective is criticised for (i) not examining conditions, often external, which give rise to certain meanings and experiences; (ii) omitting to explain the unintended and often significant consequences of action, which by definition cannot be explained by reference to human intention; (iii) not addressing structural conflicts within society and organisations, and ignoring contradictions which may be endemic to social systems; and (iv) neglecting to explain historical change; that is, how a particular social order came to be what it is, and how it is likely to vary over time (Fay cited in Orlikowski and Baroudi, 1991).

4.4.1.3 Pragmatism

Pragmatism emerged in the writings of the late 19th and early 20th century scholars including James, Pierce, Dewey, Mead (Menard, 1997). James (1907, p. 92) asks "in short, what is the truth's cash-value in experiential terms?"; he stresses the appeal to experience as a common test for all constructions (Scheffler, 1986, p. 2). Peirce's major focus is to describe the normative standards we follow, to explain how our use of them is rational, and to show that inquiring well and responsibly will take us to the truth (Hookway, 2000, p. 2) and he proposes the notion of logical method (Scheffler, 1986, p. 2). Dewey elaborates a theory of intelligence; he offers a unified conception of thinking as an active interchange between organism and environment which reveals the continuity between "the humblest learning… and most refined theorising" (Scheffler, 1986, p. 2). Finally,

Mead focuses on symbolism and called for a methodology of human science to recognize the importance of symbols and their significance in understanding human behaviour (Hirschheim, 1985).

From a pragmatic perspective, the current meaning or (instrumental or provisional) truth value of an expression "is to be determined by the experiences or practical consequences of belief in or use of the expression in the world" (Johnson, 2004, p. 16). Pragmatism tends to emphasise what works rather than metaphysical concepts like 'Truth' and 'Reality' (Goles and Hirschheim, 2000). Thus, pragmatists think "that if something makes no difference to practice, it should make no difference to philosophy" (Rorty, 1995, p. 281). Ontologically, pragmatism assumes an objective reality, existing externally to the individual. However, this reality is grounded in the environment and experience of each individual, and can only be imperfectly understood. The researcher's choice of one version of reality over another should be governed by how well that choice results in anticipated or desired outcomes (Goles and Hirschheim, 2000). At an epistemological level, pragmatism views the process of acquiring knowledge as a continuum of objectivity and subjectivity (Goles and Hirschheim, 2000).

Pragmatism is comparatively well suited to this study. First, there is growing interest in pragmatism in organisational and information studies (Goldkuhl, 2004) and in Information Systems specifically (Ågerfalk, 2010). Ågerfalk (2010) indicates that pragmatic concepts and concerns could be of immense value to IS research. Second, pragmatism upholds the objections made against positivism (and its successors) but objects to the over-emphasis placed on subjective interpretations in anti-positivist research traditions (Goldkuhl, 2004). Finally, pragmatism is seen to be most closely aligned with this study's epistemological assumptions. Specifically, pragmatism is based on a fallibilistic view of knowledge as a provisional scheme of hypotheses based on probable reasoning (cf. Scheffler, 1986, pp. 8-9). Pragmatism also views thought as being *intimately interwoven with action* in a purposive context (cf. Scheffler, 1986, pp. 8-9). For example, Rorty (1991) suggests an 'antirepresentationalist' account of knowledge,

where knowledge is not a matter of "getting reality right, but rather as a matter of acquiring habits of action for coping with reality" (p. 1). Similarly, Davidson (1963) has proposed the notion of a 'primary reason' (the primary reason for an action is its cause). These views are commensurate with (i) the epistemological stance of this study; (ii) this study's interest in the nature of knowledge-creating behaviours in virtual worlds; and (iii) this study's stance in relation to the association between knowledge creation intentions, knowledge-creating behaviours and knowledge creation outcomes.

4.4.2 Research mode: adopting a qualitative approach

The purpose of this section is to discuss the second element of the study's research design: its research mode. Research strategies are commonly categorised in terms of whether they employ a quantitative (cf. Section 4.4.2.1) or qualitative (cf. Section 4.4.2.2) research mode. It is indicated that a qualitative research mode is most suitable in the context of this study.

4.4.2.1 Quantitative research

Quantitative research is typically associated with positivist research and therefore dominates research in the IS field (Straub, 1989; Orlikowski and Baroudi, 1991; WenShin and Hirschheim, 2004). Quantitative analysis typically uses numerical analysis to illustrate relationships among factors (WenShin and Hirschheim, 2004). One of the strengths of quantitative research is that quantitative approaches are well formulated and clear criteria exist for conducting quantitative research (Kaplan and Maxwell, 1994). In particular, statistical analysis offers a universal means of evaluating key points and making generalised conclusions based on the evidence gathered (Oates, 2006).

Despite the widespread use of quantitative research methods, they are not considered appropriate in the context of this study. First, this study seeks to investigate a fundamentally social phenomenon (i.e. knowledge creation) and scholars (e.g. Kaplan and Duchon, 1988) question the applicability of quantitative methods for the study of social systems, where there are "so many uncontrolled –

and unidentified - variables" (p. 572). Second, the study seeks to build (rather than test) theory based upon empirical observation. However, the application of quantitative statistical techniques is better suited to theory testing because quantitative statistical techniques can "obscure the understanding of reality of any particular situation" (Fitzgerald, 1997, p. 145). This is because the need to apply values to variables in quantitative research "often leads to the elimination of factors that, although they may have relevance, are difficult to value" (Galliers and Land, 1987, p. 900). The upshot is that "we are left not knowing whether different results could be obtained if other variables had been considered" (ibid.). As a result, there has been a "general dissatisfaction with the type of research information provided by quantitative techniques" in the Information Systems field (Benbasat *et al.,* 1987, p. 369).

4.4.2.2 Qualitative research

In recent years, there has been growing recognition of the value of qualitative methods (WenShin and Hirschheim, 2004; Kaplan and Duchon, 1988; Benbasat *et al.,* 1987). In qualitative research, the researcher's goal is to gain an holistic overview of the context under investigation (Miles and Huberman, 1994, pp. 5-7). Thus, the hallmark of qualitative research methods is immersion in context (Kaplan and Duchon, 1988) and qualitative research is conducted through an intense and/or prolonged contact with the field (Miles and Huberman, 1994, pp. 5-7). Further, qualitative research is traditionally associated with non-positivist forms of research (e.g. interpretivist research). Therefore, qualitative research involves the development of categories and meanings (drawn on initial understanding of the perspectives of those being studied) through an iterative process (Kaplan and Duchon, 1988); and qualitative methods are seen as an array of interpretive techniques seeking to describe, decode, translate and otherwise come to terms with the meaning of certain naturally occurring phenomena in the social world (Van Maanen, 1979a).

Qualitative research methods are appropriate in explanatory research setting for at least two reasons. First, qualitative methods are seen as "a source of well-

grounded, rich descriptions and explanations of processes in identifiable local contexts" (Miles and Huberman, 1994, p. 10). Second, qualitative methods preserve chronological flow and suffer minimally from retrospective distortion and therefore offer (in principle at least) a precise way to assess causality in organisational affairs" (Miles, 1979, p. 591). Therefore, a qualitative approach is considered appropriate in the context of this study because it is explanatory in nature: it seeks to explain the forces causing a phenomenon (i.e. knowledge creation in virtual worlds) and to identify plausible causal networks shaping the phenomenon (Marshall and Rossman, 2006).

4.4.3 Research method: adopting the case study method

The purpose of this section is to consider the third element of the research design: its research method. Marshall and Rossman (1989) suggest that qualitative research methods ought to be selected according to the purpose of the study. The objective of this study is explanatory in nature. That is to say, this study seeks to build an empirically grounded theory to *explain* knowledge creation in virtual worlds by means of extending (or refining) a preliminary theoretical framework of knowledge creation (that has been derived from literature). That is to say, it is fundamentally concerned with seeking to explain the forces causing a phenomenon or to identify plausible causal networks shaping that phenomenon (cf. Marshall and Rossman, 2006, p. 69). Therefore, the discussion centres on three qualitative research methods that are recommended by Marshall and Rossman (2006) for use in explanatory research contexts: field studies (Section 4.4.3.1), ethnographies (Section 4.4.3.2) and case studies (Section 4.4.3.3).

4.4.3.1 Field study

A field study is a study carried out in a natural setting with human subjects (Jenkins, 1985). Field studies are often viewed as cross sectional case studies (Fitzgerald, 1997). Specifically, field studies are seen as field oriented, cross-sectional case studies consisting mainly of qualitative, anecdotal observations that allow researcher ratings to be included (cf. Kaplan, 1986). Thus, when a multiple case study exceeds a dozen or more sites (or individuals), researchers are most

likely to refer to the study as a field study (Boudreau *et al.,* 2001). Similarly, Klein and Myers (1999) suggest that in the IS field, field studies include in-depth case studies and ethnographies.

The field study method is not considered appropriate in the context of this study for a number of reasons. First, the external validity of field studies is not as rigorous as other approaches (Jenkins, 1985). Second, the internal validity of field studies is low (Jenkins, 1985) because it is not possible to manipulate independent variables in a field study (Kaplan, 1986). Third, field studies are considered appropriate where the research enters the field with a good idea of the manner in which data will be collected and analysed (Buckley *et al.,* 1976); this is not the case in this study.

4.4.3.2 Ethnography

Ethnography emerged in the field of anthropology (Hine, 2000) and is primarily concerned with identifying the insider or emic view. There are multiple ethnographic paradigms (Van Maanen, 1979a) but ethnography is fundamentally committed to deep understanding through participation and observation (Hine, 2000). Therefore, ethnography typically requires long periods of time in the 'field' and is directed toward the production of detailed, observational evidence (Yin, 2003, pp. 10-11) or "thick description" (Hammersley cited in Denscombe, 2007, p. 67). In fact, Delamont (2004) suggests that what he calls proper ethnography is participant observation done during field work and that participant observation and ethnography are used interchangeably in literature and are therefore synonymous. Reflexivity remains an important characteristic of ethnography and is one of the techniques used to achieve reliability and validity (Delamont, 2004).

Ethnography is not considered appropriate for this study for a number of reasons. The practice of ethnography has continually faced challenges concerning objectivity and validity (Hine, 2000, p. 41). One of the traditional responses to these critiques has been that ethnography produces an 'authentic' understanding of a culture based on emergent rather than *a priori* concepts (ibid.). However, the

realist notions that underpin this argument (that ethnography describes cultures as they really are) have been robustly challenged by constructivist approaches to knowledge (cf. Berger and Luckmann, 1971) that began to emerge in the 1970s (Hine, 2000, p. 42). In effect, there is an unresolved tension between a methodological approach based on naturalism and an approach to the subject matter of ethnography that is based on constructionism and cultural relativism (Hammersley and Atkinson, 2007, pp.10-11). Further, the vast majority of the qualitative studies conducted in the past twenty years outside of anthropology have been based on interviews (Delamont, 2004) rather than participant observation. In the particular case of the IS field, Klein and Myers (1999) argue that no clear distinction can be made between in-depth case studies and ethnographies in the IS field. In addition, Yin (2003, pp. 10-11) suggests that case studies do have the advantage of not relying solely on ethnographic or participant observer data. For these reasons, the ethnographic method was rejected as a research method for this particular study.

4.4.3.3 Case study

Case studies are one of the most common ways to conduct qualitative research (Stake, 2005) and are commonly used in the field of Information Systems (Orlikowski and Baroudi, 1991; WenShin and Hirschheim, 2004). Yin (1994) defines a case study as "an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 13). Case studies are fundamentally concerned with research in a natural setting (Benbasat *et al.,* 1987, p. 370) or real-life context (Robson, 1993, p. 146) where boundaries are not clearly evident (Benbasat *et al.,* 1987; Yin, 1994). For example, Starbuck (1976) illustrates that organisational boundaries vary dramatically in accordance with the focus of a particular study. Thus, in organisational studies it may be possible to "say 'Now I am inside' or 'Now I am outside', but one can never confidently say, 'This is the boundary'" (p. 1071). Case studies use "multiple methods of data collection" (Benbasat *et al.,* 1987, p. 370). The main strength (and source of credibility) of case studies is their "ability to deal with a full variety of evidence"

(Yin, 1994, p. 8) and to allow the triangulation of descriptions and interpretations (Stake, 2005, p. 443). Case studies may also be holistic or embedded, depending on the number of units of analysis (Yin, 1994).

Case studies may be of intrinsic or instrumental interest (Stake, 2005). In an intrinsic case study, the researcher has an intrinsic interest in the case. In an instrumental case, the primary research interest is external to a particular case rather than being focused primarily on the particular case "in all its particularity and ordinariness" (Stake, 2005, p. 445). Case studies may also be single or multiple studies. Single cases have the advantage of taking less time and resources than multiple cases but selecting a single case does amount to "putting all your eggs in one basket" (Yin, 1994, p. 53). Thus, whilst the single case study is appropriate under certain circumstances (Yin, 1994, pp. 39-53), evidence from multiple cases is generally considered more compelling (Yin, 1994, p. 46). Miles and Huberman (1994) argue that "multiple-case sampling adds confidence to findings" (p. 29) and several authors (Benbasat *et al.,* 1987; Eisenhardt, 1989) argue that the use of multiple cases can facilitate theory building and generation.

Despite the strengths of case based research, there are a number of problems associated with case study based research. The case study has suffered from a perceived lack of rigour (Yin, 1994) and has been criticised because of its limited generalisability (Yin, 1994; Stake, 2005). However, the foremost concern when using case studies is to generate knowledge of the particular (Stake, 1995), from which analytic (rather than statistical) generalisation is possible (Stake, 1995; Yin, 1994). The validity of case study research findings is also routinely questioned: readers "are left questioning the extent to which the propositions raised by the researcher are supported by the data; whether potential alternative propositions have been 'overlooked'; whether all cases were systematically evaluated before propositions were raised; whether the researcher saw only what they set out to see in the data; and whether the process is reproducible" (Lillis, 1999, p. 87). These problems serve only to underline the necessity for the development of an appropriate case study protocol in carrying out case based research.

Notwithstanding the issues associated with case studies, there is much to recommend the adoption of a case study approach in the context of this study. A case researcher seeks to develop deep insights into a phenomenon by means of intensively studying a small number of entities and to use those deep insights as a basis from which to generate hypotheses (Yin, 1994). This is in line with the approach adopted in this study where the absence of deep insights in relation to the nature of knowledge creation in virtual worlds at the outset of the study has precluded the possibility of generating specific hypotheses in relation to knowledge creation in virtual worlds. In particular, there is much to recommend the adoption of a multi-case study method. Miles and Huberman (1994) have argued that multiple cases increase generalisability and provide an opportunity for more sophisticated descriptions and more powerful explanations. In addition, Strauss and Glaser (1970) have argued that cross-case analysis improves researchers' abilities to calculate when events or incidents will or will not occur and to form general categories of how those conditions may be related. In the context of this study particularly, multiple cases are especially appropriate given that the primary interest in cases in this study is instrumental rather than intrinsic (cf. Stake, 2005) and given the explanatory nature of the study (cf. Marshall and Rossman, 2006).

4.4.4 Selecting data collection techniques

Data collection is a central part of any research project (Robson, 1993). However, even though research designs have become increasingly complex, data collection "plods along the relatively parochial self-report path with researchers devoting little effort to considering the range of alternatives available to them" (Van Maanen, 1979, p. 525). Therefore, the purpose of this section is to explicitly consider the range of data collection techniques that are available in seeking to carry out a qualitative multi-case study of knowledge creation in virtual worlds.

Marshall and Rossman (1989, pp. 79-108) identify two fundamental data collection techniques (observation including participant observation and in-depth interviewing) and three supplemental techniques (questionnaires and surveys;

specialised forms of interviewing; unobtrusive measures). Data collection techniques should be chosen according to the type of information sought (Marshall and Rossman, 2006). This section considers each technique in turn. Further, theory building researchers typically combine multiple data collection methods (Huberman and Miles, 2002, p. 13). This is because the use of multiple data collection methods enables triangulation which "provides stronger substantiation of constructs and hypotheses" (Eisenhardt, 1989, p. 538; see also Jick, 1979). In particular, when interviews are combined with observation, the researcher can check description against fact or to seek clarification where necessary (Marshall and Rossman, 2006). Therefore, the discussion argues in favour of a combination of data collection techniques including: (i) participant observation, (ii) interviewing, and (iii) the collection of documentary and archival materials.

4.4.4.1 Observation

Observation is a naturalistic form of enquiry as it takes place in a natural setting (Angrosino and Mays de Perez, 2003). Observation involves rich descriptions of events, behaviours and artefacts in a particular social setting (Marshall and Rossman, 2006). Participant observation is a particular form of observation and requires immersion in the social world so that the researcher can begin to experience reality as the participants do (Marshall and Rossman, 1989, p. 79). Observation is primarily associated with exploratory and explanatory (rather than predictive) research (Marshall and Rossman, 2006).

There are a number of issues associated with observation. Observation, is time intensive (Walsham, 2006), especially in qualitative settings where raw notes must be converted into write-ups (Miles, 1979, p. 593). In addition, the interaction of the researcher and subjects of the study can change behaviours and there is a possibility that observer bias may be incorporated into observational data (Angrosino and Mays de Perez, 2003). Oates (2006) suggests that verbatim quotations, triangulation and reflexivity can be used in order to overcome the researcher's selective recall, selective perception and accentuated perception.

Nevertheless, observation is characterised as the "fundamental base of all research methods" and the "most powerful source of validation" in social and behavioural science (Angrosino and Mays de Perez, 2003, pp. 107-108). Data gathered using observation is seen to have an 'authenticity' that other forms of data may lack (Hine, 2000). Qualitative research methods have undergone a "triple crisis of representation, legitimation and praxis" (Denzin in Hine, 2000) that has led to the problematization of authenticity. Authors have questioned whether or not there can be such a thing as authenticity if identity is no longer seen as singular and if knowledge is seen as being socially constructed (Hine, 2000). Through observation, the researcher learns about behaviour and about meanings attached to behaviour. In particular, participant observation can provide a yardstick against which to measure the completeness of data gathered in other ways (Becker and Geer cited in Sieber, 1973). Thus, there has been an increase in the amount of observation based research taking place in the IS field; and this is seen as a direct response to the call to make IS research more relevant to practice (Baskerville and Myers, 2004; Walsham, 2006). Given the unique nature of virtual worlds and the dearth of existing empirical research based on them, the use of observational techniques (and the use of participant observation in particular) is considered not only desirable but essential in the context of this study.

4.4.4.2 Interviews

Interviewing is extensively used in qualitative research (Yin, 2003). Interviews are a flexible technique (Fitzgerald, 1997): they enable researchers to gather large amounts of data quickly and to immediately follow up on that data (Marshall and Rossman, 2006). However, interviewing is seen to be a time consuming process and a difficult one because of the ambiguity of the spoken word (Fontana and Frey, 2000). Interviews can be undertaken in individual and group contexts. Interviews can take place in person, via email (e.g. Hine, 2000) or via the Internet (cf. Mann and Stewart, 2005). Interviews can be classified into three broad categories (Marshall and Rossman, 2006). *Informal or unstructured interview strategies* allow study participants to speak their mind (Oates, 2006) but require a lot of time and are relatively more susceptible to interviewer effect (Patton, 1990).

They are commonly used in situations where the primary purpose is discovery rather than confirmation (Oates, 2006). General *interview guide interviews* are more systematic and comprehensive and may therefore require less time; however they are not well suited to emerging issues (Patton, 1990). *Standardised open-ended interviews* can be used to compensate for interviewer skills and can facilitate data analysis (Patton, 1990). They are of particular benefit in scenarios where consistency and comparability across multiple sites are required (Patton, 1990). Interviews are typically recorded by taking field notes or through the use of audio/visual recording devices (Oates, 2006). Making audio recording interviews produces a 'truer' record of what was said, enables direct quotation and allows the researcher to fully engage with the interviewee during the interview and to re-examine the transcript multiple times (Walsham, 2006), which may be important for certain forms of analysis. However, producing transcripts is clearly a time consuming activity and the presence of recording equipment may make the interviewee less open or truthful (Walsham, 2006).

The use of interviews was considered appropriate in the context of this particular study for a number of reasons. Interviews afford the researcher the opportunity to "probe deeply, to uncover new clues, to open up new dimensions of a problem" (Burgess, 1982, p. 107). Interviews are an important means of allowing researchers to access the interpretations of informants (Walsham, 2006).

4.4.4.3 Supplemental data collection techniques: unobtrustive measures

Marshall and Rossman (2006) indicate that a number of supplemental data collection techniques can be used in carrying out qualitative research. This section considers the use of unobtrusive measures and the use of questionnaires.

Unobtrusive measures are measures that do not require the researcher to intrude in the research context. Thus, unobtrusive measures are seen as an opportunity to overcome the problems associated with self-report but are sometimes avoided because the fact of multiplicity increases the likelihood that data will be inconsistent (Webb and Weick, 1979). Ryan and Bernard (2003) observe that

"most of the archeologically recoverable information about human thought and human behaviour is text" (p. 259). In the context of a study carried out in a virtual world, online documentary and archival records represented a significant opportunity to utilise unobtrusive measures.

Surveys can be considered a research strategy in their own right or as a data collection technique to be used as part of an overall research strategy. Surveys are primarily associated with quantitative approaches and are typically associated with explanatory and predictive research (Marshall and Rossman, 2006). However, quantitative data are also valid inputs for interpretive and primarily qualitative research (Walsham, 2006). The core strengths of survey questionnaires are that they can be used to gather a large amount of data in a short space of time, are easily administered and statistical analysis is rapid (Fitzgerald, 1997). Survey questionnaires were not considered appropriate for this particular study for a number of reasons. In the first instance, Marshall and Rossman (1989) suggest that surveys are most suitable where an exploratory or descriptive focus is required. Section 4.4.2 indicates that this study is explanatory in nature. Second, there is growing scepticism that survey based techniques can "produce data that do not distort, do violence to, or otherwise falsely portray the phenomena such methods seek to reveal" (Van Maanen, 1979a, p. 522). Finally, survey based research delivers snapshots in time (Rogers, 2003) rather than process oriented accounts and are therefore inappropriate for this study given its central focus on knowledge creation processes.

4.4.5 Selecting data analysis techniques

Despite the importance of data analysis, qualitative data analysis methods remain poorly formulated (Miles and Huberman, 1994). There are few guidelines to assess the soundness of a given qualitative technique (Van Maanen, 1979a). At the same time, qualitative analysis makes heavy use of the researcher's own mind in analysis and interpretation (Janesick, 1998) and the reliance on interpretations and classifications imposed by the researcher potentially subjects the data to bias (Lillis, 1999).

Therefore, the purpose of this section is to explicitly consider the range of data analysis techniques that are available in seeking to carry out this study. Data analysis techniques can be classified as being in the linguistic tradition or in the sociological tradition (Ryan and Bernard, 2003). Techniques in the linguistic tradition treat the text itself as an object of analysis; techniques in the sociological tradition treat the text as a "window into human experience" (Ryan and Bernard, 2003, p. 769). Techniques in the sociological tradition are most often used to analyse chunks of text (*code* text) to develop conceptual models (Ryan and Bernard, 2003). Given this study's concern with the development of a conceptual model of knowledge creation in virtual worlds, techniques in the sociological tradition are considered most suitable in this instance. Data analysis techniques in the sociological tradition include content analysis and semiotics; grounded theory and schema analysis (Ryan and Bernard, 2003). In addition, the data analysis techniques proposed by Miles and Huberman (1994) are in the sociological rather than the linguistic tradition. Content analysis, semiotic, and schema analysis techniques are infrequently used in the IS field. Therefore, the discussion which follows considers data analysis techniques used in Grounded Theory (Section 4.4.5.1) and those proposed by Miles and Huberman (1994) (Section 4.4.5.2).

4.4.5.1 Data analysis techniques in Grounded Theory

Grounded theory developed by Barney G. Glaser and Anselm L. Strauss. Grounded theory was at the "forefront of the qualitative revolution" (Charmaz, 2005, p. 509) and continues to offer "rich possibilities" in the 21st century (Charmaz, 2005, p. 507). Grounded theory is a comparative method that allows the researcher to focus data collection and build inductive middle-range theories through successive levels of analysis and conceptual development (Charmaz, 2005). It involves simultaneous data collection and analysis and can lead to the creation of an integrated set of concepts that "not only synthesise and interpret [empirical materials] but also show processual relationships" (Charmaz, 2005, p. 508). In a pure grounded theory analysis, theory emerges during the analysis of data and the emergent theory is tested constantly against further theoretically sampled empirical data (Strauss, 1987). Thus, this form of analysis is sometimes referred to as constant comparative analysis (e.g. Janesick, 1998). Coding is the

first step in analyzing data and coding practices give insights into the assumptions of the researcher and the participants. Grounded theory includes open, selective and axial coding. The initial coding phase in grounded theory forces the researcher to define the action in the data statement. Codes are "active, immediate and short" and coding is done on a line by line basis. Each piece of data can inform earlier data and the researcher will "give their data multiple readings and renderings" (Charmaz, 2005, p. 517).

The study is informed from the outset by a preliminary research framework that is informed by extant theory and seeks to further refine that framework through empirical investigation. Therefore data analysis techniques based upon pure grounded theory are not considered appropriate in the context of this particular study because the study is strongly theory-driven. Miles and Huberman (1994) also present an approach to data analysis that is described as "pragmatic grounded theory" (Lillis, 1999, p. 89). This is discussed in the next section.

4.4.5.2 Data analysis techniques in Miles and Huberman (1994)

Miles and Huberman (1994) present a sophisticated and comprehensive approach for managing, analyzing and interpreting qualitative empirical materials which draws on grounded theory and analytic induction and shows how researchers might employ codes, memos and diagrams to go from field notes to a conceptual understanding of processes. Miles and Huberman (1994) argue that data analysis contains three linked sub processes that take place before, during and after data collection. These are data reduction, data display and conclusion drawing/verification. Data reduction is the process of selecting, simplifying, abstracting and transforming raw case data. Data display is the organised assembly of information to enable the drawing of conclusions. Drawing conclusions and verification refers to drawing meaning from the data and building a logical chain of evidence.

In carrying out data analysis in the context of this study, the Miles and Huberman approach was considered appropriate for a number of reasons. First, this approach

has enjoyed widespread use and is considered both elegant and systematic (Denzin and Lincoln, 1998, p. 40). Second, Miles and Huberman have extended the range of analytical procedures available to qualitative researchers "in a very considerable way" (Fielding and Lee, 1998, p. 39) and the Miles and Huberman approach can be used for a broad spectrum of research designs. Specifically, Using the Miles and Huberman approach, the researcher can configure approaches to data reduction, data display and conclusion drawing/verification in accordance with the particular needs of their own study. The authors argue that their approach can be used to support both loose and inductive (exploratory and descriptive) research designs as well as tight and deductive (explanatory and predictive) research designs. Finally, the approach to data analysis advocated by Miles and Huberman can easily facilitate the integration of data gathered using the different data collection techniques that are used in this study.

4.5 Presenting the research protocol

Miles and Huberman (1994) observe that qualitative research methods tend to be poorly formulated and suffer a perceived lack of rigour. In particular, Lillis (1999) suggests that qualitative research "lacks an accepted language in which to communicate study design parameters and the critical links between design and credible research outcomes" (Lillis, 1999, p. 80). As a result, the legitimacy and credibility of qualitative research conclusions are commonly questioned (Miles and Huberman, 1994). Therefore, the purpose of this section is to clearly describe the research protocol that was used to carry out this study.

Figure 4.8 presents the study's research protocol from two perspectives. *Figure 4.8(a)* illustrates the research protocol at more abstract level. Here, the figure attempts to describe some of the relationships between data collection and data analysis activities. For example, the figure illustrates that:

(i) The preliminary framework influenced data collection and the early stages of data analysis (using a grey arrow)

(ii) There was also a mutually constitutive relationship between data collection and the early stages of data analysis (using two vertical, bi-directional arrows)

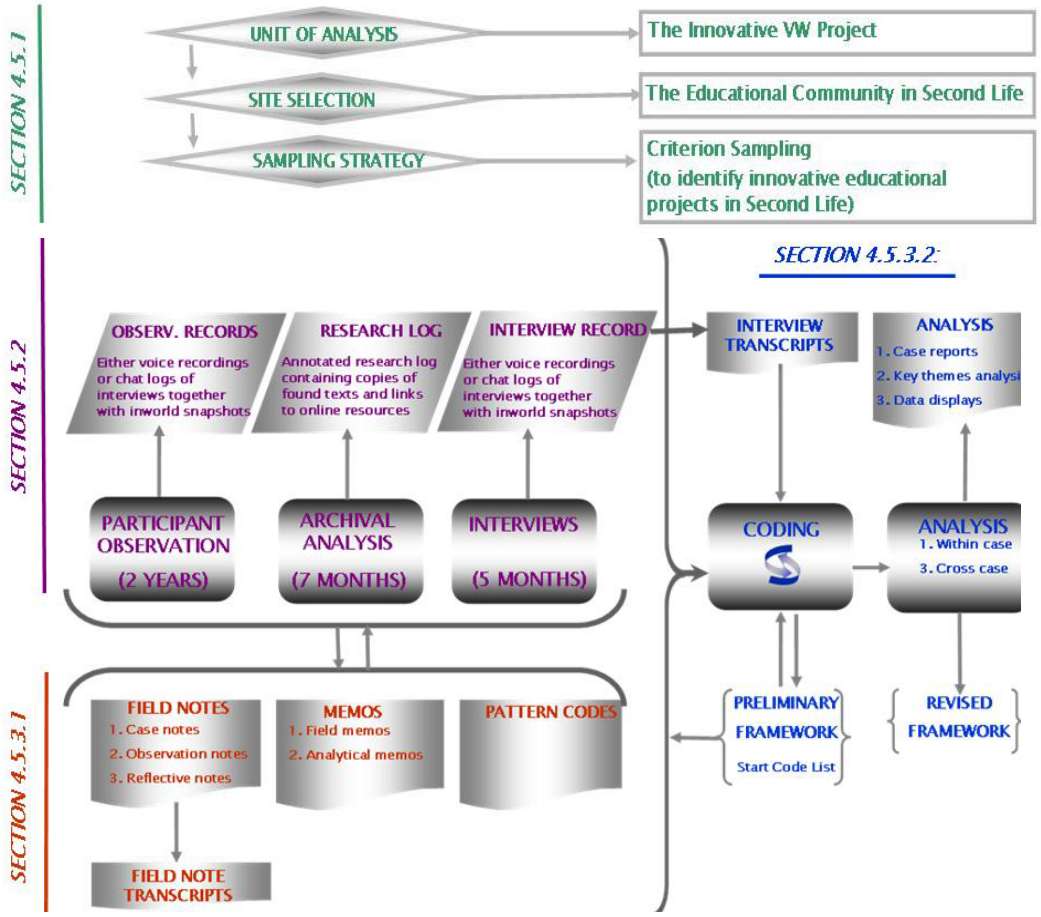
(iii) The coding process was the iterative nature of the coding process (using two interlocking, curved arrows)

(iv) The preliminary framework both informed and was informed by data coding (using two bi-directional arrows)

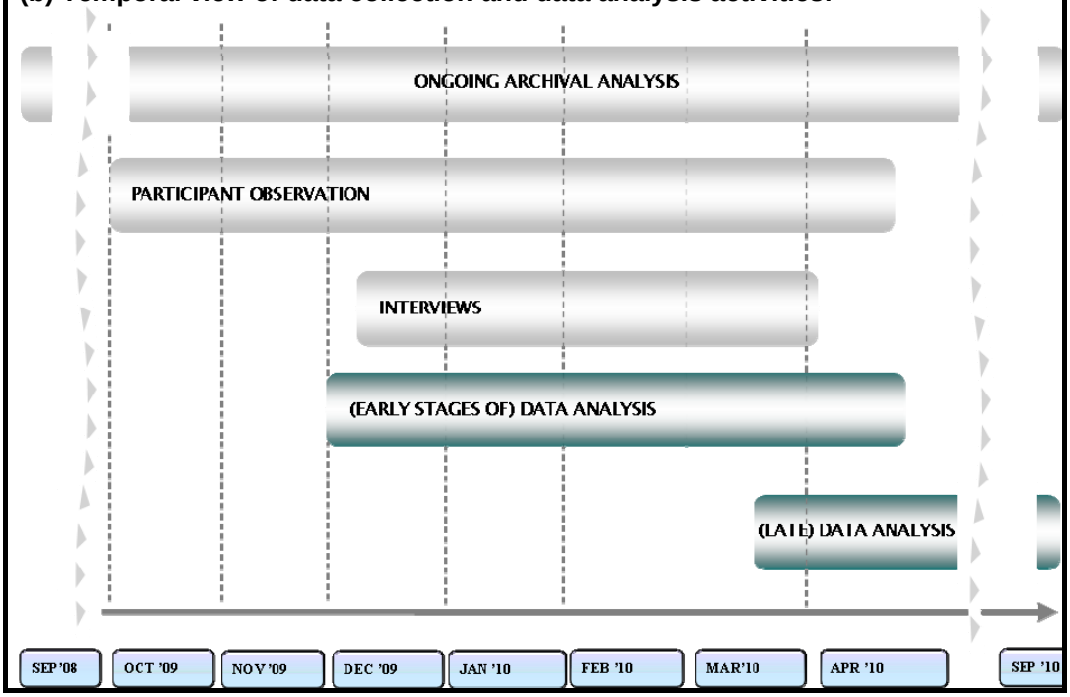
In addition, Figure 4.8(a) summarises the research outputs from each activity. For example, the figure identifies the different types of data that were generated during each data collection activity. *Figure 4.8(b)* illustrates the research protocol from a temporal viewpoint. This figure highlights the overlap between data collection and data analysis in the study. This is an important feature of qualitative data analysis as the researcher is trying to "developing categories from the data, through constant comparative analysis over the entire time frame of the study" (Janesick, 1998, p. 388).

FIGURE 4.8 PRESENTATION OF THE RESEARCH PROTOCOL

(a) Atemporal view:



(b) Temporal view of data collection and data analysis activities:



The remainder of this section is structured according to Figure 4.8(a). More specifically, Section 4.5.1 explains how the research objective for the study was used to identify an appropriate unit of analysis for the study ("*the innovative virtual world project"*) and describes the sampling strategy that was used (to identify innovative educational projects in Second Life) as a result. Section 4.5.2 then describes how each data collection technique was carried out and describes the actual data that was collected in detail. Finally, Section 4.5.3 describes the (i) early stages and (ii) late stages of data analysis in turn. This section describes the different types of analyses that were carried out and how these analyses ultimately lead to the generation of the data displays that are presented in this thesis.

4.5.1 Unit of analysis, site selection and sampling strategy

In order to carry out multiple-case research, it is essential that appropriate cases are selected (Eisenhardt, 1989). Therefore, this section describes how the study's research objective was used to derive the study's unit of analysis (Section 4.5.1.1) and shows how decisions about site selection (Section 4.5.1.2) and sampling (Section 4.5.1.3) were made as a result. Finally, Section 4.5.1.4 introduces each of the six case studies.

4.5.1.1 Unit of analysis

The "key issue in selecting and making decisions about the appropriate unit of analysis is to decide what it is you want to be able to say something about at the end of the study" (Patton, 1990, p. 168). The objective of this study is to investigate knowledge creation in virtual worlds. In addition, a preliminary framework has been derived from extant research to guide the study. This framework focuses on knowledge creation intentions, knowledge-creating behaviours and knowledge creation outcomes. This framework therefore suggests an inherently process orientation for the study.

In order to complement the process orientation of the study, the *innovative virtual world project* was selected as the unit of analysis for the study. Focusing on projects taking place within virtual worlds had the added advantage of facilitating

the identification of the temporal and behavioural boundaries of cases: the analysis can focus specifically on knowledge creation intentions, behaviours and outcomes in relation to specific projects with definite start and end points.

A focus on innovative virtual world projects suggests a focus on either (i) individuals working in groups that are carrying out innovative virtual world projects or (ii) groups carrying out innovative virtual world projects. In the context of this study, the literature review highlights the fact that the existence of supra-individual knowledge structures is controversial (Walsh, 1995). Furthermore, whilst researchers have provided substantial evidence that knowledge structures have strong effects on perceptual processes and outcomes in organisations at the individual level, empirical investigation of collective cognition in organisations is only just beginning (Elsbach *et al.,* 2005). For these reasons, knowledge creation at the individual level is the primary focus of the study. Individuals (rather than groups) taking part in innovative virtual worlds projects were identified as the primary embedded units of analysis for the study.

4.5.1.2 Site selection

Having identified the innovative virtual world project as a suitable unit of analysis for the study, it was necessary to choose an appropriate site at which to carry out the study. Second Life® was selected for several reasons. Second Life fits the definition of non-game oriented virtual world presented in Chapter Two: Second Life is an online, immersive, interactive environment that is based on community, content creation and commerce. Furthermore, Second Life has a number of unique features that were designed to stimulate user-driven innovation. These include Second Life's (i) marketplace[9], (ii) currency exchange service (the LindeX), and (iii) terms of service which grant users real-world intellectual property rights on their virtual creations (Ondrejka, 2004). Thus, Second Life is a particularly good choice for creative expression (Ward and Sonneborn, 2009). Finally, Second Life has become the *de facto* virtual world for commerce (Kim *et al.*, 2008) and as a

[9] See https://marketplace.secondlife.com/ Accessed 2nd November, 2011

result, Second Life is of particular interest in the IS field. As a result, most virtual worlds studies in the IS field to date are focused on Second Life.

According to Hagel and Armstrong (1997), large scale virtual communities will consist of a large number of sub-communities. Indeed, both the literature review and the analysis of online documents and archives related to Second Life pointed to the existence of a number of sub-communities within Second Life. Therefore, in terms of site selection, it was also deemed necessary to select a particular sub-community within Second Life within which to carry out the study. Preliminary observations of Second Life suggested that the educational community in Second Life would be particularly well suited to the task of seeking out innovative virtual world projects in Second Life for a number of reasons:

(i) Preliminary observations indicated that a large number of real world educational institutions were actively carrying out educational projects in Second Life. These observations indicated that the educational community was highly active both inworld and on online forums. In addition, preliminary observations of the Second Life educational community suggested that its members were eager and willing to engage with other researchers investigating virtual worlds.

(ii) Based on his meta-analysis of determinants of organisational innovation, Damanpour (1991) concludes that scholars should distinguish between different types of innovation and different types of organisation. By concentrating on educational projects specifically, the analysis would be concerned with particular kinds of innovation.

(iii) The monitoring of virtual world communities' (online) public documentary and archival records suggested that educational projects in virtual worlds were typically of similar size, scope, and duration and educational innovation. This would facilitate the use of a multiple-case research design and cross case analysis

(iv) Educators have long been associated with virtual worlds. Active Worlds in particular was well known for its mature educational

community. In addition, it has been noted that educators have been instrumental in bringing about many of the innovations that have taken place within virtual worlds over the years. This was thought to increase the likelihood that the researcher would successfully be able to identify innovative projects for the study.

4.5.1.3 Sampling strategy and sample size

In qualitative research, sampling tends to be *purposive* rather than random (Eisenhardt, 1989; Miles and Huberman, 1994, p. 27; Patton, 1990, p. 230). The "logic and power" of purposeful sampling is based on selecting information-rich cases for in-depth study (Patton, 1990, p. 230). Therefore, qualitative researchers usually work with "*small* samples of people, nested in their context and studied in depth" (Miles and Huberman, 1994, p. 27). Table 4.1 summarises the main sampling strategies used in qualitative research according to Patton (2002) and Miles and Huberman (1994).

TABLE 4.1 SUMMARY OF SAMPLING STRATEGIES
- Based on Patton (2002, pp. 243-244) and Miles and Huberman (1994, pp. 27-34)

	STRATEGY	DESCRIPTION
1.	INTENSITY	Information-rich cases that manifest the phenomenon intensely but not extremely (Miles and Huberman, 1994, p. 28)
2.	***CRITERION***	**Studies all the cases that meet some predetermined criterion. Can be applied to identify cases from quantitative questionnaires for in-depth follow-up (Patton, 2002, p. 238)**
3.	HOMOGENEOUS	Focuses, reduces, simplifies, and facilitates group interviewing (Miles and Huberman, 1994, p. 28)
4.	MAXIMUM VARIATION	Documents diverse variations and identifies important common patterns (Miles and Huberman, 1994, p. 28). "Any common patterns that emerge from great variation are of particular interest" (Patton, 2002, p. 235)
5.	TYPICAL CASE	Taking above average, average and below average cases. Purpose is to capture major variations rather than identify a common core (Patton, 2002, p. 236)
6.	CONFIRMING AND DISCONFIRMING CASES	Additional cases are selected to test ideas from earlier cases. Confirmatory cases fit already emergent patterns to confirm findings, add richness, depth and credibility. Disconfirming cases can reveal rival interpretations or can serve to place boundaries around confirmed findings (Patton, 2002, p. 239)
7.	OPPORTUNISTIC	Taking advantage of new opportunities during actual data collection
8.	CONVENIENCE	Saves time, money and effort, but at the expense of information and credibility (Miles and Huberman, 1994, p. 28)
9.	STRATIFIED PURPOSEFUL	Illustrate the characteristics of a certain sub-group of cases (Patton, 2002, p. 244)
10.	EXTREME / DEVIANT CASE	Learning from highly unusual manifestations of the phenomenon of interest (Miles and Huberman, 1994, p. 28)

According to Patton (1994, p.50), decisions about sampling strategies depend on prior decisions about the appropriate unit of analysis to study. In the context of this study, the nature of the unit of analysis chosen for the study ("the innovative virtual world project") necessitated the use of criterion sampling. This was because the researcher had to establish some means of evaluating whether or not a particular project was innovative or not. When criterion sampling is used, all cases must meet some predetermined criterion or criteria.

Marshall and Rossman (1989, p. 54) indicate that ideal sites for qualitative research include those where entry is possible. Therefore the researcher initially posted an invitation to participate in the study (cf. Appendix B) on a number of online forums[10] maintained by members of the Second Life educational community in November, 2009. The invitation specified that the researcher was seeking to investigate "innovation and knowledge creation in… the educational community within Second Life" and was seeking out virtual worlds educational projects that "(i) were carried out by or for third level institutions, (ii) were developed by at least three individuals, and (iii) can be reasonably well recalled by those individuals". This tactic did not yield a significant number of responses. Therefore, the researcher sought to generate a list of possible cases by soliciting project nominations from the Second Life educational community. This tactic yielded thirty project nominations but ten of these nominations were self-reported.

Therefore, the researcher sought to identity possible cases by carrying out an inspection of online archival records found on websites related to education in Second Life. In total, this process led to the identification of 164 "innovative virtual world projects". All nominations were numbered and stored in a Microsoft Excel (2003) sheet.

Traditional measures of innovativeness (e.g. number of patents; associated income) could not be used to identify innovative Second Life educational projects.

[10] These were (i) the SLED (Second Life Educational Community) mailing list; (ii) the SLRL (Second Life Researcher's List) mailing list; and (iii) several professional virtual worlds groups on LinkedIn)

Therefore, the researcher evolved a list of inclusion and exclusion criteria (together with a points system) that could be used to evaluate projects in terms of their suitability for the study. Table 4.2 summarises these criteria. The table illustrates that seven inclusion criteria and six exclusion criteria were used. Both sets of criteria were designed with three main aims. First, that there would be some form of 'tangible' evidence that members of the education community within Second Life felt that selected case studies were 'innovative' (cf. criteria I2; I3; I4; I5; I6). Second, that it would be possible to gather sufficient data from selected case studies (cf. criteria I1; E1; E5; E6). Third, that selected case studies would be suitable for cross case analysis; in other words, that selected case studies would be comparable in terms of size and scope (cf. criteria E2; E3; E4).

TABLE 4.2 SAMPLING CRITERIA FOR SELECTING INNOVATIVE VIRTUAL WORLD PROJECTS

Code	Type	Criterion	Points
I1	Inclusion	Project members had volunteered to participate in the study	+3
I2	Inclusion	Project had been suggested multiple times	+2
I3	Inclusion	Project had received funding that listed innovativeness as a criterion	+2
I4	Inclusion	Project was high profile or an educational showcase	+2
I5	Inclusion	Project was selected by well known virtual worlds educators	+2
I6	Inclusion	Project was award winning	+2
I7	Inclusion	Researcher discretion [facilitate element of opportunistic sampling]	+1
E1	Exclusion	Insufficient information is available with regard to the project	NA
E2	Exclusion	Project not carried out in Second Life	NA
E3	Exclusion	Project not carried out for a third level institution	NA
E4	Exclusion	Project not developed by at least three individuals	NA
E5	Exclusion	Project not completed recently (cannot be reasonably well recalled)	NA
E6	Exclusion	There are access problems with this project	NA

The primary purpose of the mechanism was to rigorously identify "innovative virtual world projects" rather than to evaluate the innovativeness of virtual world projects *per se*. Therefore, a project was considered innovative if it met one or more criteria. Specifically, individual projects were scored according to the primary inclusion criterion for that project. For example, if a project's team members had volunteered to take part in the study (Criterion I1), that project was awarded three points. If the researcher felt the project was innovative, that project was awarded one point (Criterion I7). All other projects that met one of the remaining inclusion criteria were given a score of two points. Using this mechanism, an element of opportunistic sampling was incorporated into the mechanism. Further, this mechanism prioritised projects where participants had

volunteered because it was felt that voluntary participation in the study would facilitate the collection of rich data. At the same time, this mechanism included projects that the researcher felt would be suitable for the study but these were given a lower priority than projects that met any of the other criteria. If a potential case study met one or more of the exclusion criteria, it was eliminated.

Using this mechanism, 53 cases received a positive score and were therefore deemed innovative for the purposes of the study. Of these 53 projects,

- 6 projects were given a score of 3 (participants had volunteered for the study)
- 15 projects were given a score of 2 (met one/more criteria for innovativeness)
- 32 projects were given a score of 1 (included based on researcher discretion).

The researcher attempted to make contact with individuals who had been involved in all of these cases. In total, 32 emails were sent and 15 viable case study projects were generated. In three instances, participants opted out of the study in its earliest stages. A further three cases were found to be inappropriate for the study because they were subsequently found to breach one or more of the exclusion criteria (see above). Data was therefore collected from nine cases in total. Upon completion of data collection, it became clear that the researcher had gained insufficient access in three of the nine cases and had therefore collected insufficient data on those cases. Thus, the study presents an analysis of six case studies:

- 1 project (GLA) was given a score of 3 (participants had volunteered for the study)
- 1 project (RIT) was given a score of 1 (included based on researcher discretion)
- 4 projects were given a score of 2 (met one/more criteria for innovativeness).

Patton (1990) observes that "validity, meaningfulness, and insights generated from qualitative inquiry have more to do with the information-richness of the cases selected and the observational/analytical capabilities of the researcher than with sample size" (pp. 184-185). In particular, Lincoln and Guba (1985) argue that redundancy should be used as the primary criterion in determining sample size because the purpose of qualitative research is to maximise information: "sampling is terminated when no new information is forthcoming from new sampled units" (p. 202). Similarly, Eisenhardt (1989) suggests that theoretical

saturation has been reached at the point where incremental learning has become minimal because the researcher is observing phenomena that have been seen before. In this study, the researcher determined that the point of theoretical saturation had been reached once six case studies had been completed. This decision was based upon the generation and continual review of data analysis materials during data collection.

4.5.1.4 Introducing the case studies

The purpose of this section is to introduce each of the study's six cases: FOB, EXT, RIT, GLA, MZO and LOY[11]. Table 4.3 provides an overview of the key aims of each of the case study projects. Each of the cases is then presented in turn using a standard format which includes:

(i) Background information on the real life organisation(s) involved

(ii) A description of the Second Life project itself

(iii) A narrative summary of the case study

TABLE 4.3 OVERVIEW OF CASE STUDIES

Case	Project aim
FOB	To bring students into a virtual world; an intrinsically cybernetic and artificial cultural landscape, born of science fiction and inhabited by the virtual human in order to explore the implications of scientific and technical advances for the future of humanity
EXT	To leverage the unique affordances of Second Life to create educational materials that could not feasibly be created using other technologies and to package those materials by means of a Machinima video so that they could be published online for future use
RIT	To use Second Life to create demonstrations and simulations of animation algorithm concepts that are difficult or impossible to create in the real world
GLA	To use scenario driven and problem based learning to improve nurses' skills in taking patient histories and undertaking physical examinations in real life
MZO	To follow a structured and formalised research agenda over a three year period in order to incrementally develop and use a virtual laboratory in Second Life to teach lab and experimental skills to science students
LOY	To improve students' chances of being hired as border control officers by allowing them to rehearse the role of a border control officer in a virtual border setting

[11] Case names have been modified to protect the identity of the cases in accordance with the research protocol

4.5.1.4.1 Case 1: FOB

The FOB project took place at an American college (called ESC). ESC was founded in 1971. Its mission is to use innovative, alternative and flexible approaches in higher education. The college targets adult learners and has a student population of 18,000. It offers associate, bachelor's and master's degrees (onsite and online) and is one of thirteen arts and sciences colleges in an American university.

This case study was included in this study as it met one or more of the inclusion criteria set out in the sampling mechanism which is explained in Section 4.5.1.3. The project involved the creation and development of a Second Life activity for students taking a new interdisciplinary science course (called FOB) at ESC College. The key concept for the project was to bring students into a virtual world; an intrinsically cybernetic and artificial cultural landscape, born of science fiction and inhabited by the virtual human in order to explore the implications of today's unprecedented scientific discovery and technological advancement for the future of humanity. According to the course instructor, students would also be required to use what was termed the "scientific method" to guide their explorations of Second Life. Therefore, students had to craft their own research questions (hypotheses) at the outset of the activity and then draw upon their own direct experience in Second Life to address them. Students would first enter Second Life using one of the default avatars provided by Linden Labs. They would then be taken to a purpose built "transformation station" in Second Life which would prepare students for the activity. Students would choose from a range of pre-selected locations that they would like to visit in Second Life in accordance with their own research questions. Then, a cyborg (an automated avatar and key concept for the course itself) would help students to select a new avatar and provide a HUD (a heads up display). This HUD acted as a guide for students exploring Second Life: it contained information about each location written by the instructors to help students to carry out the assignment.

The FOB team had secured funding to investigate "models for rich and meaningful online courses in science and mathematics". Having explored a number of virtual worlds, the team decided to carry out a project in Second Life. Four course authors were assembled from geosciences (F.EDU), genetics, mathematics and the philosophy of science, media and technology (F.FAC) to write the course. Meanwhile, F.FAC began to informally discuss designs with F.DEV. F.FAC then recruited F.DEV for a period of three months to help develop the project. F.DEV began by formally identifying the project's requirements and worked closely with F.FAC throughout to develop both the transformation station and the HUD. He also worked closely with three instructional designers who began to explore the pre-selected Second Life locations to create specific content for the HUD regarding each location.

4.5.1.4.2 Case 2: EXT

In America, the EXT is a large non-formal educational network designed to help people use research-based knowledge to improve their lives. The service, founded in 1914, is provided by designated land-grant universities located in each state, includes about 15,000 educators, and involves programs at nearly 3000 local offices. In most states the educational offerings are in the areas of agriculture and food, home and family, the environment, community economic development, and youth development. CES is very interested in extending their reach by means of the internet. To that end, they are currently developing a "coordinated, Internet-based information system" which includes Web 2.0 and Virtual Worlds technologies; the purpose of which is to grant online access to specialised information and education to citizens.

This case study was included in this study as it met one or more of the inclusion criteria set out in the sampling mechanism which is explained in Section 4.5.1.3. This case study concerns a project which was carried out entirely in Second Life by a facilitator from the Information Technology staff of EXT (based in New York), an educator based at Pennsylvanian State University, and a developer (based in Florida). The project was based on teaching aspects of Turf grass

management. The key concept for the project was to leverage the unique affordances of Second Life to create educational materials that could not otherwise exist and to package those materials by means of a MACHINIMA video so that they could be published online for subsequent use. The team created three interactive inworld exhibits. The first exhibit is called the “Sod Ball”. It is a spherical exhibit which allows the user to familiarise themselves with different kinds of Pennsylvanian turf grass. The second exhibit is designed to enable students to familiarise themselves with effective turf grass mowing practices. Thus, the exhibit consists of a simulation of growing grass (its growth rate has been increased so that students can see the grass growing) and it enables students to practice effective mowing techniques in the virtual world. The third exhibit is highly immersive and it is the only one to incorporate audio visual materials. Its purpose is to teach students about the proper use of pesticides to control the Japanese beetle. Students walk through a mega-sized earthen tunnel which simulates the home of the beetle and can view the beetle at an enlarged scale during each stage of its life cycle so that they can better understand effective techniques to control beetle populations at those different stages.

E.EDU had been appointed at his own university to investigate the educational potential of Second Life. He “walked around Second Life for a long time” and became aware that CEXT had already carried projects in Second Life and had a presence there. He eventually met with E.FAC and they agreed to carry out a turf grass project which was to be funded by E.EDU and would be designed and created by E.FAC and E.DEV. The project was carried out in its entirety in Second Life.

4.5.1.4.3 Case 3: RIT

RIT is a private American university that was founded in 1979 and has a student population of approximately 16,000. RIT offers more than, 200 academic programs across eight constituent colleges in the areas of Arts, Business, Science and Technology, Engineering and Information Sciences. RIT’s mission is to provide technology-based educational programs and it therefore offers curricula

which are relevant to emerging technologies. RIT has a well known co-operative educational program which allows students to alternate periods of study on campus with paid employment.

This case study was included in this study on the basis of researcher discretion in accordance with the sampling strategy set out in Section 4.5.1.3[12]. The case concerns a project that was carried out by a faculty member at RIT's Computer Science department. The key concept for the project was that the faculty member would be able to use Second Life to create demonstrations and simulations of animation algorithm concepts that are difficult or impossible to create in the real world. The course was delivered and assessed entirely in Second Life in spring, 2009. By working in Second Life, the class found themselves working on animation algorithms within the environment that were being used to determine the mechanics of the environment itself

R.EDU had an interest in using Second Life to teach computer animation concepts to final year computer science students. He successfully submitted a grant application to pursue that and then found out that RIT's library group were at that time trying to promote the use of Second Life at RIT and were in fact looking for pilot projects to carry out in Second Life. He was given a plot of land on the RIT island and even though R.FAC and R.DEV were on hand to facilitate his project, he decided to take a crash course on building and scripting in Second Life that ran in Second Life and set about designing the inworld demonstrations to accompany the course himself. Students were taught entirely in Second Life and despite feeling that animation in Second Life was limited in comparison with other animation tools, many students chose to complete their assignments and were then assessed inworld.

[12] The researcher based this decision on the description of the project found at http://online.rit.edu/about/newsletter/one_article.cfm?which=143 Accessed 8 December, 2009

4.5.1.4.4 Case 4: GLA

GLA is made up of six academic schools in the areas of business, health and science and technology. It has a student population of 17,000 and is one of Scotland's largest universities. GLA aims to "develop and research innovative forms of learning and teaching for a wide range of students" and has created the Caledonian Academy to facilitate the achievement of that aim. The academy's activities are focused on the "effective and innovative use of new technologies in learning and teaching" and it is responsible for all of GLA's Second Life projects.

This case study was included in this study on the basis that the team volunteered to take part in the study and in accordance with the sampling strategy set out in Section 4.5.1.3. This case study is concerned with a virtual patient project that was carried out at the university's School of Health. The project was a winning entry in a competition hosted by the university to seek out pilot project ideas from within the university itself. *The key concept for the project was to use scenario driven and problem based learning to improve nurses' skills in taking patient histories and undertaking physical examinations.* The team first of all created a virtual ward. Then, they populated the ward with a number of virtual patient avatars. Students could interact with virtual patient avatars in order to take patient histories. This was enabled by chat bot technology so that in effect, the students were communicating with computer programs designed to simulate intelligent conversation. In addition, speech synthesis was used so that the virtual avatars had actual voices. Based on the patient's history, students would then simulate a physical examination of these avatars; for example, students could listen to the patients' heart sounds.

GLA became involved in Second Life in autumn, 2007. At that time, an island in Second Life was purchased and developed and a project manager (G.PM) was recruited to oversee Second Life projects. G.PM worked with G.FAC (who was based at the Caledonian academy) in order to stimulate interest in Second Life on campus. Together, they organised a competition for pilot project ideas which was designed to "stimulate understanding" at the university. The winning entry came

from the School of Health. The prize consisted of six month's training in Second Life with G.PM and was taken up by G.DEV (who was based at the School of Health). G.DEV then returned to the School of Health and worked in close collaboration with G.EDU to develop the virtual ward, the virtual patients, and the chat bot and speech synthesis technology used to power the virtual patients.

4.5.1.4.5 Case 5: MZO

UL is a leading UK university. It was founded in 1921 and has 23,000 students. It is ranked in the top 3% of universities in the world and is committed to international excellence through "the creation of world changing research and high quality, inspirational teaching".

This case study was included in this study as it met one or more of the inclusion criteria set out in the sampling mechanism which is explained in Section 4.5.1.3. This case study is concerned with the completion of the first phase of a funded, three year, collaborative research project at UL. The project is being carried out by UL's Learning Technologies R&D team (the BDRA) and the genetics department. Its aim is to investigate laboratory-based biomedical science activities in Second Life and their impact on "the student experience and learning outcomes" in comparison with other modes of learning. *The key concept for this project was to follow a structured and formalised research agenda in order to incrementally develop and use a virtual laboratory in Second Life over a three year period*. The team are deliberately seeking to incrementally improve their understanding of Second Life in a rigorous and formal manner. In the first phase of the project, the team familiarised themselves with Second Life by actually developing a virtual laboratory and then used it to teach students basic lab skills. The phase began in autumn, 2009 and was completed in April, 2010. The second phase of the research project will take one year and will investigate the effectiveness of the virtual lab to facilitate learning about experimental lab work. The team envisage that in the final stages of the project, students will design and carry out experiments in Second Life itself.

This project was carried out by individuals (M.FAC and M.DEV) from the university's Learning Technologies R&D team (the BDRA) and individuals based in the genetics department (including M.EDU). Whilst the genetics department were entirely new to Second Life, the R&D team were not. In carrying out the first phase of the project, M.DEV invested considerable effort in familiarising himself with Second Life in order to be able to effectively work with developers within Second Life on later stages of the project. He was involved in creating the laboratory but chose to recruit a developer from within Second Life to create the scripted elements of the laboratory (which would give the laboratory its functionality and interactivity). M.EDU worked with that person to ensure that the laboratory functioned as it should and was responsible for ensuring that the virtual laboratory was an accurate representation of a real life laboratory setting.

4.5.1.4.6 Case 6: LOY

LOY is a medium-sized, rural college of applied learning and technology in Canada. The college was founded in 1967 to provide career-oriented diploma and certificate courses. LOY was the first Canadian college to teach in a virtual world. This case study was included in this study as it met one or more of the inclusion criteria set out in the sampling mechanism which is explained in Section 4.5.1.3. This case study is concerned with a project that was designed for Customs and Immigration students. These students were hoping to work as border police. The key concept for the project was to improve students' chances of being hired as border control officers by allowing them to rehearse the role of a border control officer in a virtual border setting. Initially, the instructor (L.EDU) would demonstrate for the students and then students would take turns to role play the scenario. The team found that substantial learning took place during the virtual role play and during in-class debriefs that followed each role play. The course ran successfully and there were substantial improvements in terms of student performance. Each year, the simulation has been expanded to allow for more sophisticated scenarios to be acted out by students. In this past year, an interactive car has been added which can be searched for contraband.

L.FAC had recently been hired at LOY and was interested in promoting Second Life as an e-learning tool. He had started to seek out faculty members at LOY and was approached by L.EDU. L.EDU had been teaching a course to train border guards at the college for a number of years but felt that students were not benefitting as fully as they could. She wondered if Second Life might offer a solution and the pair decided to create a simulation of a border crossing to allow students to act out the scenario. Over the course of a few weeks, L.FAC worked with L.DEV and another developer (who were both students enrolled at LOY at the time) to create the simulation. They brought L.EDU to Second Life (for the first time) to demonstrate the simulation. They also worked closely with her when she carried out the role playing activity with students. Since the completion of the project, LOY's Second Life team have launched themselves as a design company within Second Life.

In summary, this section has presented an account of the first element of the research protocol: the key research decisions made prior to the commencement of data collection and data analysis (cf. Figure 4.8). More specifically, the section has presented an account of the key research decisions made prior to the commencement of data collection and data analysis. The discussion has explained the rationale for selecting the innovative virtual world project as the unit of analysis for this study. The discussion has also explained the rationale for selecting the educational community within Second Life as an appropriate site within which to carry out the study. Finally, the discussion has explained how innovative educational projects in Second Life were selected during the study.

4.5.2 Data collection

This section is concerned with the second major element of the study's research protocol: data collection (cf. Figure 4.8). As indicated in Section 4.4.4, three data collection techniques were selected for this study: (i) documentary and archival data collection (Section 4.5.2.1); (ii) participant observation (Section 4.5.2.2) and (iii) interviewing (Section 4.5.2.3). Finally, 4.5.2.4 also presents a focused discussion of the manner in which the study's preliminary framework was operationalised during interviews.

Before delving into the particulars of each of the three data collection techniques used in this study, it is noted that all research materials were stored electronically in date order using a clear and transparent filing system to facilitate easy access to research materials. In addition, Microsoft Excel (2003) was used to support coding activities and was also to produce data displays. Systematic and persistent analysis activities, together with the generation of summaries and other analytic materials, were absolutely essential in this study in terms of preventing data overload. In addition, it is observed that many qualitative researchers have turned to computer applications to facilitate data management and analysis. These applications allow text to be coded and searched; and they can be used to build conceptual models and identify exceptions (Denzin and Lincoln, 1998). The researcher had investigated a number of these applications. However, in the context of this study, the researcher opted to systematically organise research materials using coherent filing and labelling structures. This approach effectively grounded the analysis in the data.

4.5.2.1 Documentary sources and archival records

Online documentary sources and archival records were monitored from September, 2008 to September, 2010. These records were found in online forums dedicated to education in virtual worlds such as websites, blogs and mailing lists maintained by members of the Second Life educational community. According to Peraklyla (2005), this approach to data collection results in the creation of "naturally occurring data". In the context of this study, this data collection

technique allowed the researcher to become familiar with virtual worlds educational discourses. In particular, this technique yielded insights into the kinds of approaches and directions that were being pursued by Second Life educators in general and also into the particular issues and challenges that they faced at that time. Finally, this data collection technique also played an important role in allowing the researcher to successfully identify innovative educational projects in Second Life for the purposes of the study (cf. Section 4.5.1.3). Table 4.4 indicates that data collected using this technique was collated in an annotated research log that contained copies of found texts and links to online resources.

TABLE 4.4 DATA COLLECTION (i): DOCUMENTARY & ARCHIVAL DATA COLLECTION		
		(Sept. 2008 → Sept. 2010)
MATERIALS GENERATED	**FORMAT**	**DETAILS**
Annotated research log containing copies of found texts (e.g. texts from web pages, mailing lists and online forum discussions) and links to online resources (e.g. online videos)	MS Word (2003) files	18 files; 887 pages

4.5.2.2 Participant observation

Participation observation in Second Life was carried out between December, 2009 and April, 2010. The researcher estimates that 640 hours were logged in Second Life during this time[13]. Table 4.5 summarises the researcher's participant observation in Second Life. In particular, the table indicates that participant observation was primarily carried out within (i) educational, (ii) technical and (iii) community forums. In addition, the table presents a summary of the research materials that were generated during participant observation.

[13] This estimate is based upon an average of thirty two hours spent in world for twenty weeks

TABLE 4.5 DATA COLLECTION (ii): PARTICIPANT OBSERVATION IN SECOND LIFE	
FORUMS	**PRIMARY EXAMPLES**
Educational forums	Virtual worlds best practices in education conference (VWBPE, 2010)
	Weekly meetings of the Virtual Worlds Education Roundtable (VWER)
	Weekly meetings of the International Society for Technology in Education (ISTE)
Technical forums	The Second Life Pro (SL Pro, 2010) conference
	Weekly meetings of the Smarter Technology group
	Weekly building classes at New Citizens Inc. (NCI)
	Weekly building classes at Builders' Brewery
Community forums	Weekly meetings of the Metanomics group
	Weekly meetings of the We Are The Network group
Exploratory activities	Well known educational and science-related locations in Second Life *(College of Scripting, Music and Science; First World War Poetry Digital Archive; Infolit iSchool; ISTE island; Karuna; The Life and Times of Uncle D; New Citizens Incorporated (NCI); Sci-Lands; SploLands; Virtual Ability; Virtual Africa; Virtual Hallucinations Lab)*
	Well known role playing locations in Second Life (e.g. Isle of Wyrms) Well known steam-punk locations in Second Life (e.g. Caledon) Well known cyber-punk locations in Second Life (e.g. InSilico) Well known historical locations in Second Life (e.g. Chicago Roaring '20s; the, 1920s Berlin project)
	Miscellaneous locations including art exhibitions, music events (including live performances), theatrical events (e.g. SL Shakespeare Company), and Studio Wikitechture

MATERIALS GENERATED	FORMAT	DETAILS
1. Public chat logs	Text file	c. 3000 pages **(i)**
2. (Private) instant messaging logs	Text file	c. 444 pages **(ii)**
3. Inworld snapshots	Digital images	6000 images in total
4. Sound recordings of voice sessions **(iii)**	Audio files	152 files; 110 hrs
Educational sessions:		*59 files; 43 hours*
Technical sessions:		*44 files; 37 hours*
Community oriented sessions:		*23 files; 18 hours*
Exploratory sessions:		*26 files; 12 hours*

(i) *This estimate was calculated by placing public chat logs generated in February into a text document; selecting a size 12 font and a line spacing of 1.5; counting the number of pages of text; and multiplying by four (the bulk of the data was calculated over a four month period)*

(ii) *This is an approximate figure that was calculated by placing all instant message logs for the first week in February into a text files; selecting a size 12 font and a line spacing of 1.5; counting the number of pages of text; and multiplying by twelve. Note that this is therefore a conservative estimate because the level of participant observation carried out in this week was under average*

(iii) *The apparent discrepancy between the number of inworld sessions recorded and the number of hours logged in Second Life is due to the fact that the majority of inworld sessions were carried out in text rather than voice (these transcripts are part of the public chat logs)*

Overall, Table 4.5 illustrates the extent to which observational activities reflected the fact that the study's primary focus was on educators in Second Life. The researcher also went to some effort to improve her understanding of the technical aspects of Second Life in order to have a working knowledge of technical challenges faced by educators in carrying out projects. At the same time, the researcher engaged with non-educational communities in Second Life in order to better understand the context within which Second Life educators – many of whom were active in these communities – operated. All of these forums typically met on a weekly basis. This afforded the researcher an opportunity to get to know members of the Second Life educational community by means of regular contact.

The researcher also carried out a number of one-off visits to well-known locations in Second Life (educational and non-educational locations are distinguished in Table 4.5). These locations were typically visited by the researcher alone or as part of organised tours that had been publicised within Second Life's educational community. As time went by, the researcher increasingly relied on 'word of mouth' to identify new and interesting locations to visit and also became a more regular visitor at specific locations or virtual communities that were of interest. The insights gained from these activities enabled the researcher to gain better traction with study participants during interviews.

Table 4.5 also describes the variety of research materials that were generated during participant observation. Public and private chat logs were recorded as text files and audio files were also created when voice was used in Second Life. In addition, a large number of snapshots were taken during participant observation[14].

[14] Over 6,000 snapshots were generated during data collection

Snapshots were taken for a variety of reasons during participant observation. In particular, snapshots were taken to record:

- Changes in the researcher's avatar appearance over time
- New locations visited in Second Life
- New individuals met in Second Life
- Every session attended (conference, presentation, meeting, class, event)
- Every one-to-one conversation
- Every interesting observations made by other users in text (i.e. in local chat, private IM or group IM) in relation to:
    - Second Life
    - Education in Second Life
    - Creativity and innovation in Second Life
    - Questions or issues raised by the researcher
- New 'discoveries' or insights about features of Second Life, such as:
    - the interface (e.g. the use of particular menus to monitor and control lag)
    - the use of online tools inworld (e.g. the use of web-based collaborative real-time text editors inworld)
    - communication convention (e.g. the use of '/me' or ASCII art)
- Interesting (impressive, unusual or well-designed)
    - inworld objects and scripts (e.g. an animated, transparent limb)
    - inworld tools (e.g. an inworld collaborative debugger tool)
    - observations made by other users in text (i.e. in local chat, private IM or group IM)

Each snapshot was named based on the reason for taking the snapshot. Thus, each snapshot became a kind of an annotated, graphical field note. In addition, because the snapshots were filed in date order, the snapshots could be viewed as a time ordered slide show. The researcher periodically reviewed these snapshots in this manner during data collection and data analysis. The researcher could look through these slideshows in a matter of minutes and literally "see the story of the study" at a glance. Used in this manner, the snapshots became a graphical

narrative summary of the study itself. This technique became an effective means of dealing with the severe data overload that arose during the study and prompted a number of important insights. Had the researcher attempted to use video capture technology, it would not have been possible to annotate the research materials in real time; nor would it have been possible to review research materials at speed.

Finally, the Internet changes the research scenario and alters the ways in which researchers collect, analyse and represent data (Markham, 2005, p. 793). Online communication is not at all like face to face communication (Markham, 1998, p. 34). New communication technologies highlight certain features of interaction and obscure others; thus, traditional methods of capturing data may need to be modified or discarded (Markham, 2005).

With regard to the nature of participant observation in a virtual world, it is important to acknowledge the onerous nature of the task both in terms of the technical proficiencies required and in terms of the social skills that are needed and the communicative nuances that must be appreciated in order to participate and communicate effectively in a virtual world. Appendix E provides a detailed account of the researcher's experiences in terms of carrying out participant observation in Second Life. As the account in Appendix E illustrates, it took a substantial amount of time to develop an understanding of (i) how educators at large were approaching education in Second Life at the time and (ii) the nuances of the debates that were raging in the Second Life educational community at the time (the debate surrounding Second Life versus rival platforms and open virtual world platforms in particular, for example). All of this is quite apart from the time it took to acquire the 'soft' skills needed to use Second Life effectively. It literally took *months* to learn how to effectively use the Second Life client; to understand the 'lingo' and jargon that pervades communication in Second Life; to appreciate the importance of the visual appearance of the avatar in Second Life; to develop the skill to keep up with multithreaded discussions (i.e. discussions amongst large groups of people using voice, local chat and private chat simultaneously); and to develop the skill to be able to effectively contribute to these multithreaded

discussions. Certainly, other Internet researchers (e.g. Hine, 2000; Jones, 1999; Markham, 1998; Jones, 1997) have grappled with similar issues. However, the researcher did not fully appreciate these issues prior to data collection.

Despite these issues, participant observation was an indispensable – albeit radically time consuming - component of the study's research design. It was by participating in the Second Life educational community and exploring the social and technical aspects of Second Life that the researcher developed the necessary understanding to complete this study. In addition, it led to the emergence of a variety of insights with regard to the specificities of virtual worlds as sites for online research.

In particular, it led to a number of observations regarding the nuances of communication and interaction in virtual worlds. For example, it highlighted the subtle cues that residents could use to make inferences about other residents. Thus, the researcher discovered that:

(i) users could look at other avatars' appearance and interactions (with the environment or with other users) and discern whether or not they were novice or expert users (cf. Boostrom (2008) for a discussion of the stigmatised 'newbie'),

(ii) experienced users could tell old an avatar (an account) was just using just that avatar's second name (i.e. without having to look at the avatar's profile),

(iii) if a user was familiar with another user, they could recognise their friend even if that friend wasn't using their main avatar (i.e. if they were using an 'alt') by watching their interactions.

Indeed, as the researcher became more familiar with Second Life, study participants were more inclined to observe that she 'looked' as if she knew her way around. In fact one participant (F.DEV) expressed his appreciation for the fact that the researcher did her

> research "on [her] own two feet", so-to-speak. :) ".

(He specifically objected to researchers "spamming multiple forums" for people linking to "some cheap survey site", arguing that they were not doing research).

In addition, these observations highlighted the extent to which users 'judge' other users based on their avatars' appearances. One resident argued that this was appropriate in Second Life (whereas it would be less appropriate in real life) because of the fact that users have complete control over how their avatars look in Second Life. Indeed one of the study's participants suggested that it was for this reason that the researcher needed to ensure that her avatar "looked the part". She should take the community seriously, he said, if she expected them to take her seriously.

These insights have implications for researchers' interactions in virtual worlds and shed light on the specificities of observer effects in virtual world research. What impact, for example, do the researcher's appearance and skill level have on how they are perceived and how others interact with them in a virtual world? These questions only began to emerge as the study was carried out and so there was little the researcher could do to address them, though these effects were mitigated by the use of unobtrusive measures in carrying out the study.

4.5.2.3 Interviews

Within each case, interviewees were initially selected based upon the recommendations of the researcher's primary contact in each project. However, it emerged that most of the projects had been carried out by individuals who occupied one of three primary roles within projects:

(i) Project **EDU**cators (responsible for projects' pedagogical aspects)

(ii) Project **DEV**elopers (responsible for building projects in Second Life)

(iii) Project **FAC**ilitators (responsible for managing and facilitating projects)

Therefore, the researcher ensured that interviews had been carried out with individuals occupying each of these roles within all of the cases.

Note that a naming convention is used throughout this analysis to uniquely identify each interviewee. Each interviewee was named using the initial letter of their project's name (e.g. 'F' for FOB) and the acronym for their role within that case (e.g. 'EDU' for educators, 'DEV' for developers). The format of this naming convention is as follows:

[Initial letter of the case's name] . **[Role of interviewee within that case]**
e.g. F, E, R, G, M, L . *e.g. EDU, DEV, FAC*

For example, interviews were carried out at FOB with F.EDU, F.DEV, and F.FAC

Table 4.6 details the interviews carried out in this study. The table provides information about when interviews were carried out and also indicates whether interviews were carried out using inworld voice or inworld chat. The table also includes information in relation to any supplementary data collection activities that were carried out such as additional inworld site visits. For instance, the table shows that an additional interview was carried out with M.EDU. This interview was a follow up interview that took the form of a guided tour of the MZO project. The table also summarises the research materials that were generated during interviews.

TABLE 4.6 DATA COLLECTION (iii): INTERVIEWS						
	INTERVIEW	**DATE**	**FORMAT**	**DURATION**	**TRANSCRIPT**	**SUPPLEM. ACTIVITIES**
FOB	F.FAC	FEB, 2010	VOICE	75 mins	23 pages	Free access granted (and several visits made in order to) to inspect the project build in Second Life
	F.DEV	FEB, 2010	TEXT	150 mins	27 pages	
	F.EDU	FEB, 2010	VOICE	90 mins	23 pages	
EXT	E.FAC	DEC, 2009	VOICE	75 mins	21 pages	Free access granted (and several visits made in order to) to inspect the project build in Second Life
	E.DEV	JAN, 2010	VOICE	75 mins	18 pages	
	E.EDU	JAN, 2010	VOICE	90 mins	35 pages	
RIT	R.FAC	JAN, 2010	VOICE	1 hour	19 pages	Free access granted (and several visits made in order to) to inspect the project build in Second Life Participation in guided tour of the island organised for members of the educational community in Second Life in January, 2010
	R.DEV	FEB, 2010	VOICE	1 hour	18 pages	
	R.EDU	FEB, 2010	VOICE	75 mins	23 pages	
GLA	G.PM	JAN, 2010	VOICE/ TEXT	4 hours	57 pages	Free access granted (and several visits made in order to) to inspect the project build in Second Life Participation in private scripting class with G.PM in March, 2010
	G.FAC	MAR, 2010	TEXT	2 hours	24 pages	
	G.DEV	FEB, 2010	VOICE	90 mins	32 pages	
	G.EDU	FEB, 2010	VOICE	1 hour	19 pages	
MZO	M.FAC, M.DEV, M.EDU	FEB, 2010	VOICE/ TEXT	3 hours	50 pages	Free access granted (and several visits made in order to) to inspect the project build in Second Life
	M.EDU	MAR, 2010	VOICE/ TEXT	1 hour	35 pages	
LOY	L.FAC	FEB, 2010	VOICE	75 mins	22 pages	Free access granted (and several visits made in order to) to inspect the project build in Second Life Participation at two public lectures on the LOY project given by L.FAC in Second Life
	L.DEV	FEB, 2010	VOICE	1 hour	19 pages	
	L.EDU	FEB, 2010	VOICE	1 hour	21 pages	
				28 hours	486 pages	

MATERIALS GENERATED		**FORMAT**	**DETAILS**
1. Sound recordings of voice sessions	**(i)**	Audio file	16 files; 28 hours
2. Case contact summary	**(ii)**	Audio file	18 files; 90 minutes
3. Typed transcript of interviews	**(iii)**	Text file	18; 486 pages

(i) *Sound recordings were not made for all interviews because some interviews were carried out using text*

(ii) *Case contact summaries were recorded in voice after each interview and transcribed in full*

(i) *Transcripts were later used during data coding (cf. Section 4.5.3.2)*

Interviews were semi-structured and were carried out with the aid of an interview guide. All interviews were carried out inworld. Interviews were carried out "on site" in Second Life. During the interviews, the researcher was immersed *in* the educational projects with study participants; several participants chose to physically guide the researcher through these projects during the interviews. In addition, interviews were carried out in voice or text chat according to the wishes of study participants.

Study participants were provided with notecards which contained copies of a participant information sheet and a copy of the interview guide (an inworld snapshot of these artefacts is provided in Appendix C). Study participants were also asked to provide any copies of documentation in relation to projects. A number of participants provided copies of research papers that had been published about the projects. In addition, participants directed the researcher toward online repositories of information about projects. These typically took the form of wikis and blogs. These resources provided additional insights to the researcher during the course of data collection in terms of both the subjective understandings of study participants in relation to the projects and in terms of project outcomes vis. student feedback and performance improvements.

4.5.2.4 Focus on operationalising the preliminary framework in interviews

The preliminary framework used to guide the study was focused on three main constructs: knowledge creation outcomes; knowledge-creating behaviours; and knowledge creation intentions. As indicated in Section 4.3, the preliminary framework defines *knowledge creation intentions* as *behavioural intention to create (declarative and/or procedural) knowledge*. Further, the preliminary framework suggests that knowledge creation intentions can be understood by means of considering intrinsic motivation to create knowledge and knowledge creation capacity stemming from prior related knowledge. Intrinsic motivation to create knowledge was defined as *an internal or authentic motivation to create knowledge*. In terms of operationalising the framework, the researcher looked for qualitative indications of intrinsic motivation within the transcripts in accordance with this definition. Knowledge creation capacity was defined as *the capability to create new knowledge that stems from prior related knowledge*. In terms of operationalising the framework, the researcher relied on study participants to identify prior related knowledge. Specifically, the researcher asked study participants to describe any experiences they had that they deemed relevant to them or useful to them in terms of carrying out the projects.

As indicated in Section 4.3, specific knowledge-creating behaviours were not pre-specified by the preliminary framework. However, the framework suggests that knowledge-creating behaviours can be classified as exploratory or exploitative. During interviews, study participants were asked about the techniques they had used to develop (i) their understanding of how to do things and how to educate in virtual worlds, and (ii) their understanding about Second Life and about education in Second Life.

As indicated in Section 4.3, the preliminary framework defines *knowledge creation outcomes* as *changes in declarative and procedural knowledge frameworks*. Specifically, declarative knowledge creation is defined as changes in knowledge frameworks relating to knowledge about things; and procedural knowledge is defined as changes in knowledge frameworks relating to knowledge of how to do things. In terms of operationalising the preliminary framework, knowledge creation outcomes were evaluated in this study by means of self-reported data. In other words, this study used *perceived* knowledge creation outcomes as an indicator of knowledge creation outcomes. Thus, knowledge creation outcomes were evaluated in this study in accordance with the extent to which participants reported on their own *perceptions* of the extent to which they had created new declarative knowledge (knowledge about things) and new procedural knowledge (knowledge of how to do things) in carrying out their projects.

The rationale for this approach stems from the fact that knowledge cannot be directly observed or studied (Jakubik, 2008). Therefore, the presence of knowledge structures is typically inferred in organisational research (Walsh, 1995, p. 283). Thus, scholars (e.g. Huber, 1991; von Krogh, 1998) have tended to evaluate 'perceived' rather than 'actual' knowledge creation outcomes. This is in part due to the difficulty associated with attempting to directly measure knowledge frameworks and is also in part due to the fact that knowledge creation outcomes may involve the creation of 'false' (March, 1991) or 'incorrect' knowledge frameworks. Huber (1991) argues that the crucial element (in relation

to learning) is that "the organism be consciously aware of differences and alternatives and have consciously chosen one of these alternatives" (p. 89); and therefore defines organisational learning outcomes in terms of whether units within the organisation recognise that "potentially useful" knowledge has been created. Similarly, Von Krogh (1998) investigates what is termed "enhanced potential to act" (pp. 134-136).

During interviews, study participants were asked about the extent to which they felt that they had (i) developed their understanding of how to do things and how to educate in virtual worlds, and (ii) developed their understanding about Second Life and about education in Second Life. It is noted that knowledge creation outcomes were seen to differ definitionally from project outcomes. For example, it is entirely possible that a wildly successful project could have had very moderate knowledge creation outcomes. This would be the case where, for instance, a highly knowledgeable team completed a project that posed no particular challenge for them.

In summary, this section has presented an account of the second element of the research protocol: data collection (cf. Figure 4.8). More specifically, the section has presented an account of each of three data collection techniques used in this study and has described the research materials that were created using each technique. In particular, the section has outlined how the preliminary framework was operationalised in the study during interviews.

4.5.3 Data analysis

This section is concerned with the third major element of the study's research protocol: data analysis. Data analysis was carried out in this study using the approach described in Miles and Huberman (1994). Data analysis began at the start of the empirical portion of the study. All of the data analysis materials were repeatedly reviewed by the researcher during data collection and data analysis phases of the study. Further, both interview transcripts and early analysis materials were transcribed in full. As illustrated in Figure 4.8, data analysis was carried out during data collection (the 'early' stages of data analysis) and after data collection (the 'later' stages of data analysis). Each of these stages is presented in this section in turn. The data analysis materials generated in the earliest stages of the study are summarised in Table 4.7. The contents of the table are used as a means of structuring the discussion which follows.

TABLE 4.7 (EARLY) DATA ANALYSIS MATERIALS

TYPE	MATERIAL	PHASE	FORMAT	NO.	DURATION	LENGTH
FIELD NOTE	Case study field note	Collection	Audio file	12	2 hr 30 min	172 pages
	Observation field note	Collection	Audio file	37	4 hr 15 min	
	Reflective field note	Collection	Audio file	11	1 hr 8 min	
MEMO	Field memo	Collection	Audio file	12	1 hr 53 min	
	Analytical memo	Analysis	Audio file	76	5 hr 44 min	
PATTERN CODE	Pattern code	Analysis	Audio file	46	2 hr 30 min	
(METHOD) MEMO	Method. memo (i)	Collection	Audio file	32	2 hr 20 min	N/A
	Method. memo (ii)	Analysis	Audio file	23	1 hr 3 min	N/A

EXHIBIT 1: REFLECTIVE FIELD NOTE (cf. Section 4.5.4.1)

REFLECTIVE FIELD NOTE VWER Reaction Grid Tour, 2010 02 18 WS550129

Indications of immersion. Sitting during the reaction grid tour last night now admittedly I was in a new environment and feeling a little bit lost so that probably meant that I was a little bit lost but having made a frittata for two I ate the entire lot because I just wasn't thinking about what I was doing and I just kept eating and I looked over and it was gone and during the exact same meeting for the last twenty minutes I was parched and there was a glass of water sitting right beside me, there, and I was thinking about it you know I was conscious of this glass of water and needing a drink and for the entire last twenty five minutes I didn't touch it and it was only at the end that I had the drink and thought this is ridiculous and that's not something that happens in the real life unless you are yourself actually talking and presenting something at a meeting I find it very hard to believe that somebody in a real life meeting would not would be so concentrated that they couldn't afford the time to drink.

EXHIBIT 2: ANALYTICAL MEMO (cf. Section 4.5.4.2)

ANALYTICAL MEMO, 2010 03 19 WS550296.WMA

People talk about you just have to eventually throw yourself in and just do it. Nothing bar experience is important. The talk yesterday about information search strategies and now I'm interested in the outcomes of the search strategies. Utility is important. You won't search for it unless you have a need for it. Language is important. You can't find it if you don't know oh I just pressed the wrong button, damn. You can't find it if you don't have the right language. One of the techniques we use is to watch experts work and you can do that by attending the builder's brewery session you are literally tapping into their stream of consciousness as they talk out what they're doing and show it to you. It is a demonstration. I hear about steam punk, I hear a good talk about that and so I want to find out about steam punk and I go looking for it. So the stimulation of creativity, sorry curiosity, and ability to search and find what you're looking for, the time to put into it and the wherewithal to process it. That goes on. And finding your niche is a big thing. For educators using virtual worlds for education because that's something they've decided is relevant to them but I wonder if it's an expression of their virtual selves more so than it is an expression of the functionality of the platform

EXHIBIT 3: PATTERN CODE (cf. Section 4.5.4.3)

PATTERN CODE, 2010 02 11 MOTIVATION WS550089.WMA

The community does not provide the knowledge and skills for people to do their job; they are largely getting this knowledge themselves in a self directed fashion. Some people do use the community but it's more limited and people are self directed learners here. I do however think that knowledge and innovation are different; that the people who are truly innovative tend to be aware of the bigger picture of virtual worlds and what works for them. They appear to have some sort of a meta level understanding of how to leverage the technology that doesn't come from the immediate know-how that people need to do their jobs but that possibly comes from an involvement in the community

4.5.3.1 Early stages of data analysis: field notes, memos, pattern codes

The purpose of this section is to describe the early stages of data analysis. The section considers field notes, memos and pattern codes in turn.

Field notes (cf. Table 4.7) are "an ongoing stream-of-consciousness commentary about what is happening in the research, involving both observation and analysis-preferably separated from one another" (Eisenhardt, 1989, p. 539). In the context of this study, the researcher produced three kinds of field notes. Field notes were spoken rather than written and were recorded using a voice recorder. Field notes were subsequently transcribed in full. Transcribed field notes were classified when they were created and were filed in accordance with this classification. Field notes were periodically reviewed during the course of the study.

As illustrated in Table 4.7, three types of field notes were generated in the early stages of data analysis: case study field notes, observation field notes and reflective field notes.

(i) *Case study field notes* were generated after any case study contact with the exception of interviews (case contact summaries were produced after interviews).

(ii) *Observation field notes* were produced after participant observation contacts. Both of these field notes included what Miles and Huberman (1994) describe as "reflective remarks" (p. 66).

(iii) *Reflective field notes* were created commentaries specifically on the researcher herself; on her experiences of working in a virtual world and her own personal journey in Second Life.

Memos (cf. Table 4.7) are "the theorising write-up of ideas about codes and their relationships as they strike the analyst while coding… it can be a sentence, a paragraph or a few pages… it exhausts the analyst's momentary ideation based on data with perhaps a little conceptual elaboration (Glaser, 1978 pp. 83-84). In the context of this study, four kinds of memo were produced. Memos were spoken

rather than written and were recorded using a voice recorder. Memos were subsequently transcribed in full.

As illustrated in Table 4.7, three types of memos were generated in the early stages of data analysis: field memos, analytical memos and methodological memos.

(i) *Field memos* were generated during data collection. Field memos were always linked back to particular interviews and observations. They were used to extend the analysis beyond individual data collection techniques and were therefore an important source of data triangulation

(ii) *Analytical memos* were generated after data collection. Analytical memos operated at a higher level of abstraction than field memos.

(iii) *Methodological memos* were created at all stages of data collection and data analysis. Those that were created during data collection were distinguished from those created during data analysis. Methodological memos were created whenever a change was being contemplated or had actually been made to the research design

Both field and analytical memo contained integrative discussions that pulled together data from cases and participant observation. They therefore allowed for an integration of emerging insights arising out of each of the three data collection techniques employed in the study. They therefore allowed for an integration of emerging insights arising out of each of the three data collection techniques employed in the study. Methodological memos were useful in terms of revealing the thought processes underpinning emergent research design decisions.

Finally, ***pattern codes*** (cf. Table 4.7) are "explanatory or inferential codes, ones that identify an emergent theme, configuration, or explanation… [they] are a sort of meta-code" (Miles and Huberman, 1994, p. 69). Pattern codes were spoken rather than written and were recorded using a voice recorder. Each pattern code was named and dated. Pattern codes were subsequently transcribed in full.

4.5.3.2 Later stages of data analysis: data coding, case analyses, data display

The purpose of this section is to present an account of the later stages of the data analysis process. As illustrated in Figure 4.8, the interview transcripts from the study's six cases were fully coded. The coded data was then used to carry out both within-case and cross-case analyses. A number of analysis materials were generated during these activities, including a set of case reports and a series of data displays. This section discusses each of these elements in more detail.

Data codes are defined by Miles and Huberman (1994) as "tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study" (p. 56). Miles and Huberman (1994) argue that "coding is analysis. To review a set of field notes, transcribed or synthesised, and to dissect them meaningfully, while keeping the relations between the parts intact, is the stuff of analysis" (Miles and Huberman, 1994, p. 56). Miles and Huberman (1994) recommend the creation of a provisional "start list" of codes prior to fieldwork that comes from the conceptual framework, research questions etc (p. 58). Table 4.8 presents the start code list that was created for the study according to an early version of the preliminary framework. A closer inspection of the codes within the list reveals that many of these codes are constructs and variables found in existing innovation and knowledge management research (cf. Chapter Three).

TABLE 4.8 START CODE LIST	
CODE TYPE	**CODE NAME**
Context code: Emergent contextual issues	KCContext
Knowledge codes:	KCTDomain KCTType
Process / Activity codes: Any processual aspects of the cases, any activities that took place	KCPActivities KCPDirection KCPInteractions KCPMode (e.g. SECI)
Actor codes: Any aspect of the actor: their background, level of expertise, beliefs, motivations, commitments, their social status and social capital	KCFHuman capital KCFFluency KCFPrior related experience KCFTraining KCFComfort zone KCFSelf-efficacy KCFPreconceptions KCFExpectations KCFGoal orientation KCFCommitment KCFIntrinsic motivations KCFExtrinsic motivation KCFSocial status KCFSocial capital KCFAccess to knowledge KCFParticipatory style
Group and network codes: Any aspect of project groups and the social networks within which individuals and groups were embedded	KCPRoles KCFRole of evangelist/champion KCFRole of gate watcher KCFMentor KCFFeedback / job satisfaction KCFCulture, climate KCFSocial cohesion KCFSocial stability KCFStength of ties
Environment codes: Aspects of the environment	KCFImmersion / Presence KCFSynchronicity KCFUncertainty/instability KCFVisibility KCFSerendipity / opportunism KCFPropinquity
EXHIBIT 4: THREE CODE EXTRACTS EXAMPLES	
[CONTEXT]	L.DEV: the fun ones to work on are the ones that don't even exist anywhere else but in Second Life; those ones do take a while because they have to be designed from the ground up
[PROJECT OUTCOMES]	L.EDU: my feeling is that working on Second Life is even more powerful for these students than when they were on placement at the border because all they were doing then was watching which is very different than doing… but in Second Life they're doing; so they are as real to life as being in that booth, making those decisions
[PROJECT ASSETS - PROCESSES]	L.DEV: we learned through our own experiences and then we'd check what other people were doing on builds I mean half of - there's quite a bit of the learning that actually took place out on our part by this investigating what other people were doing you know you'd say "oh that's a great idea" or "oh this doesn't work at all" or "why would you even do this" and then you know take a step back and realise "oh that's a fantastic idea"

Once all of the data collected for the study had been transcribed in full, this start code list was used to code one case. The coding was carried out in Microsoft Excel (2003). Each code was numbered and dated and the source of the code was also recorded. The start code list was fully revised prior to coding the remaining cases. The revised coding scheme associated each code with a specific construct from the preliminary framework. The coding scheme continued to evolve as each of the cases was coded but maintained this overall structure. For example, it emerged during the process that it would be meaningful to extend the classification of knowledge-creating behaviours to distinguish between exploratory and exploitative knowledge-creating behaviours that were carried out endogenously and exogenously[15]. When each case had been coded in full, the codes were aggregated in Microsoft Excel (2003) according to construct. Examples of coded data are presented in Table 4.8.

The importance of ***within-case analysis*** stems from the need to deal with the "staggering volume of data" generated in case-based research, and to safeguard against what Pettigrew terms "death by data asphyxiation" (Eisenhardt, 1989, p. 540). Within-case analysis typically involves writing detailed reports for each of the cases selected for the study (Eisenhardt, 1989). Once the data had been fully coded for each case, the researcher used the codes to construct a detailed case summary of each case (an extract from GLA is provided in Section 7.3.6 of Appendix C). This summary considered knowledge creation intentions, knowledge creation outcomes, and knowledge-creating behaviours. As a first step toward cross-case analysis, the researcher constructed a summary of key themes emerging in the cases overall whilst this process was being completed. This summary was structured in accordance with the preliminary framework. Figure 4.9 provides samples of key themes recorded in PowerPoint and a sample of coded data from the study. Further examples are provided in Appendix C.

[15] The distinction between endogenous and exogenous behaviours has its roots in innovation research and in social network analysis literatures which have explored the role of market orientation and external linkages in organisational innovation.

FIGURE 4.9 EXAMPLE OF AN EMERGENT THEME (on Knowledge-creating behaviours)

- Techniques used by individuals to create knowledge:
  - Books and online search the most commonly used techniques
  - Some have stated that their style of learning is not to engage with others
  - In only two cases so far, project members have actively engaged in virtual worlds exploration but one of these was more sophisticated
  - Inworld search is not effective – word of mouth and avatar / slurl reputation biggest aids but not always reliable
  - Community is rarely used directly to facilitate knowledge creation by educators
    - Though most people do cite the SLED list
    - Building groups and scripting groups do seem to be highly active outside education
    - Reluctance to be seen to not be proficient – especially where one's avatar is a "professional"
    - Strongly against the hype of what can be done in virtual worlds
    - It is generally agreed that the community is an invaluable resource though some commented that educators are not visionaries ISL
    - "Virtual worlds are just places
    - One person did invite people to her island to review her work but she was young and it was her own research project rather than work
  - Often there is a single individual that has helped or has been instrumental and is often a personal friend and maybe not an educator
  - Still very half baked – there is no best practice yet and all are feeling their way in the dark
  - Lots of stuff is still not even documented by the Lindens – things are just "not known"
  - It's harder to know how people construct their know what knowledge than their know how knowledge
  - It's hard full stop because recollections are imprecise – they "pick things up"

Moving further into ***cross-case analysis***, the researcher constructed a spreadsheet in Microsoft Excel (2003) that counted each code for each case. This strategy was adopted because qualitative researchers are encouraged to develop quantifiable schemes for coding complex data sets (Jick, 1979). This technique proved to be effective as it allowed for a more systematic identification of key themes running across all of the cases and at the same time allowed the researcher to 'dip in' to the original data at will. Once this spreadsheet had been constructed, the researcher used the data contained within it to construct a series of *data displays,* which would facilitate the analysis process.

Finally, ***data displays*** are visual formats that present information systematically (Miles and Huberman, 1994, p. 91). Data displays can also provide insights through images (visualization) that might not otherwise emerge (Inselberg 2005). In addition, data displays allow the researcher to "look at data in many divergent ways" – which is "the key to good cross case analysis (Eisenhardt, 1989, p. 540). Thus, data displays allow the user to draw valid conclusions and take needed action (Miles and Huberman, 1994, p. 91).

In the context of this study, data displays were constructed during analysis as a data reduction mechanism and to allow the researcher to apprehend the data in diverse ways. The researcher experimented with numerous data displays during the course of data analysis. This is considered a fitting way to approach the construction of data displays: the design of qualitative research "cannot be given in advance; it must emerge, develop, and unfold" (Lincoln and Guba, 1985, p. 225). The data displays used in the thesis were selected for their information richness. These displays include tables, matrices, radar charts and line charts. The displays reveal insights into knowledge creation in virtual worlds that would not otherwise emerge. Together, they provide a tangible, traceable and explicit means of achieving the study's research objective. Thus, they acted as an indispensable tool for escaping data overload during the study.

In summary, this section has described the research protocol for this study in depth. More specifically, the section has described (i) the decisions made in this study in relation to its unit of analysis ("the innovative virtual world project"), site selection and sampling strategy, (ii) the approach to data collection adopted in the study, and (iii) the approach to data analysis that was used in this study. The next section concludes this chapter by discussing the techniques used through the study to ensure the trustworthiness of its findings.

4.6 Ensuring the trustworthiness of the research findings

Researchers seeking to collect data are faced with the task of creating a research design which maximises the generalisability of the evidence collected, the precision of the measurement of actors' behaviours, and the realism of the situation or context in which the evidence was collected (McGrath, 1984): "the very things you can do to increase one of these reduces one or both of the other two" (McGrath, 1984, p. 31). However, without rigour, "research is worthless, becomes fiction, and loses its utility" (Morse *et al.,* 2008, p. 2). Yet few scientific techniques have been developed to address the scientific worth and rigour of qualitative research in general and case study research in particular (Riege, 2003). This section considers tactics used to ensure trustworthiness in this we study.

In *quantitative* research, reliability and validity are the criteria upon which research is evaluated. Here, reliability is defined as "the extent to which results are consistent over time and an accurate representation of the total population under study" (Joppe cited in Golafshani, 2003, p. 598) and validity is defined as the extent to which "the research truly measures that which it was intended to measure" (ibid). Thus, the credibility of research findings in the quantitative research tradition is intimately connected with the research instrument used by the researcher (Morse *et al.,* 2002). In *qualitative* research "the researcher is the instrument" (Patton, 2001, p. 14). Therefore, the "trustworthiness of a research report lies at the heart of issues conventionally discussed as validity and reliability" (Seale, 1999, p. 266). For this reason, it is inappropriate to judge qualitative research using quantitatively oriented criteria (Guba, 1981; Strauss and Corbin, 1990, p. 250; Janesick, 1994, p.217; Healy and Perry, 2000). Thus, the trustworthiness of qualitative studies is evaluated in terms of: (i) *credibility* (in place of internal validity), (ii) *transferability* (in place of external validity), (iii) *dependability* (in place of reliability) and (iv) *confirmability* (in place of objectivity) are (Lincoln and Guba, 1985, p. 219; Erlandson *et al.,* 1993, p. 132).

The concept of '*credibility*' relates to the degree of confidence in the 'truth' a study's findings have for a particular context (Lincoln and Guba, 1985). In

qualitative research settings, a study's credibility relates to the extent to which the constructed realities of the inquiry's respondents are compatible with those that are attributed to them (Erlandson, 1993, p.30). The concept of '*transferability*' relates to the extent to which a study's findings can be applied in other contexts or with other respondents (Lincoln and Guba, 1995, p. 290). The naturalistic researcher questions the extent to which true generalisation is actually possible but holds that the transferability of a study's findings can be evaluated through the use of thick description and the detailed explanation of context (Erlandson, 1993, pp. 31-32). The concept of '*dependability*' relates to the extent to which the study's findings are considered stable over time and over conditions; the key to establishing the dependability of a study's findings lies in the extent to which its findings are auditable (Erlandson, 1993; Yin, 1994). Finally, the concept of '*confirmability*' relates to the extent to which a study's findings are the product of a systematic methodology and analysis; it can be evaluated by means of considering the extent to which (i) a study's findings are grounded in the data, the extent to which the study's inferences are logical and (ii) the extent to which discrepant data has been taken into account the (Erlandson, 1993, p. 171).

The trustworthiness of this study's findings (from the pragmatist's perspective) ultimately lie in the "experiences or practical consequences" (Johnson, 2004, p. 16) of belief in its findings. Nevertheless, the research protocol used in the study was purposely designed to maximise the credibility, transferability, dependability, and confirmability of the study's findings. Table 4.9 summarises techniques used in this study to ensure the trustworthiness of this study's findings. Individual techniques are listed in the table in a loosely chronological order. The table illustrates that the majority of techniques that have been proposed were used in carrying out the study (those that were not used were considered inappropriate because of the nature of the study's research music design).

TABLE 4.9 ENSURING THE TRUSTWORTHINESS OF THE STUDY'S FINDINGS					
TECHNIQUE	QUALITATIVE CRITERIA:				AUTHOR(S)
	CREDIBILITY	TRANSFERABILITY	DEPENDABILITY	CONFIRMABILITY	
Purposive sampling		✓			Erlandson (1993)
Prolonged engagement	✓				Lincoln and Guba (1985) Erlandson (1993)
Persistent observation	✓				Lincoln and Guba (1985) Erlandson (1993)
Thick description		✓			Erlandson (1993)
Reflexive journal	✓	✓	✓	✓	Erlandson (1993)
Case study protocol			✓		Yin (2003)
Triangulation	✓				Lincoln and Guba (1985) Erlandson (1993)
Use multiple sources				✓	Yin (2003)
Referential adequacy	✓				Lincoln and Guba (1985) Erlandson (1993)
Use case study database			✓		Yin (2003)
Have a chain of evidence				✓	Yin (2003)
(Dependability) audit			✓		Lincoln and Guba (1985) Erlandson (1993)
(Confirmability) audit				✓	Lincoln and Guba (1985) Erlandson (1993)
Review by key informants				✓	Yin (2003)
Peer debriefing	✓				Lincoln and Guba (1985) Erlandson (1993)
Member checks	✓				Lincoln and Guba (1985) Erlandson (1993)

In qualitative research, *purposive sampling* is considered more appropriate than conventional sampling techniques (Erlandson *et al.,* 1993, p. 148; Lincoln and Guba, 1985, p. 210) and can be used to help ensure credibility (Erlandson *et al.,* 1993, p. 148). As indicated in Section 4.4.4, the researcher employed a purposive sampling strategy that was designed in accordance with preliminary observations made by the researcher in relation to the educational community in makers Second Life.

Prolonged engagement and *persistent observation* help to ensure credibility (Erlandson *et al.,* 1993, p. 148; Lincoln and Guba, 1985, p. 210). Prolonged

engagement enables the researcher to learn the culture of a social setting over an extended time period that tempers distortions introduced by particular events or by the newness of researchers and respondents to each other's presence (Erlandson *et al.,* 1993, p. 133). *Persistent observation* is more specific and involves the identification of those characteristics "that are most relevant to the problem or issue being pursued and focusing on them in detail" (Lincoln and Guba, 1985, p. 304). As illustrated in Figure 4.8, the researcher spent a period of five months as an active participant in Second Life's educational community; engaged in preliminary observations for a further two months; and actively monitored online forums for a period of two years. Further, the use of the preliminary framework served to focus the researcher's participation with and engagement in Second Life on those issues that were most relevant to knowledge creation in a and virtual world.

Thick description involves collecting and reporting "sufficiently detailed descriptions of data in context… to allow judgements about transferability" (Erlandson *et al.,* 1993, p. 33). In this study, the analysis makes extensive use of direct quotations to illustrate the context of Second Life. Further, the researcher has included a detailed account of her own experiences in Appendix E. During data collection, the *reflexive journal* is used as a kind of diary or daily journal to record a variety of information about the researcher and about the research. In addition to creating a variety of data collection materials (including methodological memos), the researcher also maintained a document called the "ship's log" in order to record her daily schedule and to bring together any observational data (such as snapshots or chat logs) that were of particular interest. The researcher also used (dated and categorised) voice recordings to record her personal experiences and also to record methodological decisions being made. The spoken word appeared to be in some way closer to the researcher's thoughts than the written word. In addition, the researcher found it beneficial to repeatedly re-listen to these recordings during data collection and data analysis in order to re-enter earlier streams of consciousness and review earlier thought we processes.

The use of a *case study protocol* is "a major tactic in increasing the *reliability* [dependability] of case study research" and is 'essential' for multi-case research designs (Yin, 1994, p. 63). A case study protocol should include (i) an overview of the case study project, (ii) field procedures, (iii) case study questions (e.g. table shells for specific arrays of data, potential sources of information etc), and (iv) a guide for the case study report (e.g. outline, format of the narrative etc) (Yin, 1994, pp. 64-65). In the context of this study, the researcher maintained a series of documents in a folder called "meta" that pertained to the case study protocol used in this study. Prior to the data collection phase of the study, the researcher invested a substantial amount of time in planning a number of possible approaches to data analysis in particular. The rationale for this lay in the fact that one of the biggest challenges facing qualitative researchers relates to data overload. By focusing on data analysis tactics prior to data collection, the researcher was able to mitigate some of these issues and was more quickly able to develop suitable approaches for the data analysis stage of the are project.

Triangulation can be achieved in four ways: through the use of multiple and different data, methods, investigators and theories (Denzin, 2009). In this study, two types of triangulation were used: (i) method triangulation and (ii) data source triangulation. Method triangulation involves the use of multiple methods to study a single problem and interpret the findings (Denzin, 2009). Data source triangulation involves the use of a variety of data sources within the same method (Patton, 2002, p. 247). The use of multiple methods and multiple sources in this study yielded data that was naturally occurring (participant observation) and free of observer effects (unobtrusive measures) and allowed the research to generate an analysis that could take into account both the actual behaviours and espoused views of Second Life's educational community. Further, the researcher sought to ensure the *referential adequacy of materials*. This means that data materials would be context-rich and holistic to provide background meaning to support data analysis, interpretations, and audits (Erlandson *et al.,* 1993, p. 139). Specifically, the researcher collected all chat logs generated during her participant in Second

Life and took thousands of snapshots that provided a graphical record of her explorations of Second Life in general and her case studies in the particular.

An *audit trail* allows an auditor to determine the trustworthiness of the study (Erlandson *et al.,* 1993, p. 149). It is therefore important that adequate records be kept during the study (Erlandson *et al.,* 1993, p. 149). Lincoln and Guba (1985, pp.319-320) suggest that audit trail materials include (i) raw data, (ii) data reduction and analysis products, (iii) data reconstruction and synthesis products, (iv) journal (process notes), (v) materials relating to intentions and dispositions (including peer debriefing notes and journal entries), and (vi) information relative to any instrument development. In the context of this study, a *case study database* was used to facilitate the maintenance of a clear audit trail through the data. Specifically, the researcher used a sophisticated filing procedure to store case notes, documents, tabular materials and narratives. The filing procedure distinguished data collection and data analysis materials and employed a file naming system that preserved the chronological order of case study dreamers materials.

Finally, the literature recommends a number of techniques that can be used by the researcher to solicit feedback from others. The *member check* (what Yin (2003) refers to as a review by key informants) "is the most crucial technique for establishing credibility" (Lincoln and Guba, 1985, p. 314). Nevertheless, there are dangers associated with this technique. For example, member checks can be misleading "if all the members share some common myth or conspire to mislead" (Erlandson *et al.,* 1993, p. 143). In the context of this study, this was a serious issue as many of the study participants were openly evangelistic about Second Life and its potential for education (often in the face of considerable resistance and opposition that they encountered in the real world). A further issue associated with the use of member checks is that study results have been "synthesised, decontextualised, and abstracted from (and across) individual participants, so there is no reason for individuals to be able to recognise themselves or their particular experiences" (Morse *et al.,* 2002, p. 7). In the context of this of study,

member checking was conducted in interviews (by verifying interpretations and data gathered in earlier interviews) and at the end of interviews (by summarizing the data and allowing respondents to immediately correct errors of fact or challenge interpretations) (as per Erlandson *et al.,* 1993, p. 142). In addition, study participants were furnished with copies of the research report. The researcher also presented an interim analysis of knowledge creation in virtual worlds at the Virtual Worlds Best Practices in Education conference in February, 2010. The presentation was presented as a dialogue between the researcher and an active member of the Second Life educational community and was designed to encourage audience members (Second Life educators, including study participants) to provide feedback to the researcher on an interim data dreams analysis.

With *peer debriefing*, the research solicits feedback from peers that will "refine and, frequently, redirect the inquiry process" (Erlandson *et al.,* 1993, p. 31). In this study, the researcher availed of an excellent opportunity for peer debriefing, which took the form of regular workshops organised by one of her supervisors and attended by his current and former Ph.D. students. Further, these workshops had a potent and tangible catalyzing effect not just on this particular research study but on all of the research projects that were discussed at them. The researcher also had a number of very fruitful discussions with another student at the university who carried out ethnographic research on the collaborative production of digital goods in Second Life.

4.7 Summary

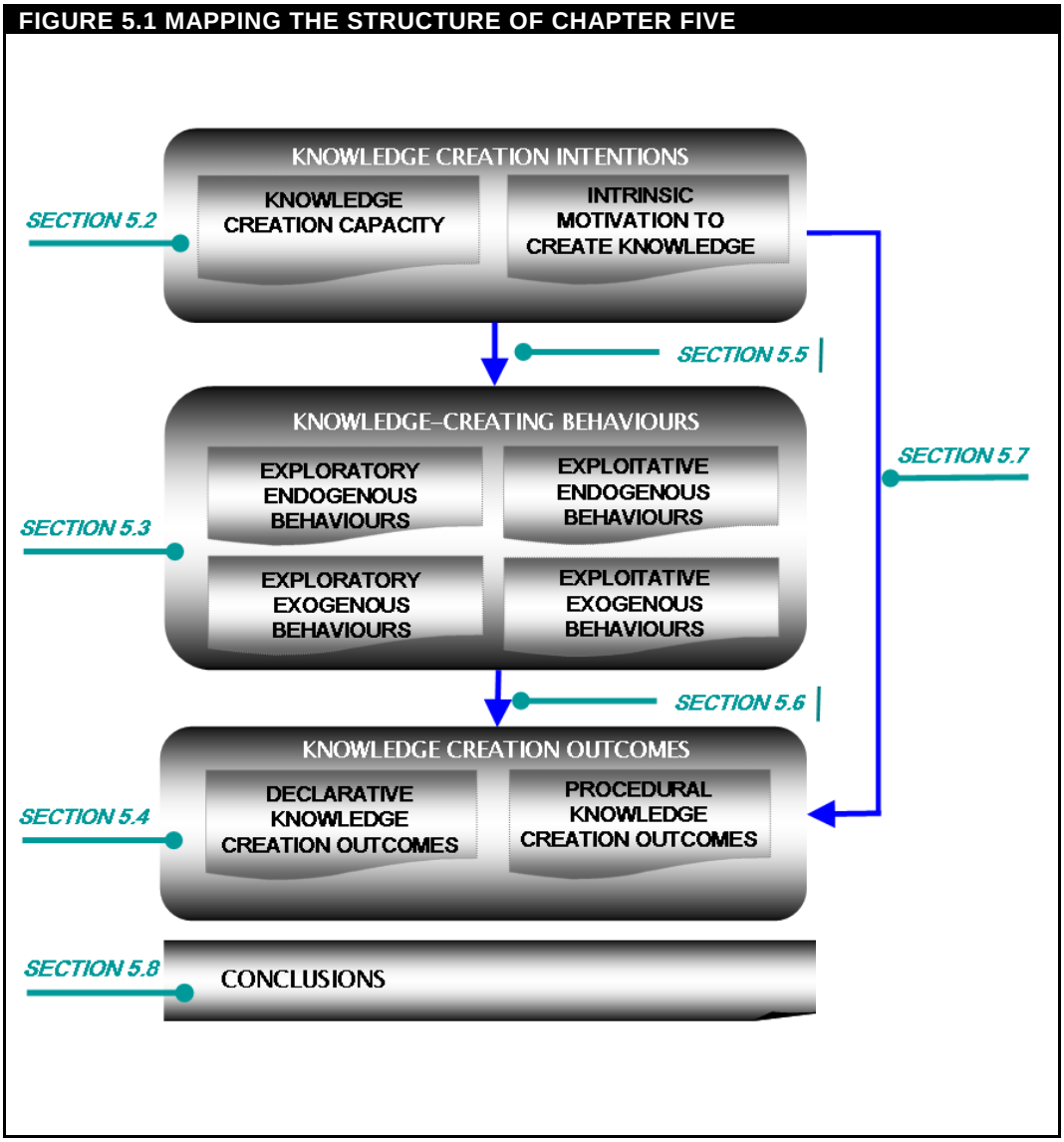
This chapter has presented an account of this study's research design. The chapter has articulated the research objective for the study (to investigate knowledge creation in innovative virtual world projects) and has used it as the basis upon which to construct a preliminary framework of knowledge creation in virtual worlds to guide the study. The chapter has also explicitly evaluated the methodological approaches available and has outlined the rationale underpinning the decision to construct a pragmatist, qualitative, multi-case research design. In addition, the chapter has described the study's research protocol in detail. More specifically, it has described (i) the decisions made in this study in relation to its unit of analysis ("the innovative virtual world project"), site selection and sampling strategy, (ii) the approach to data collection adopted in the study, and (iii) the approach to data analysis that was used in this study. Finally, the chapter has concluded by explaining the techniques used through the study to ensure the trustworthiness of its findings.

5 PRESENTING THE RESEARCH FINDINGS

5.1 Introduction

This chapter presents the findings of the study conducted in six innovative educational projects in Second Life. Figure 5.1 summarises the overall thread of the chapter. The figure illustrates that the first six sections of the chapter are organised in terms of the preliminary framework (presented in Section 4.3) used to guide the study.

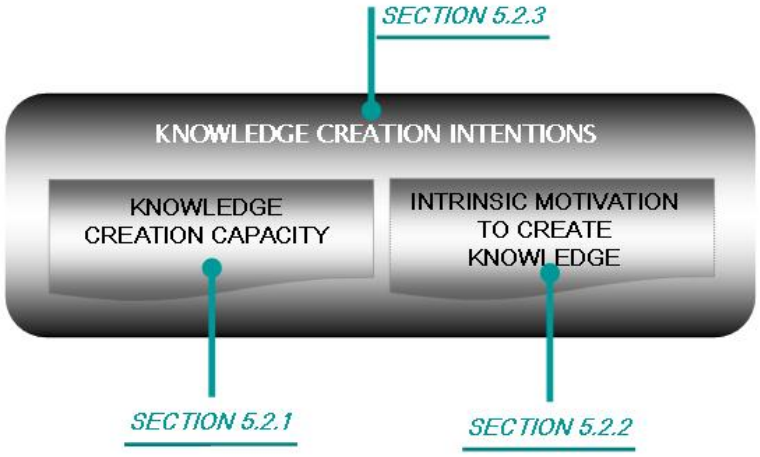
FIGURE 5.1 MAPPING THE STRUCTURE OF CHAPTER FIVE



5.2 Knowledge creation intentions

The purpose of this section is to examine the first construct of the preliminary framework (*knowledge creation intentions*) in the cases. The knowledge creation intentions construct is recalled from Section 4.3 in Figure 5.2. The figure also illustrates how this section is structured: the section focuses on each element of the construct in isolation (Sections 5.2.1 and 5.2.2) and then examines them in relation to one another (Section 5.2.3).

FIGURE 5.2 EXPLORING KNOWLEDGE CREATION INTENTIONS



K.C. Intentions	Behavioural intentions to create (declarative and/or procedural) knowledge
K.C. Capacity	Capability to create new knowledge stemming from prior related knowledge
K.C. Intrinsic motivation	An internal or authentic motivation to create knowledge

5.2.1 Knowledge creation capacity

Table 5.1 presents the analysis of knowledge creation capacity (stemming from prior related knowledge). The cases are listed in the columns of the table and the individuals within each case are listed in the rows[16]. Knowledge creation capacity was evaluated by the researcher as either 'high' or 'low' based on analysing the relevant data codes and the case summaries created during analysis.

TABLE 5.1 CROSS CASE ANALYSIS: KNOWLEDGE CREATION CAPACITY

	FOB	EXT	RIT	GLA	MZO	LOY
FOR THE FACILITATOR (*.FAC)	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**LOW**	**HIGH**
FOR THE DEVELOPER (*.DEV)	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**
FOR THE EDUCATOR (*.EDU)	**LOW**	**LOW**	**HIGH**	**HIGH**	**LOW**	**LOW**

Table 5.1 indicates that *knowledge creation capacity was high for thirteen of the study's eighteen participants*. Specifically, the table indicates that knowledge creation capacity was high for only one individual at MZO. The table indicates that levels of prior related knowledge were high for at least two study participants at FOB, EXT, and LOY. In all three cases, it was the educator whose prior related knowledge that was considered low. Finally, the table illustrates that knowledge creation capacity was high for all participants in two cases (RIT and GLA).

Most of the study's participants argued that they had substantial levels of prior related knowledge, even though many of them were new to Second Life. The data reveals that *participants drew upon a wide range of prior experiences that were not obviously relevant to Second Life in seeking to make sense of education in Second Life*. This trend was especially strong amongst project developers, many of whom (R.DEV; E.DEV; G.DEV; M.DEV) were relatively inexperienced in terms of Second Life. Thus, L.FAC argues that his experience in digital media and theatre enabled him to very quickly 'get' Second Life and education in Second Life. For him, learning in Second Life could be structured as you might structure a real life theatrical intervention or alternative performance environment. L.FAC explains that his experience with theatre gave him a real insight into how you

[16] The naming convention used to uniquely identify study participants is outlined in Section 4.5.2.3

might "construct a reality around the experience" you are trying to create for students. In Second Life, like theatre, "whatever you want to happen can happen". Similarly, G.DEV drew upon prior related knowledge from the realm of science fiction literature. The connection between the two is not readily apparent[17], but this knowledge meant that he saw virtual worlds on the horizon more than a decade ago. He explains that "the ideas were around… [but] the technology couldn't keep up".

Educators, on the other hand, were less likely to suggest that they had high levels of knowledge creation capacity (stemming from prior related knowledge). A closer inspection of the data suggests that participants, educators in particular, often struggled to identify and leverage prior related knowledge when it came to Second Life. M.FAC explains that educators who are unfamiliar with Second Life can actually apply their skills as educators when it comes to learning design in Second Life but they do "have to think a little bit" about it first. In other words, *individuals do not always realise that they can draw upon their previous experiences when designing and developing new educational applications of Second Life*.

At a higher level of abstraction, the analysis of knowledge creation capacity (stemming from prior related knowledge) underlines its significance in virtual worlds. In particular, the analysis indicates that *knowledge creation capacity stemming from prior related knowledge plays an important role in shaping the (i) attitudes, (ii) expectations, and (iii) behaviours of study participants*. Each of these points is discussed in turn.

Knowledge creation capacity (stemming from prior related knowledge) affected individuals' *attitudes* in relation to knowledge creation in Second Life. Second Life can be "quite an intimidating place" for anyone with "low skills and perhaps

[17] The more time one spends in Second Life the more apparent it is that many of Second Life's most active proponents see Second Life, and the potential of Second Life, in way that is influenced – if not inspired - by science fiction literature

no real knowledge of how it [Second Life] is being used" (M.FAC). Participants with low levels of prior related knowledge reported having a sense of discomfort, fear, or intimidation in Second Life. For example, R.FAC explains that her earliest work in Second Life was "a scary, scary thing". However, participants also observed that a sense of comfort was absolutely necessary in terms of working in Second Life and could only be acquired through direct experience in Second Life. This observation was borne out in this study, where participants with more substantial levels of prior related knowledge felt that knowledge creation was faster, easier and more comfortable. For example, F.FAC argued that her academic background was a very good preparation and that she found it 'easy' to acquire knowledge and skills in Second Life.

Knowledge creation capacity (stemming from prior related knowledge) also affected individuals' *expectations* in relation to knowledge creation in Second Life. On the one hand, it was suggested that a lack of prior related knowledge made it difficult to have expectations in the first place. For example, E.FAC observes that those with limited prior related knowledge found it difficult to make sense of Second Life because

> a non-game-oriented, 3D immersive space just doesn't have any equivalent for people [to] hang their hat on

On the other hand, being able to draw on prior related knowledge what a "strong advantage" for F.FAC. Thus, L.FAC argued that he did not know of a single successful project in a virtual world that was run by someone who was not already an expert in Second Life.

Finally, knowledge creation capacity (stemming from prior related knowledge) affected individuals' *behaviours* in relation to knowledge creation in Second Life. For example, G.FAC explains that her initial involvement in Second Life was driven by a "gut feeling" about the significance of the technology that stemmed from prior related knowledge. She explains that

> when you work in this for a long time, you tend to spot potential trends

In particular, the analysis suggests that *teams leveraged prior related knowledge to derive useful metaphors of Second Life which were used in turn as templates to*

guide action. Whilst the role of metaphor in facilitating the sharing of knowledge is already recognised in literature (Nonaka, 1994), participants' comments illustrate the extent to which *the creation of metaphors in Second Life amounts to the construction of new meta-knowledge*[18] *that is used as template to guide action*. In particular, teams with strongly technical (e.g. FOB and GLA) and strongly creative (e.g. LOY and FOB) backgrounds derived different kinds of metaphors about Second Life that reflected their backgrounds and used these metaphors to guide their projects. For example, respondents with creative backgrounds (L.FAC, G.DEV, and R.EDU) felt that Second Life held a powerful theatrical metaphor which provided them with a clear vision of what they were trying to achieve very early on. Meanwhile, G.DEV (who had quite a technical background) drew upon a web services metaphor in terms of envisioning his virtual patient project.

5.2.2 Intrinsic motivation to create knowledge

Table 5.2 presents the analysis of intrinsic motivation to create knowledge. The cases are listed in the columns of the table and the individuals within each case are listed in the rows[19]. Intrinsic motivation to create knowledge was evaluated by the researcher as either 'high' or 'low' based on analysing the relevant data codes and the case summaries created during analysis.

TABLE 5.2 CROSS CASE ANALYSIS: INTRINSIC MOTIVATION TO CREATE KNOWLEDGE

	FOB	EXT	RIT	GLA	MZO	LOY
FOR THE FACILITATOR (*.FAC)	HIGH	LOW	LOW	HIGH	LOW	HIGH
FOR THE DEVELOPER (*.DEV)	LOW	HIGH	LOW	HIGH	HIGH	HIGH
FOR THE EDUCATOR (*.EDU)	LOW	LOW	HIGH	HIGH	LOW	LOW

Table 5.2 shows that *intrinsic motivation to create knowledge was high for half the study participants*. Specifically, the table shows that intrinsic motivation to create knowledge was high for three individuals at GLA; for two individuals at LOY; and for one individual in the remaining cases. The table also shows that levels of intrinsic motivation to create knowledge were highest for developers and lowest for educators.

[18] The analysis presented in Section 5.3 will focus specifically on the concept of meta-knowledge
[19] The naming convention used to uniquely identify study participants is outlined in Section 4.5.2.3

Study participants recognised that *having a general interest in, or sense of excitement about, Second Life (an intrinsic motivation to use it) is not only desirable but essential*. For example, L.DEV argues that one of his "personal philosophies" is that engagement comes from enjoying what you're doing and is "crucial to effective learning". Similarly, R.DEV argues that when educators are not fired up about education in Second Life, they allow themselves to be guided by other team members. She explains that educators who are highly interested in Second Life projects tend to be more involved in them. In these cases, the projects 'grow', students participate more actively (a kind of social contagion of intrinsic motivation), and Second Life "becomes a much better tool".

The analysis also reveals that *intrinsic motivation to create knowledge in Second Life was fragile.* Even though levels of intrinsic motivation were high in this study, there was evidence to suggest that *the pervasiveness of negative normative beliefs concerning Second Life had a significant and negative effect on intrinsic motivation to create knowledge.* There was mounting frustration both within cases and within Second Life's educational community in general that arguments regarding the efficacy of Second Life as an educational tool were falling on deaf ears; and there was often a sense of preaching to the choir in Second Life forums. Participants had difficulties in terms of explaining Second Life to work colleagues (L.FAC; E.EDU) and to friends and family (E.FAC). This made it all the more difficult to communicate the potential of the environment for education (G.PM; E.EDU). Participants were frustrated and described a sense of having to hide or apologise for their work. For example, E.FAC has given up on evangelizing for Second Life with real world peers and E.EDU has resolved to say nothing about his project until it is completed[20]. Further, these negative reactions could have more sinister effects. At EXT, E.FAC describes being taunted by fellow students about her work in Second Life. She observes that these taunts wouldn't be appropriate for any other occupation:

> it's almost as if I were a pole dancer

[20] The researcher acknowledges that her interest in Second Life met with similar skepticism

These observations illustrate that negative normative beliefs about Second Life (i) hampered efforts to communicate and legitimise newly created knowledge in virtual worlds and (ii) reduced intrinsic motivation to create that knowledge in the first place.

Further, the analysis reveals that *intrinsic motivation to create knowledge in Second Life was primarily driven by (i) the hedonic consumption of virtual worlds by study participants; (ii) technical challenge and (iii) social contagion (within teams)*. The discussion considers each point in turn.

The analysis also suggests that *intrinsic motivation to create knowledge was typically inspired by the hedonic consumption of virtual worlds***.** One of the great strengths of Second Life as an environment is its capacity to support hedonic participation in it. Thus, F.DEV explains that he has a particular love of both computer games and online worlds. He explains that he lends his talents to improve these games and worlds because

> the better the game, the more people play, for longer as well, and the happier I am as a player to enjoy it as it thrives.

Many study participants (e.g. F.FAC; F.DEV; E.FAC; E.DEV; L.FAC) were engaged in either hedonic or voluntaristic participation in Second Life either before or during the case study projects. In fact, a number of study participants (e.g. E.FAC) described themselves as evangelists for Second Life.

In addition, the analysis suggests that *intrinsic motivation to create knowledge was often driven by technical challenge in Second Life;* especially for developers[21]. Developers (at RIT, GLA and LOY) were motivated by a desire to push the technology itself (and themselves) beyond what it was (and they were) technically capable of doing. R.DEV and L.DEV expressed admiration for those who are capable of creating things in Second Life that Second Life itself cannot technically deliver; for those who can "fake it". Similarly, G.DEV explained that he knew that what he wanted to achieve could be done in principle, but that it

hadn't yet been done before in practice. Conversely, intrinsic motivation to create knowledge was lowest for educators. Educators, more so than any other group, were primarily concerned with the scope of Second Life to support education and learning and were far less interested in the technology *per se*. From the outset, educators tended to have very specific needs to meet or problems to solve. For example, E.EDU was seeking learning materials to reduce teaching time. In other words, educators' intrinsic motivation to create new knowledge was often limited to the confines of their projects. For example, R.EDU was hoping to create learning materials that cannot be created in real life. Similarly, G.EDU was concerned with improving nurses' diagnostic and history taking skills.

Finally, the data suggests that *intrinsic motivation to create knowledge could be contagious within teams*. That is to say, highly motivated individuals in teams spur each other on to create new knowledge. At LOY, for example, this synergistic quality arose in terms of the interactions amongst developers. L.DEV explains that developing scripting skills (creating procedural knowledge) is "one of the most fun things we do". L.DEV explains than whenever they had some 'downtime', they would think of something they would like to make and go and develop it. L.DEV explains that they tended to do this work together because

> there's only so much fun you can have on your own

He explains, for example, that one of his colleagues was interested in developing a vehicle script that would include a particle system (a computer graphics technique used to render phenomena such as fire). His colleague therefore created a vehicle in the shape of a giant chocolate chip cookie and developed a particle system to render the vehicle's exhaust fumes. This example illustrates that when intrinsic motivation to create knowledge is high, knowledge creation has a hedonic quality: it's fun.

[21] Recall that levels of intrinsic motivation to create knowledge were highest for developers

5.2.3 An integrative analysis of knowledge creation intentions

This section analyses both elements of the knowledge creation intentions construct in tandem. The need for this (emergent) analysis was identified when data analysis began to suggest that prior related knowledge can influence intrinsic motivation to create knowledge.

Table 5.3 juxtaposes intrinsic motivation to create knowledge (on the horizontal axis) against knowledge creation capacity (on the vertical axis). Each cell is numbered (Cell 1, 2, 3 and 4) and contains a grid. Each grid plots the 6 cases (FOB, EXT, RIT, GLA, MZO and LOY) on the horizontal axis against each of the 4 roles (FAC, DEV, EDU) on the vertical axis. Using this layout, it is possible to distinguish (i) levels of intrinsic motivation to create knowledge and (ii) levels of prior related knowledge for each individual in the study. For example, Cell 1 reveals that there were four individuals in the study (F.DEV; E.FAC; R.FAC and R.DEV[22]) who had low levels of intrinsic motivation to create knowledge and high levels of knowledge creation capacity.

TABLE 5.3 CROSS CASE ANALYSIS: KNOWLEDGE CREATION INTENTIONS

	Low intrinsic motivation to create knowledge	**High intrinsic motivation to create knowledge**
High knowledge creation capacity	FOB EXT RIT GLA MZO LOY FAC: ☐ ☑ ☑ ☐ ☐ ☐ DEV: ☑ ☐ ☑ ☐ ☐ ☐ EDU: ☐ ☐ ☐ ☐ ☐ ☐ **(Cell 1)**	FOB EXT RIT GLA MZO LOY FAC: ☑ ☐ ☐ ☑ ☐ ☑ DEV: ☐ ☑ ☐ ☑ ☑ ☑ EDU: ☐ ☐ ☑ ☑ ☐ ☐ **(Cell 2)**
Low Knowledge creation capacity	FOB EXT RIT GLA MZO LOY FAC: ☐ ☐ ☐ ☐ ☑ ☐ DEV: ☐ ☐ ☐ ☐ ☐ ☐ EDU: ☑ ☑ ☐ ☐ ☑ ☑ **(Cell 3)**	FOB EXT RIT GLA MZO LOY FAC: ☐ ☐ ☐ ☐ ☐ ☐ DEV: ☐ ☐ ☐ ☐ ☐ ☐ EDU: ☐ ☐ ☐ ☐ ☐ ☐ **(Cell 4)**

Cell 4 shows that none of the study's participants reported low levels of knowledge creation capacity (stemming from prior related knowledge) and high levels of intrinsic motivation to create knowledge. Cell 2 shows that half of the study's participants reported high levels of knowledge creation capacity and high levels of intrinsic motivation to create knowledge.

A closer inspection of the data suggests an explanation: it was only once study participants had developed a sense of comfort in Second Life (as a result of developing a knowledge or understanding of Second Life) that their attentions could turn to the challenge of creating knowledge in Second Life. Participants developed a sense of comfort in Second Life either (i) by directly experiencing Second Life or (ii) by accessing the experiences of others in Second Life.

In terms of directly experiencing Second Life, most participants acknowledged that becoming familiar with Second Life was a process of overcoming a sense of discomfort or fear in it. This sentiment was most clearly expressed by two college students who gave a talk in Second Life that was attended by the researcher. These students specifically described their experiences in Second Life in terms of "learning to be comfortable with discomfort". These observations suggest that there is an association between knowledge creation capacity (stemming from prior related knowledge) and intrinsic motivation to create knowledge. Proposition P4 therefore states that

> **[P4] Prior knowledge of and comfort in the environment are necessary for the development of intrinsic motivation to create knowledge in virtual worlds**

In terms of accessing the experiences of others in Second Life, the analysis highlights the extent to which study participants relied on real world contacts rather than on contacts within Second Life in order to develop this knowledge of Second Life. An interesting example of this is found at MZO where the team relied on colleagues who had previously worked in Second Life. M.DEV explains that the team were able to build upon their colleagues' previous work

> either by analogy or extrapolation or through some other process.

In so doing, the team could "make decisions based on something other than guess work". Similarly, F.EDU described one of her [real life] colleagues as her "primary Second Life help desk" and L.EDU underlined the importance of "hand holding".

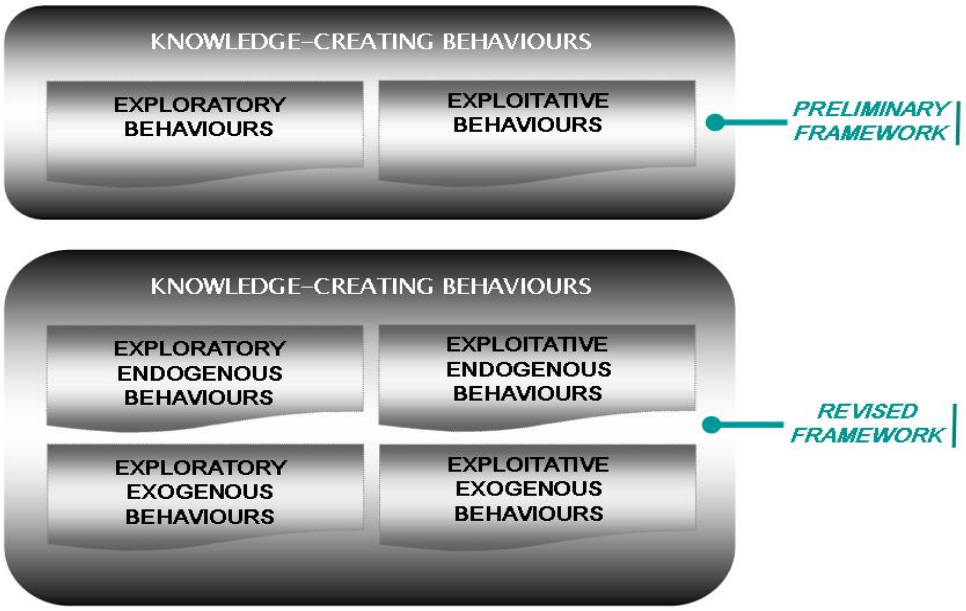
[22] The naming convention used to uniquely identify study participants is outlined in Section 4.5.2.3

5.3 Knowledge-creating behaviours

This section analyses *knowledge-creating behaviours* in the cases. Figure 5.3 recalls the knowledge-creating behaviours construct from Section 4.3. The figure also illustrates how the classification was extended during the study (to distinguish endogenous and exogenous knowledge-creating behaviours). Table 5.4 presents the classification in more detail: it identifies and describes each of the knowledge-creating behaviours in each category.

The section presents three distinct analyses. Section 5.3.1 presents a variable-oriented analysis focused on knowledge-creating behaviours themselves Section 5.3.2 presents a case-oriented analysis focused on knowledge-creating behaviours at the case level. Finally, a process-oriented analysis focuses on how behaviours are used over time within cases (Section 5.3.3) and across cases (Section 5.3.4).

FIGURE 5.3 THE KNOWLEDGE-CREATING BEHAVIOURS CONSTRUCT



Exploratory endogenous behaviours:	Taken to create knowledge that is substantively different from existing knowledge and are carried out internally within the team or within the team's location in Second Life
Exploratory exogenous behaviours:	Taken in an attempt to create knowledge that is substantively different from existing knowledge and are carried out externally of the team or outside the team's location in Second Life
Exploitative endogenous behaviours:	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out internally within the team or within the team's location in Second Life
Exploitative exogenous behaviours:	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out externally of the team or outside the team's location in Second Life

TABLE 5.4 TAXONOMY OF KNOWLEDGE-CREATING BEHAVIOURS*			
Category	**K.C. Behaviour and Code**		**Description of the behaviour**
Exploratory Endogenous **(OR-END)** *Taken to create knowledge that is substantively different from existing knowledge and are carried out internally within the team or within the team's location in Second Life*	Brainstorming	***OR.END.1***	Involves several team members meeting to explore ideas
	DIY / Practice	***OR.END.2***	Involves efforts on the part of individuals to acquire Second Life skills such a building or scripting skills
	Self directed learning	***OR.END.3***	Involves utilising online, offline and inworld informational resources to become familiar with Second Life's technical and educational aspects
Exploratory Exogenous **(OR-OG)** *Taken in an attempt to create knowledge that is substantively different from existing knowledge and are carried out externally of the team or outside the team's location in Second Life*	Community participation	***OR.OG.1***	Involves efforts to participate in Second Life communities (educational communities or other communities)
	Exploration inworld (opportune)	***OR.OG.2***	Involves open ended explorations of Second Life itself
	Research	***OR.OG.3***	Involves carrying out formal research in Second Life
Exploitative Exogenous **(OIT-OG)** *Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out externally of the team or outside the team's location in Second Life*	Exogenous collaboration	***OIT.OG.1***	Involves working with individuals, groups or communities
	Purposeful inworld exploration	***OIT.OG.2***	Involves purposeful or deliberate or specific or focused exploration of Second Life where the individual(s) concerned is seeking something specific narrowly focused Second Life exploration for something in particular
	Imitation (based on observation)	***OIT.OG.3***	Involves attempting to imitate (i) another build or elements of another project or (ii) behaviours used by others (for instance through watching others build inworld)
	Formal training	***OIT.OG.4***	Involves taking a formalised training course or apprenticeship in some aspect of Second Life
Exploitative Endogenous **(OIT-END)** *Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out internally within the team or within the team's location in Second Life*	Endogenous collaboration	***OIT.END.1***	Involves individuals within teams within teams working together to achieve a specific goal
	Meetings	***OIT.END.2***	Involves team members meeting inworld to discuss and coordinate projects in real or virtual world
	Development methodology	***OIT.END.3***	Involves using behaviours typically associated with software development.
	Pilot project(s)	***OIT.END.4***	Involves carrying out small scale projects to operate as a proof of concept.
	Experiment	***OIT.END.5***	Involves learning by doing or trial and error

** Note: Exploratory behaviours are blue and exploitative behaviours are green in the table.*

5.3.1 Variable-oriented analysis

This section presents what Miles and Huberman (1994) refer to as a variable-oriented analysis of knowledge-creating behaviours in the cases. The analysis examines the knowledge-creating behaviours themselves. The analysis reveals *significant differences across the cases in terms of the number and configuration of knowledge-creating behaviours*.

The section is structured according to Table 5.5, which summarise knowledge-creating behaviours in the study using the taxonomy of knowledge-creating behaviours (cf. Table 5.4). The table classifies and lists knowledge-creating behaviours. The first six columns list the cases (FOB, EXT, RIT…) and these cells show how many individuals used a particular behaviour in a particular case. The next three columns list the three roles (FAC; DEV; EDU) and these cells show how many individuals in a particular role used a particular behaviour. The next column lists the total number of unique occurrences of each of the 15 knowledge-creating behaviours. Table 5.5 also subtotals the four types of knowledge-creating behaviours within cases and within roles.

TABLE 5.5 CROSS CASE ANALYSIS: KNOWLEDGE-CREATING BEHAVIOURS

	K.C. BEHAVIOURS	CASES						ROLES			Sub-totals
		FOB	EXT	RIT	GLA	MZO	LOY	FAC	DEV	EDU	
OR-END	1. Brainstorm	2	3	2	0	0	3	4	3	3	10
	2. DIY / Practice	2	1	1	3	1	1	2	3	4	9
	3. Self directed learning	0	1	1	2	1	1	1	4	1	6
	Subtotals	**4**	**5**	**4**	**5**	**2**	**5**	**7**	**10**	**8**	**25**
OR-OG	1. Community participation	1	0	1	2	3	1	4	1	3	8
	2. Opportune inworld exploration	2	1	1	2	0	1	3	1	3	7
	3. Research	1	2	0	1	1	0	2	2	1	5
	Subtotals	**4**	**3**	**2**	**5**	**4**	**2**	**9**	**4**	**7**	**20**
OIT-OG	1. Exogenous collaboration	1	0	0	1	2	1	2	1	2	5
	2. Purposeful inworld exploration	0	1	0	1	0	1	0	1	2	3
	3. Imitation	1	0	0	1	0	1	0	1	2	3
	4. Formal training	0	0	1	2	0	0	1	1	1	3
	Subtotals	**2**	**1**	**1**	**5**	**2**	**3**	**3**	**4**	**7**	**14**
OIT-END	1. Endogenous collaboration	3	3	3	3	3	1	5	5	6	16
	2. Meetings	3	0	0	0	2	0	1	2	2	5
	3. Development methodology	1	0	0	0	2	2	0	3	2	5
	4. Pilot project(s)	2	0	0	0	2	2	2	2	2	6
	5. Experiment	1	1	1	1	0	1	0	4	1	5
	Subtotals	**10**	**4**	**4**	**4**	**9**	**6**	**8**	**16**	**13**	**37**
Total number of K.C. behaviours		**20**	**13**	**11**	**19**	**17**	**16**	**27**	**34**	**35**	**96**

OR-END: EXPLORATORY ENDOGENOUS
OR-OG: EXPLORATORY EXOGENOUS
OIT-OG: EXPLOITATIVE EXOGENOUS
OIT-END EXPLOITATIVE ENDOGENOUS

Table 5.5 shows that 96 unique *instances*[23] of knowledge-creating behaviours were identified in the study. *Prima facie*, one may observe that these types of behaviours are conceptually similar to the behaviours of participants in real life projects. However, deeper analysis reveals that these behaviours were carried out in fundamentally different ways in Second Life. In particular, the unique spatial and communicative properties of Second Life meant that it was possible to carry out these activities quickly and in some cases simultaneously. For example, participants could explore locations of interest in Second Life (OR.OG.2 and OIT.OG.2) at the click of a button and simultaneously communicate and collaborate with fellow team members (OIT.END.1) using Second Life's inworld communication channels (e.g. private instant messaging or private voice chat); whilst at the same time 'tabbing' out of Second Life to use related online information resources (OR.END.3). The table also reveals that there were *significant differences across the cases in terms of the number of knowledge-creating behaviours employed*. For example, the table shows that there were 20 instances of knowledge-creating behaviours being used at FOB but only 11 at RIT. In addition, the table shows that there were *significant differences across the* roles *in terms of the number of knowledge-creating behaviours employed*. For example, educators were responsible for 37 instances of knowledge-creating behaviours whilst facilitators were responsible for only 27.

5.3.1.1 Exploratory endogenous knowledge-creating behaviours

Table 5.5 indicates that in terms of exploratory endogenous (OR-END) knowledge-creating behaviours, brainstorming and DIY/practice were two of the most common behaviours overall. Brainstorming (OR-END-1) was used by ten out of eighteen individuals in four of the six cases; DIY / Practice (OR-END-2) was used by nine individuals and in all six cases; self directed learning (OR-END-3) was used by six individuals in five of the six cases. There were no significant differences across roles in terms of the use of exploratory endogenous behaviours; however, these behaviours were slightly more common amongst developers.

[23] An 'instance' refers to an individual using a particular knowledge-creating behaviour in a case

The analysis suggests that *brainstorming is an effective means of creating knowledge within teams*. The reliance on brainstorming in the cases reflected established work practices in the institutions within which these projects were being carried out. This explains why brainstorming activities are often carried out in the real world at the outset of projects and gradually come to be carried out inworld over time. Study participants also argue that DIY/practice was essential in order to work in Second Life. For example, L.FAC suggests that

> the best way to learn is to do things… if you really want to learn how to build there's really only one way to do it, the same with scripting, and the same with anything in life

Though brainstorming (OR-END-1) has been consistently considered synonymous to group level idea generation (Litchfield, 2008), brainstorming appears to be absent in two cases. The analysis suggests that this may have been because teams at GLA and MZO had firm ideas about their projects. The MZO project was a pilot project that formed part of a larger project. The GLA project was the outcome of a college-wide effort to generate ideas. As was noted above, brainstorming was most often carried out at early stages and in real life rather than during project implementation. Real world brainstorming was typically used in early design stages and would often involve the use of a whiteboard to literally sketch ideas out. Inworld brainstorming typically took place once development work had actually commenced. Where participants had attempted to brainstorm inworld, they were happy with the results. Inworld brainstorming differed from real world brainstorming in the sense that the moment an individual had ideas, they could start to interactively experiment with them inworld. F.DEV explains that the big difference is that inworld, "you can start playing with it the instant you have ideas".

In terms of DIY / Practice (OR-END-2), many participants had developed the earliest elements of their islands as a way to familiarise themselves with working in a virtual world. These earliest builds were often kept on the islands for posterity. Self directed learning (OR-END-3) tended to be carried out on an individual basis but people typically had colleagues or inworld contacts to turn to

for advice and assistance. Educators tended to engage in some level of self directed learning irrespective of whether or not their role required it in order to better fulfil that role.

5.3.1.2 Exploratory exogenous knowledge-creating behaviours

Exploratory exogenous (OR-OG) knowledge-creating behaviours were considered *vital in terms of allowing study participants to gain new insights into how Second Life was actually used for education*. Study participants (e.g. M.DEV, M.EDU) suggested that *even though much could be learned simply from visiting other educational locations in Second Life, it was also important to interact with other educators in Second Life*. There was as much (if not more) to be gained from understanding what educators intended to do as there was to gain from understanding what they had already done. Thus, members of the educational community strongly encouraged new residents to explore successful educational projects and to attend well known educational forums in Second Life.

Nevertheless, the analysis suggests that *exploratory exogenous knowledge-creating behaviours were less commonly used than exploratory endogenous knowledge-creating behaviours* in the cases. The table indicates that in terms of exploratory exogenous (OR-OG) knowledge-creating behaviours, inworld community participation was used by eight individuals from five cases; opportunistic inworld exploration was used by seven individuals in five cases; and research was used by five individuals across four cases. Time constraints were frequently cited as an explanation for this. In addition, the analysis reveals that study participants tended to rely on real world colleagues rather than on members of the broader Second Life community.

Participants described inworld community participation (OR-OG-1) in terms of attending weekly inworld meetings such as the VWER (Virtual Worlds Education Roundtable) or ISTE (International Society for Technology in Education) meetings. Opportunistic inworld exploration (OR-OG-2) allowed individuals and teams gain a fuller overall understanding of what was possible in Second Life. It

was considered a source of inspiration as it afforded the opportunity to observe what others were doing. This behaviour was used by individuals regardless of role, usually in their earliest stages of involvement. Whilst the need for formal research (OR-OG-3) on education in Second Life was commonly recognised, it was observed that many Second Life educators are failing to do it. In this study, research was being carried out in four of the six cases.

5.3.1.3 Exploitative exogenous knowledge-creating behaviours

Exploitative exogenous (OIT-OG) knowledge-creating behaviours were least commonly used in this study. Table 5.5 indicates that exploitative exogenous (OIT-OG) knowledge-creating behaviours manifested on just fourteen occasions across the six cases. Further, the study's six project facilitators were least likely to have used these behaviours. Exogenous collaboration (OIT-OG-1) was used by five individuals across four cases. Each of the other three exploitative exogenous behaviours was used by three individuals; most of these individuals were based at FOB, GLA or LOY. Time constraints were frequently cited as an explanation for this. In addition, study participants had a tendency to rely on real world colleagues rather than on members of the broader Second Life community. In particular, *the analysis suggests that it is difficult to collaborate exogenously (outside of one's own team) in Second Life*. Whilst educators in Second Life are happy to share resources, it seems that a number of study participants (e.g. G.EDU) had unsuccessfully attempted to identify and partner with potential collaborators. There was a strong recognition in Second Life (and amongst study participants) that the ability to stimulate effective collaborations in Second Life is a skill in itself; both F.FAC and F.DEV described this as "community building". This sentiment suggests that virtual world users face similar challenges to individuals working in distributed teams: they must work hard to overcome the challenges of communicating without face-to-face cues so that they can develop "collaboration know-how" in order to work effectively with others (Majchrzak *et al.,* 2005) in the virtual world.

The data suggests that exogenous collaboration (OIT-OG-1) was not often successfully used but efforts were made in several cases to establish useful connections with other institutions pursuing similar work. Developers commented that there is substantial co-operation taking place within Second Life's content creator communities but the extent to which educators appear to actively co-operate with one another does not appear to be as great. Individuals engaged in purposeful inworld exploration (OIT-OG-2) noted that they were more likely to actively engage with external others in doing so. Study participants at MZO did suggest that whilst it can be beneficial to explore other builds in Second Life, it can be difficult to know what other educators and developers had in mind without actually speaking with them. In terms of imitation (OIT-OG-3), participants observed that it was easier to use this approach than it was to start from scratch in Second Life. Educators tended to use this behaviour to gather conceptual ideas which could later be adapted or customised. Developers were more likely to use this behaviour to attempt to reverse engineer or otherwise deconstruct what they had seen inworld in order to develop their own skills. In other words, participants used this one behaviour to generate different forms of knowledge depending on their roles within projects. Formal training (OIT-OG-4) was rarely used but in those instances where it was used, it appears that formal training was felt to be a highly beneficial and efficient knowledge-creating behaviour.

5.3.1.4 Exploitative endogenous knowledge-creating behaviours

A total of five distinct types of exploitative endogenous (OIT-END) knowledge-creating behaviours were identified in the cases. In addition, Table 5.5 indicates that exploitative endogenous (OIT-END) knowledge-creating behaviours were the most common class of behaviours, manifesting in thirty seven instances across the six cases. There are a number of reasons why these behaviours were so common. Part of the explanations stems from the fact that there were simply more types of these behaviours. Time constraints seem to have restricted the extent to which other types of knowledge-creating behaviours have been used. In addition, the table shows that developers and educators in particular were more likely to use these behaviours than any other kind. Of all the study's participants, these

individuals were the most time constrained. Taken together, these observations suggest that other kinds of knowledge-creating behaviours were more discretionary whilst these behaviours were perhaps more necessary.

Endogenous collaboration (OIT-END-1) was used in sixteen instances across all six cases and was the most consistently present of all of the knowledge-creating behaviours found in the study. Endogenous collaboration typically took the form of more experienced team members supporting more junior members by answering questions or providing input. In particular, it tended to involve educators collaborating with developers; facilitators would mediate that process to ensure the effective communication of educator needs and technical constraints. Formal meetings (OIT-END-2) were identified as a knowledge-creating behaviour in five instances in only two cases. Meetings were held either in the real world or in the virtual world. For the most part, team members would have real world meetings unless it was necessary to meet in the virtual world. There was evidence that elements of formalised development methodologies (OIT-END-3) were employed in creating knowledge in five instances in three cases. These behaviours were typical of experienced software developers and experienced Second Life teams and included the use of rapid and iterative prototyping as well as the use of formal requirement specification strategies. Six individuals were involved in pilot projects (OIT-END-4) in three cases. Pilot projects gave team members an opportunity to engage in experimentation and to practice the necessary skills to create in Second Life. These projects also served to give educators something tangible which they could use for community outreach. Finally, five individuals used experimentation (OIT-END-5) in five cases. Four of these individuals were developers. A number of study participants argued that experimentation and trial and error were the only effective methods of understanding. It was felt that more so than any other behaviour, experimentation and trial and error enabled teams to most effectively establish the merits of alternative approaches.

5.3.2 Case-oriented analysis: identification of behavioural archetypes

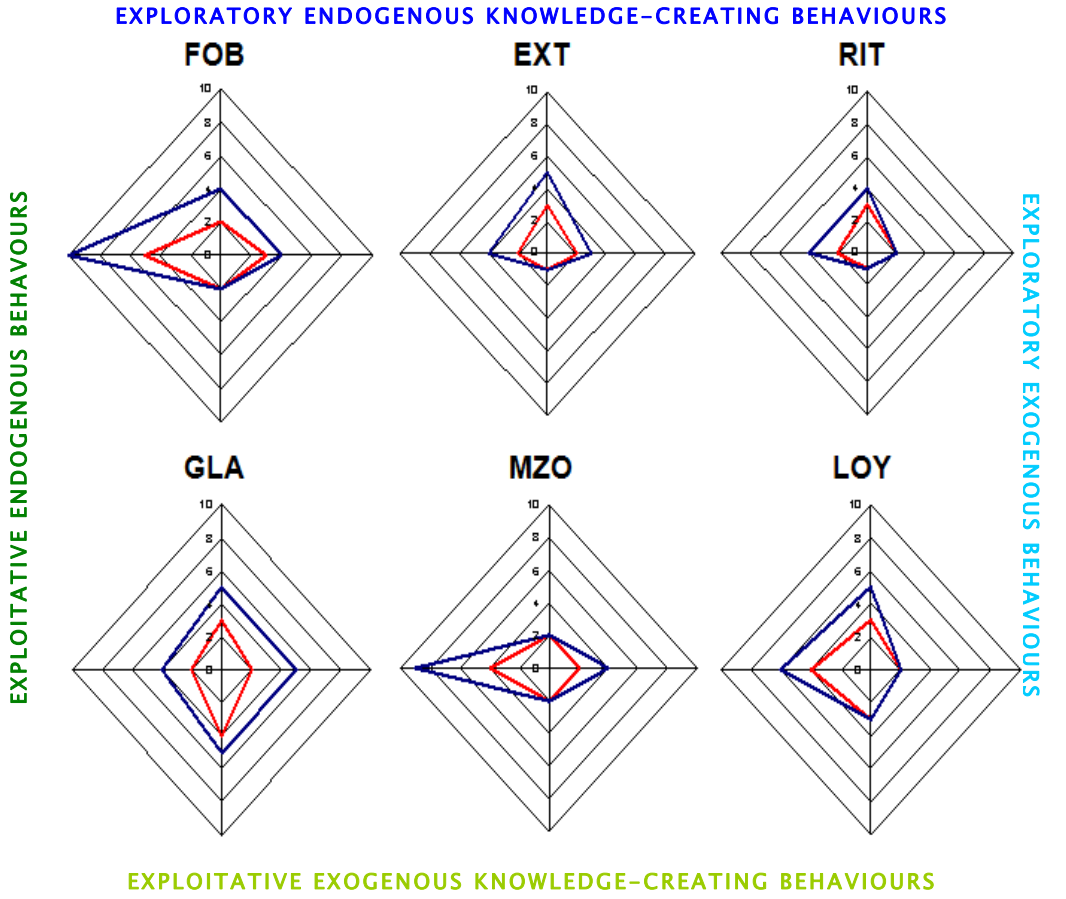
This section presents a case-oriented analysis of knowledge-creating behaviours in the cases. Overall, the analysis suggests that *individuals and teams tended to rely on endogenous (self-reliant) knowledge-creating behaviours*. In particular, the analysis identifies two distinct behavioural archetypes exist in the cases.

The analysis is based on Figure 5.4. The figure uses six radar charts (one per case). Each chart consists of four spokes corresponding to the four types of knowledge-creating behaviours identified in the study[24]. Each chart uses two distinct but related measures to illustrate a case's 'leanings' toward the four types of knowledge-creating behaviours. The blue lines describe how many individuals in a case used the four types of knowledge-creating behaviours[25]. This is referred to as a measure of knowledge-creating behaviour ***frequency***. The red lines operate at more of a case level and describe how many knowledge-creating behaviours were used in a particular case (rather than how many individuals in that case used them). This is referred to as a measure of knowledge-creating behaviour ***presence***.

Overall, Figure 5.4 supports the analysis presented in Section 5.3.1 by illustrating the level of variation across the cases in terms of both the numbers and configurations of knowledge-creating behaviours used. At the same time, the figure makes the general behavioural orientation of the cases more explicit. At this level of abstraction, the figure reveals that *the primary focus of most of the individuals and teams in this study was on endogenous (internal, self-reliant) knowledge-creating behaviours*. Specifically, the figure highlights the fact that five of the six cases are either "reaching up" (EXT, RIT) or "leaning to the left" (FOB, MZO and LOY) of the figure. The remainder of this section considers each of the configurations of knowledge-creating behaviours in turn.

[24] The numerical values depicted on the x-axis are also applicable to the y-axis
[25] The blue lines effectively repeat the data presented in Table 5.5

FIGURE 5.4 KNOWLEDGE-CREATING BEHAVIOUR ARCHETYPES



5.3.2.1 Purposeful self-reliance

The first archetype, or configuration of knowledge-creating behaviours, manifests in three cases (FOB, MZO and LOY). This configuration is characterised by a pronounced leaning to the left in the radar charts. That is to say, these teams were primarily engaged in exploitative endogenous behaviours. Therefore, these cases are described as being purposefully self-reliant.

The approach at MZO is most concertedly "left leaning". In other words, the team is primarily focused on exploitative endogenous knowledge creating behaviours. The data reveals that the team at MZO are deliberately building upon the previous experiences of MZO in Second Life as part of an incremental and explicitly stage-based approach to knowledge creation. Whilst FOB and LOY are also primarily focused on exploitative endogenous knowledge-creating behaviours, it can be seen that these teams are also maintaining a secondary focus on exploratory

(endogenous) knowledge-creating behaviours. In addition, the distance between the blue and red lines in this quadrant reflects the fact that several individuals in these cases (rather than single individuals in the team) were maintaining this secondary focus.

5.3.2.2 Opportunistic self-reliance

The second archetype, or configuration of knowledge-creating behaviours, manifests in two cases (EXT and RIT). This configuration is characterised by a pronounced "reaching up" in the radar charts. That is to say, these teams were primarily engaged in exploratory endogenous knowledge-creating behaviours. Therefore these cases are described as opportunistically self-reliant. The reliance on exploratory endogenous knowledge-creating behaviours (the extent to which the figure "reaches up" is pronounced at EXT. In addition, the distance between the blue and red lines reveals that multiple individuals at EXT were engaged in exploratory endogenous knowledge-creating behaviours. At RIT, the focus of the team is more diffused and the team maintains a strong secondary focus on more exploitative knowledge-creating behaviours. Finally, the radar charts reveal that these teams engaged in fewer knowledge-creating behaviours overall than purposefully self-reliant teams.

Finally, the configuration of knowledge-creating behaviours at GLA is unlike any of the other six cases. The configuration is balanced overall, with a slight skew in favour of exploitative exogenous behaviours. This represents a significant departure from other cases; especially because exploitative exogenous behaviours were comparably weak in all other cases. The case suggests that there may be additional knowledge-creating behavioural archetypes in virtual worlds and also underlines a point made throughout this section: that there were significant differences across the cases in terms of how knowledge-creating behaviours were carried out.

5.3.3 Within-case, process-oriented analysis of knowledge-creating behaviours

This section examines *temporal configurations* of knowledge-creating behaviours within cases. This analysis is used to construct a process-oriented cross-case analysis of knowledge-creating behaviours in Section 5.3.2.4.

Overall, the analysis reveals that *each case used quite a different temporal configuration of knowledge-creating behaviours*. On the one hand, these differences can be attributed to contextual differences in the cases. However, participants also explained that teams are "fumbling around in the dark" (E.FAC) and that Second Life is not some sort of "magic happy learning land" (L.FAC). There is no consensus on what can be achieved in virtual worlds or on the best way to achieve it. Similarly, there are no best-practices available to virtual world users in terms of using virtual worlds. Thus, knowledge-creating behaviours are being used in a non-formalised and resource-intensive manner.

The analysis is based on a series of six process-oriented displays of knowledge-creating behaviour (one per case). Each display plots time on the horizontal axis and individuals' roles (i.e. project facilitator; developer; educator) on the vertical axis. Individual knowledge-creating behaviours appear in the displays using the terminology, coding scheme and colour coding of Table 5.4.

FIGURE 5.5 WITHIN-CASE ANALYSIS: KNOWLEDGE-CREATING BEHAVIOURS (FOB)

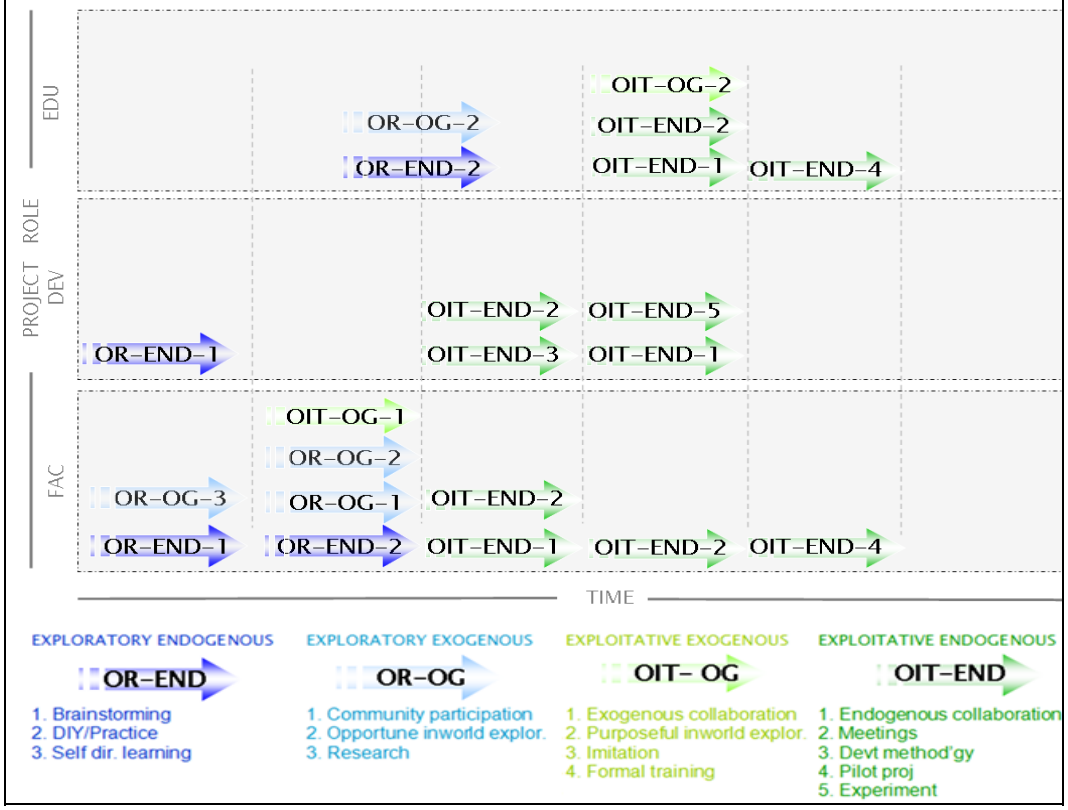


Figure 5.5 presents a within-case analysis of knowledge-creating behaviours at FOB. Overall, the analysis suggests that the approach at FOB was to leverage (i) strong pair-wise collaborative relationships (between F.FAC and F.DEV; F.FAC and F.EDU) and (ii) strong links with the Second Life community in order to complete the project as efficiently as possible. This approach was suitable as the project's goals were clearly established at the outset. However, this approach may have limited knowledge creation outcomes for some of the project's participants. As Figure 5.3 illustrates, the team as a whole used only eleven distinct knowledge-creating behaviours. The figure also reveals that F.FAC had the most active role in the project and engaged in more exploratory activities than anyone else. The figure also shows that F.EDU had minimal involvement in creating the project and her approach to knowledge creation was largely exploitative. F.DEV's role was similarly focused on exploitative knowledge creation behaviours.

FIGURE 5.6 WITHIN-CASE ANALYSIS: KNOWLEDGE-CREATING BEHAVIOURS (EXT)

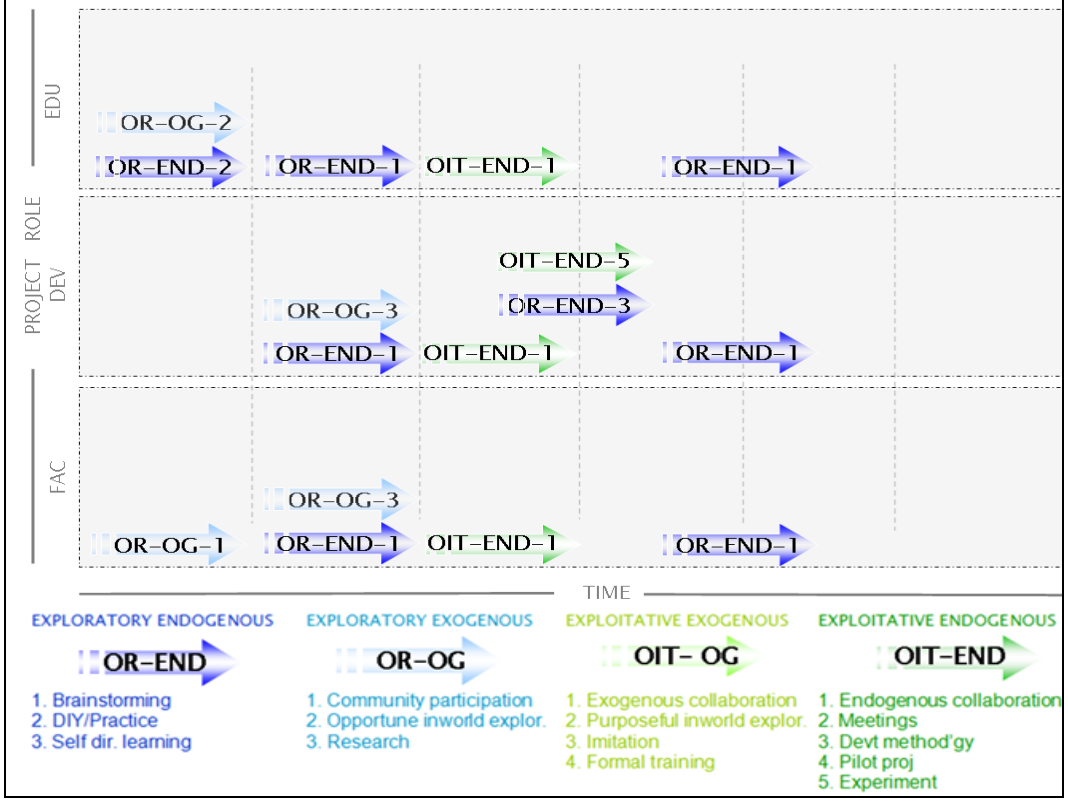


Figure 5.6 presents a within-case analysis of knowledge-creating behaviours at EXT. During the project's design and development, E.FAC acted as a consultant and mediator between E.EDU and E.DEV. This can be seen in Figure 5.4, which indicates that the team was more focused on endogenous behaviours than on exogenous behaviours: four of the eight knowledge-creating behaviours used at EXT were endogenous. This approach was suitable as the project's goals were unclear at the outset. In addition, E.EDU did not have substantial knowledge of Second Life at the outset and E.DEV was not an experienced educator. Therefore, this approach enabled team members to pool their expertise. However, it also meant that only eight unique knowledge-creating behaviours were used at EXT. In addition, the concentration of blue codes in the figure reveals that most individuals were primarily engaged in exploratory knowledge-creating behaviours (only E.DEV was centrally involved in exploitative behaviours in the project). In the end, E.EDU attributes the creativity and inventiveness in the project to E.FAC and E.DEV.

FIGURE 5.7 WITHIN-CASE ANALYSIS: KNOWLEDGE-CREATING BEHAVIOURS (RIT)

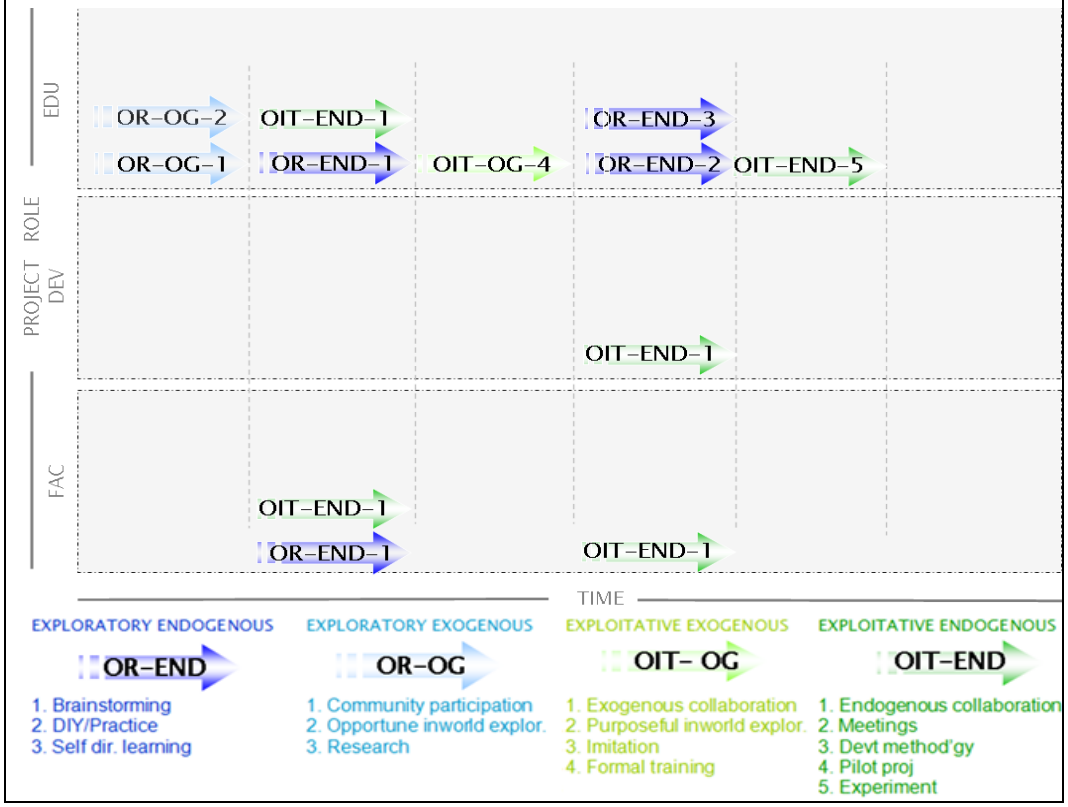


Figure 5.7 presents a within-case analysis of knowledge-creating behaviours at RIT. The figure indicates that only eight unique knowledge-creating behaviours were identified at RIT. This figure is lower than most of the other cases except EXT. This is because, despite R.EDU's inexperience in Second Life, he wished to take responsibility for the design and creation of his own inworld content and the nature of the funding he had secured for the project afforded him the time to do this. This is evidenced in Figure 5.5; which shows that R.EDU engaged in a more balanced range of knowledge-creating behaviours. This approach worked for two reasons. First, R.EDU was already fully familiar with the course content. Second, R.EDU had substantial technical skills at the outset of the project. Further, he was able to draw on R.FAC and R.DEV where necessary. However, R.EDU encountered significant problems in terms of creating some of the inworld demonstrations for the project. These problems could perhaps have been anticipated in advance had the team endeavoured to collaborate more fully at the outset of the project.

FIGURE 5.8 WITHIN-CASE ANALYSIS: KNOWLEDGE-CREATING BEHAVIOURS (GLA)

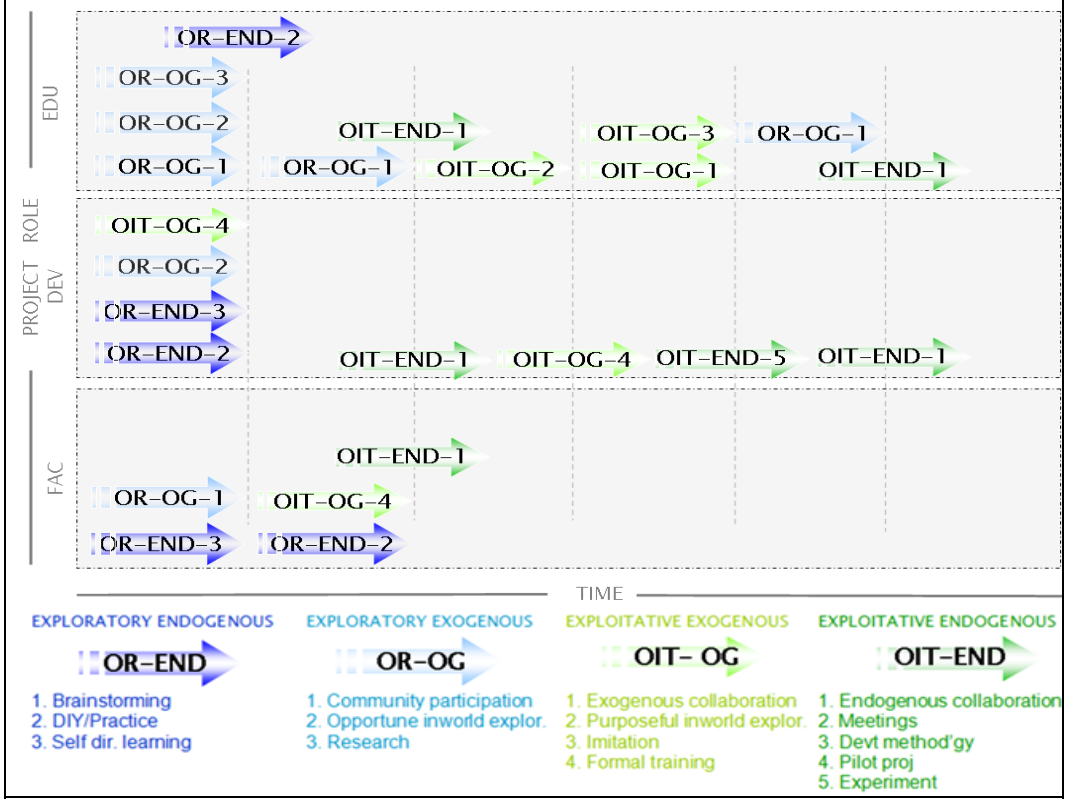


Figure 5.8 presents a within-case analysis of knowledge-creating behaviours at GLA. Strong top-level support for using virtual worlds for education meant that the team was able to leverage substantial organisational resources to complete the project. This resulted in comparatively high levels of knowledge-creating behavioural activity at GLA in comparison with other cases (as is evidenced in the figure). In addition, this strong support manifested in terms of the team's strong commitment to the project. This is reflected in Figure 5.6 which shows all three participants engaged in a mix of exploratory and exploitative behaviours. Further, the figure shows that exploratory knowledge-creating behaviours gave way to exploitative knowledge-creating behaviours over time. There was evidence to suggest that this transition was facilitated by the development of a strong and effective collaboration between G.EDU and G.DEV. This collaboration was encouraged and supported at GLA through the use of extensive informal interactions and communications that took place on an ongoing basis at GLA so that team members were continually aware of one another's activities.

FIGURE 5.9 WITHIN-CASE ANALYSIS: KNOWLEDGE-CREATING BEHAVIOURS (MZO)

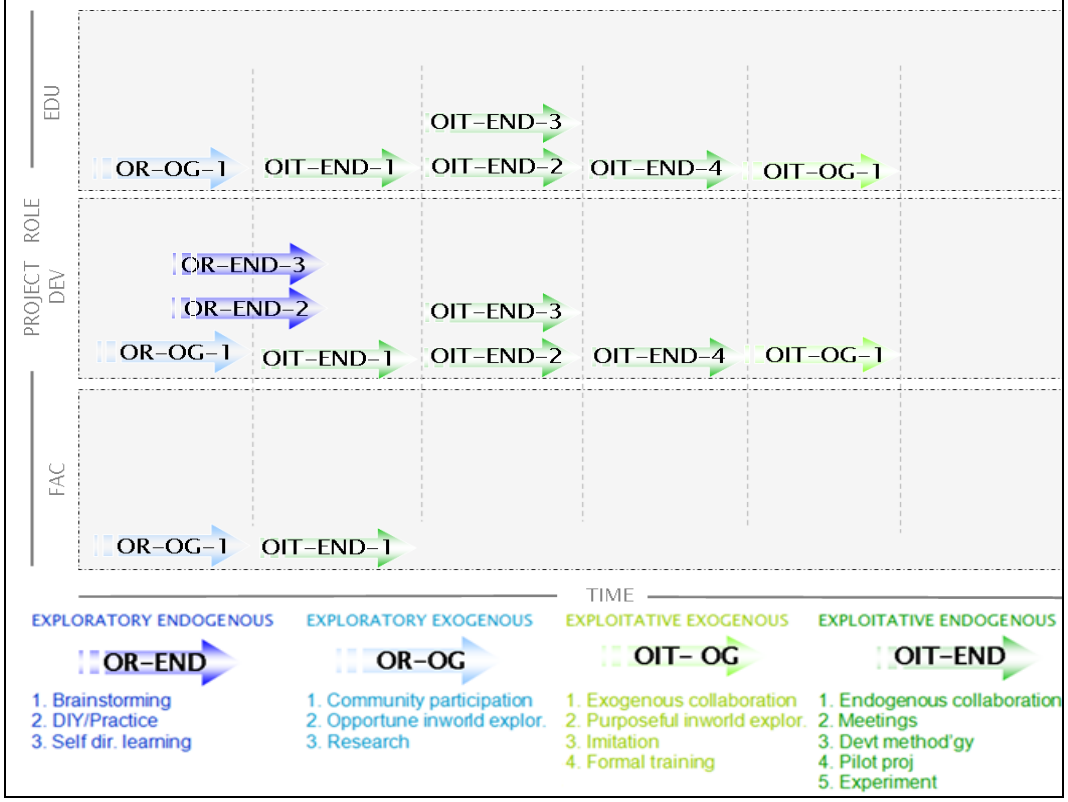


Figure 5.9 presents a within-case analysis of knowledge-creating behaviours at MZO. This case is concerned with a pilot project in Second Life that is being carried out as part of a larger three-year funded research project in Second Life. The team is composed of individuals from two separate departments within one university. One of these departments has already carried out one project in Second Life. However, most of the individuals taking part in this project are new to Second Life. The figure indicates that ten unique knowledge-creating behaviours were identified at MZO. The team begins this pilot project with a tightly focused vision of the project and its goals. This is reflected in the figure: exploratory knowledge-creating behaviours quickly give way to exploitative knowledge-creating behaviours in the case. M.DEV explains that you can build upon things that have been done previously "either by analogy or extrapolation or through some other process". Taking the time to engage both in community participation and with those who worked on MZO's 1st Second Life project allows for the development of a good understanding of the field which in turn allows the team to make decisions based upon "something other than guess work".

FIGURE 5.10 WITHIN-CASE ANALYSIS: KNOWLEDGE-CREATING BEHAVIOURS (LOY)

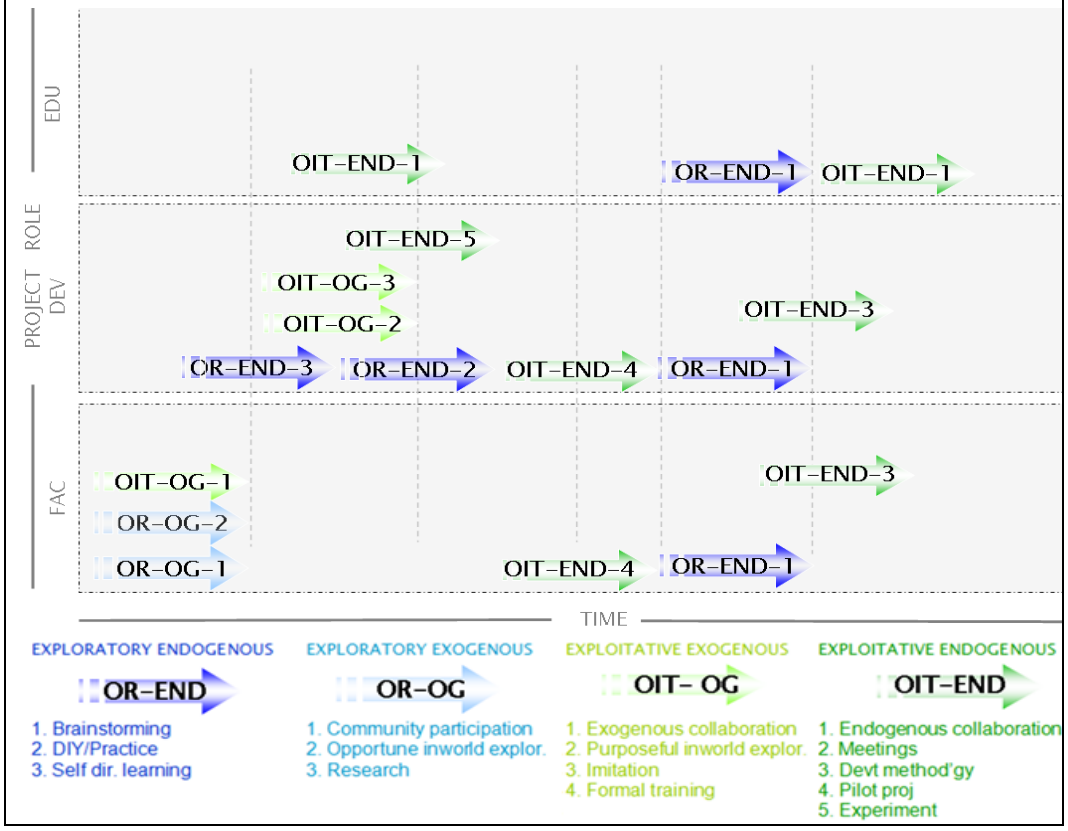


Figure 5.10 presents a within-case analysis of knowledge-creating behaviours at LOY. The figure indicates that ten unique knowledge-creating behaviours were identified at LOY. The team had initially spent six months in an 'incubator' (attempting to "incrementally discover" the skill sets they would require and then began to perfect them by means of participation) before this project began. The use of exogenous behaviours in the early stages of the project appears to be an indication of this prior experience of and familiarity with Second Life – the team knows how to go about accessing external resources from the beginning. The pursuit of excellence by means of a purposeful, incremental and iterative approach is the hallmark the LOY approach. This is reflected in the unusual mix of knowledge-creating behaviours in this case where the team returns to exploratory behaviours in the latter stages of the project (this also happens at EXT). This has been a key element in allowing the project to evolve year on year; L.FAC explains that he is "a big believer" in building upon small, successful first steps.

5.3.4 Cross-case, process-oriented analysis of knowledge-creating behaviours

This section leverages the within-case analysis presented in Section 5.3.3 to construct a cross-case, process-oriented analysis of knowledge-creating behaviours in Second Life. The analysis considers the early stages of projects (Section 5.3.4.1) and the later stages of projects (Section 5.3.4.2) in turn. Section 5.3.4.1 reveals that in the early stages of projects, participants relied on exploratory exogenous behaviours as a means of creating declarative knowledge. In particular, participants were primarily concerned with establishing (i) an overall vision of project goals and (ii) an overall vision of Second Life as soon as possible. Section 5.3.4.2 highlights the importance of creating procedural knowledge in the latter stages of projects and reveals that study participants became increasingly reliant on colleagues as projects progressed.

5.3.4.1 Knowledge-creating behaviours in the early stages of projects

An analysis of the early stages of projects reveals that *participants relied on exploratory exogenous behaviours in the early stages of projects as a means of creating declarative knowledge.*

In relation to the use of exploratory exogenous behaviours, Figures 5.5-5.10 reveal that study participants across the cases primarily relied on exploratory exogenous behaviours in the early stages of projects. In particular, many participants engaged in opportunistic inworld exploration (OR-OG-2). Participants describe visiting particular locations in Second Life and carrying out supplementary and web based research based on those explorations. Study participants underlined the notion that the work of others in Second Life was an important source of inspiration and indicated that exploratory exogenous behaviours (and inworld explorations in particular) were useful in terms of apprehending the work of other educators. For example, L.DEV explained that in order to be able to do "the best work" in Second Life, he needed to "see the state of the art". Similarly, G.EDU argued that "seeing is believing" in Second Life; seeing what other educators had done in Second Life allowed "the pedagogy to shine through". At the same time, inworld community participation (OR-OG-1)

was not especially common across the cases. Where individuals did engage in this type of knowledge-creating behaviour, it was usually the case that a member of the project team (usually the project facilitator) already had strong ties within a particular community (e.g. F.FAC) or was hoping to promote their work (e.g. E.FAC, L.FAC) in Second Life. Taken together, these observations suggest that Second Life facilitated or enabled the communication of tacit knowledge amongst educators even as the educational community in Second Life struggled to make this knowledge explicit.

Further, the data also suggests that *study participants were primarily concerned with establishing (i) an overall vision of project goals and (ii) an overall vision of Second Life* during the early stages of projects. Each of these points is discussed in turn.

In terms of developing an overall vision of project goals, there is evidence that team members shared a vision of a project's ultimate goals in at least four of the study's six cases (FOB, MZO, GLA, and LOY). At FOB, F.FAC holds that the team were able to stay true to the project's original vision to such an extent that they are still to this day able to use the same language they used to express it at the outset. At MZO, the team had a "very clear set of questions" (M.EDU) from the outset. These questions were drawn from prior institutional experience at the MZO. The team used these questions to formulate a "step by step approach" with which to answer those questions. At LOY, the project's purpose was very clear at the outset: L.EDU explains that she "had a problem to solve… there were requirements… variables… that I presented". Whilst it was "a no brainer" that they would re-create a border, they "didn't know how it would work… we were always bringing ideas to her and then we would get her feedback [and] fine tune the vision" (L.FAC). This process was done on pen and paper. Whilst this approach was "very archaic" (L.FAC), the team simply found it easier to work face to face and then migrate that into an inworld design process.

Participants explained that a higher vision of a project's aims was important because it helped to ensure that projects were carried out purposefully; that energy was not needlessly expended pursuing frivolous goals; and that participants did not lose focus by virtue of Second Life's numerous technical distractions. In addition, developing a project's goals was a source of motivation for project participants. Participants argued that project goals should (i) be appropriate for Second Life (M.FAC); (ii) be determined according to pedagogical rather than technological perspectives (G.FAC; L.FAC); (iii) be of appropriate scope (L.FAC) and (iv) be sufficiently specified (M.EDU).

In terms of establishing a broader vision of virtual worlds, Study participants at GLA and at MZO, suggested that this vision should be based on understanding what is possible rather than what already is[26]. For example, M.DEV argues that the real world should not be taken as a point of departure when designing educational projects in Second Life. Similarly, G.PM and G.FAC are agreed that a 'hacker' ethos facilitated the development of an overall vision of virtual worlds. G.PM explains that it is

> less to do with what you can do than with what you can imagine… you need to be a hacker to lift the bar and not just do good stuff, but try to regard [Second Life's] potential

The need to establish an overall vision of virtual worlds is explicated by L.FAC who states that "if you don't have a clear vision, it is hard to know what to do". Similarly, an active Second Life educator[27] described this idea in terms of the "tyranny of freedom". Schultze (2000) argues that freedom, autonomy, and self-determination can become excessive and when that happens, freedom can be experienced as a kind of tyranny. The argument made by the educator was that if anything is possible, if every avenue is open to consideration, nothing gets done. In other words, there is a kind of paralysis by analysis.

[26] As an aside, the researcher came across a Second Life group called "Not Possible in Real Life" which is popular amongst educators in Second Life

[27] The initials of that educator's avatar are S.L. and permission was granted to quote the educator

5.3.4.2 Knowledge-creating behaviours in the latter stages of projects

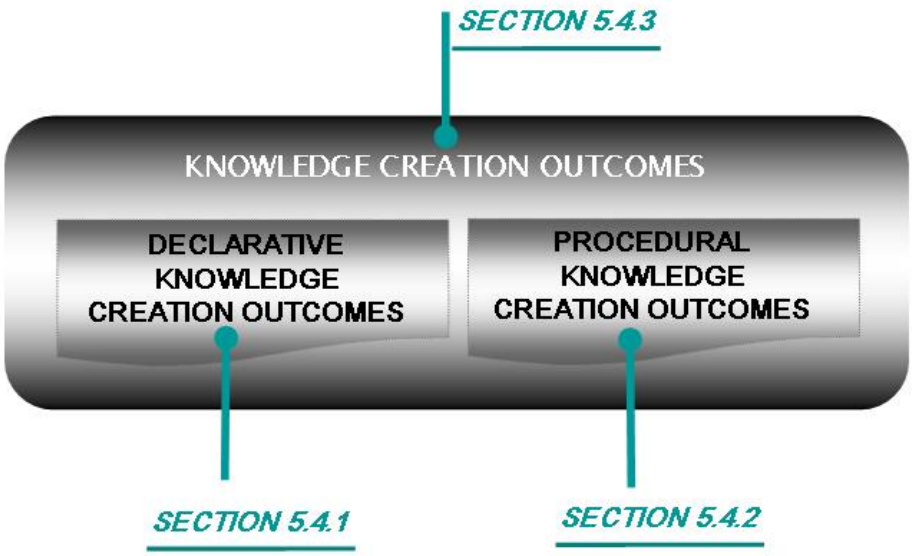
An analysis of the later stages of projects highlights *the importance of creating procedural knowledge* during these stages. The analysis also reveals that *exploratory exogenous behaviours tended to give way to endogenous behaviours*. The analysis suggests that participants became increasingly reliant on (real world) colleagues, rather than on members of the broader Second Life community, as projects progressed. In effect, the opportunities for exploitative exogenous behaviours were not fully realised in the cases.

In terms of procedural knowledge, the analysis suggests that *procedural knowledge* became a priority for study participants over time. In particular, participants turned their attention to endogenous exploratory behaviours (such as self directed learning and DIY/practice) that would stimulate procedural knowledge creation. These behaviours were typically carried out inworld but in isolation from colleagues. As projects moved from design to implementation, a stronger sense of endogenous collaboration began to emerge. This was often done on an informal basis but teams also began to arrange meetings to discuss progress. Much of this interaction was in the form of (real world) "face time" and few participants used Second Life for these purposes unless they had no choice. This development of real world social and collaborative behaviours was associated with a shift from (individualistic) endogenous exploratory activities toward (social and collaborative) endogenous exploitative behaviours inworld. That is to say, *study participants became increasingly reliant on colleagues, rather than on members of the broader Second Life community, as projects progressed*.

5.4 Knowledge creation outcomes

The purpose of this section is to examine the third construct of the preliminary framework (*knowledge creation outcomes*) in the cases. The knowledge creation intentions construct is recalled from Section 4.3 in Figure 5.11. The figure also illustrates how this section is structured: the section focuses on each element of the construct in isolation (Sections 5.4.1 and 5.4.2) and then examines them in relation to one another (Section 5.4.3).

FIGURE 5.11 THE KNOWLEDGE CREATION OUTCOMES CONSTRUCT



K.C. Outcomes	Changes in declarative and procedural knowledge frameworks
Declarative K.C. outcomes	Changes in declarative (know-about) knowledge frameworks
Procedural K.C. outcomes	Changes in procedural (know-how) knowledge frameworks

5.4.1 Declarative knowledge creation outcomes

This section presents an analysis of declarative knowledge creation outcomes in the study. The section summarises declarative knowledge creation outcomes in the cases, revealing that declarative knowledge creation outcomes were quite high in the cases. The analysis attempts to explain this observation by suggesting that (non-linguistic) symbolic forms of communication in virtual worlds facilitate declarative knowledge creation (Section 5.4.1.1). The section also introduces an emergent construct: meta-declarative knowledge. The analysis suggests that meta-declarative knowledge is important for knowledge creation in virtual worlds and that it can be derived from prior related knowledge (Section 5.4.1.2).

Table 5.6 presents the analysis of declarative knowledge creation outcomes. The cases are listed in the columns of the table and the individuals within each case are listed in the rows [28]. Declarative knowledge creation outcomes were evaluated by the researcher as either 'high' or 'low' based on analysing the relevant data codes and the case summaries created during analysis.

TABLE 5.6 CROSS CASE ANALYSIS: DECLARATIVE KNOWLEDGE CREATION OUTCOMES

	FOB	EXT	RIT	GLA	MZO	LOY
FOR THE FACILITATOR (*.FAC)	LOW	HIGH	LOW	LOW	HIGH	HIGH
FOR THE DEVELOPER (*.DEV)	LOW	HIGH	HIGH	HIGH	HIGH	HIGH
FOR THE EDUCATOR (*.EDU)	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH

The table shows that only four individuals reported low declarative knowledge creation outcomes across the cases. Further, declarative knowledge creation outcomes were highest for educators and lowest for developers. The remainder of this section presents a number of findings in relation to declarative knowledge creation in the cases.

5.4.1.1 Creating declarative knowledge through symbolic communication

The finding that declarative knowledge creation outcomes were high across the cases can be explained in terms of the ability to utilise *symbolic (non-linguistic)*

[28] The naming convention used to uniquely identify study participants is outlined in Section 4.5.2.3

forms of communication in virtual worlds. Virtual world users can literally create the world in Second Life; and can program it so that it can interact with other users. This grants users an ability to communicate without words, which is essential for the communication of tacit knowledge. In fact, many of Second Life's most successful educational projects leverage this aspect of Second Life. These projects allow users to 'live' different moments in space and time or to literally experience sensory and perceptual distortions that are not otherwise easily simulated. For example, the First World War Poetry Digital Archive[29] brings users to the trenches of World War I; and UC Davis' Virtual Hallucinations project[30] allows Second Life users to apprehend the (virtual) world through the eyes and ears of a schizophrenic patient. In the context of this study, G.EDU explains that

> there is an element of seeing is believing and certainly when you're trying to get people to use it, if you can take them to other places and say 'look, this is how they've used it here', they can see the pedagogy shining through the project and they can see this is actually relevant to teaching and learning

In other words, users can create declarative knowledge by means of passively viewing or observing other educators' work in Second Life.

Further, imitation often played a part on producing new declarative knowledge creation at GLA. The team would generate new ideas by means of looking for "serious examples" (G.DEV) in Second Life itself and would then adapt and refine those ideas by means of trial and error. This account describes what is referred to in literature as "recombinant innovation" where existing ideas can be reconfigured in new ways to make new ideas (Stark, 2009, p. 181).

These observations extend Nonaka's argument that an individual can acquire tacit knowledge without language (Nonaka, 1994, p. 19). However, the observation contradicts the argument that individuals acquire tacit knowledge solely by means of (i) joint activities (Nonaka and Konno, 1998, pp. 42-43) or (ii) shared

[29] Visit the project at http://slurl.com/secondlife/Frideswide/219/199/646/ or watch a video of the project at http://youtu.be/iQIbfvcZv8c (Accessed June 16th 2011)

experience (Nonaka, 1994, p. 19; Alavi and Leidner, 2001) with others. Here, the evidence suggests that new tacit (declarative) knowledge can be created by means of interacting with a virtual environment created by others. These observations suggest that *virtual world users should leverage the potential of virtual worlds to support symbolic communication (through avatar mediated perceptual experience) in order to create and share tacit knowledge*.

5.4.1.2 Meta-declarative knowledge and its role in knowledge creation

The observations presented in this section highlight the importance of what is here termed *meta-declarative knowledge* in terms of facilitating knowledge creation in virtual worlds. Meta declarative knowledge is defined in this study as *knowledge about declarative knowledge*. The concept of meta-declarative knowledge is similar to Kuhn's (1999) concept of "meta cognitive knowing" and to the concept of "knowing whether" (Hart *et al.,* 2001). The concept of creating meta-declarative knowledge resonates with the view that knowledge creation is as much about the specification and definition of the problem as it is about solving the problem (Nonaka and Kenney, 1991).

Study participants (L.FAC; E.EDU; E.FAC) explained that 'outsiders' had profound difficulty in establishing even a basic understanding of what Second Life was. Second Life had "no equivalent for people to hang their hats on" (E.FAC) and communicating the potential of the environment for education was therefore a serious challenge (G.PM; E.EDU). For theses reasons, participants went to great lengths to develop a meta-knowledge about the kinds of declarative knowledge that were needed for Second Life. For example, the MZO team deliberately invested significant energy to develop their own knowledge of Second Life – even though their intention was ultimately to use professional Second Life developers. M.DEV argued that this was necessary and important work because

> if you don't really know what you're asking for, you're unlikely to get what you want.

[30] Visit the project at http://slurl.com/secondlife/sedig/27/45/22/ or watch a video of the project at http://youtu.be/s33Y5nI5Wbc (Accessed June 16th 2011)

In addition, once a general understanding of the constraints or extents of the possibilities had been established, it became easier to create new knowledge within that *overall frame*. Thus, R.FAC argues that

> Once you are more aware of what's possible, you become more open and the limitations of your own understanding go way down.

These observations suggest that there is an association between meta-declarative knowledge and declarative knowledge creation outcomes. Proposition P5 therefore states that

> **[P5] Meta-declarative knowledge positively affects declarative knowledge creation outcomes in virtual worlds**

The importance of meta-declarative knowledge is evidenced by the observation that once teams had created this meta-declarative knowledge, they used this knowledge to work efficiently and purposefully. For example, F.FAC and F.DEV spent a year in informal discussions about the project before it began. This meant that by the time the project had been completed, the team were still able "stay true to the original course of the original intent" (F.FAC). There were "no tangents"; instead, there were 'refinements' of the original idea as the project evolved (F.FAC). If the future was a "cascade of potentials" (O Shea 2002, p. 119), then meta-declarative knowledge was used to realise a (particular) future that was as the team wished and perceived it to be (von Foerster 1981, p. 196).

Further, *meta-declarative knowledge was often created with reference to prior related knowledge*. M.DEV explains that

> It is essential that we take into account the way that people probably learn within a lab because either we want to replicate that in Second Life or we want to understand the essentials, abstract them out and then recreate them in a different form in Second Life.

Here, it is possible to discern that the manner in which the problem is specified (in this case, educating in a virtual world), is itself informed by prior existing knowledge (in this case, about contemporary learning design principles). In particular, the analysis suggests that this understanding was often developed by

means of, and expressed through, metaphor in the cases. These metaphors were often articulated according to the previous experiences and prior related knowledge of study participants and played an important role in structuring the efforts of teams.

Taken together, these observations *underline the role of prior related knowledge in shaping declarative knowledge creation in virtual worlds;* and therefore suggest the power of metaphor for virtual world users seeking to bridge the gap between existing knowledge and new knowledge. Proposition P6 therefore states that

> **[P6] Knowledge creation capacity (stemming from prior related knowledge) positively affects the creation of meta-declarative knowledge in virtual worlds**

This analysis calls into question the traditional conceptualization of memory in terms of recoding, storing and retrieving earlier events or objects (Ziemke, 2005). It supports the view that memory is constructive, anticipatory, and "inseparably embedded in cognitive processes" (Ziemke, 2005, p. 122). In this view, memory is "an indispensable part of cognition" (Riegler, 2005, p. 92) and has the remarkable property of both hindsight and foresight (Von Foerster, 1969). This analysis suggests that prior related knowledge is the starting point for the "wild ideas" (Osborn, 1963) that lead to creativity and innovation. The significance of metaphor, in this context, is that it exposes the "horizon of contextual meaning" (Gueldenberg and Helting, 2002, p. 107) that is derived from prior related experience and which is used in everyday life to make sense of the world. This suggests that *users and user communities in virtual worlds should therefore leverage prior related knowledge in so far as possible and consciously explore virtual worlds as metaphors in order to facilitate the gradual unravelling of the potential and limitations of virtual worlds*.

5.4.2 Procedural knowledge creation outcomes

The purpose of this section is to present an analysis of procedural knowledge creation outcomes in the study. The section first summarises procedural knowledge creation outcomes in the cases, revealing that procedural knowledge creation outcomes were modest in the cases (and were lower than declarative knowledge creation outcomes). The analysis attempts to explain this observation by suggesting that procedural knowledge creation is difficult in virtual worlds and that as a result, there is a trade-off between procedural knowledge creation at the individual level and procedural knowledge creation at the team level (Section 5.4.2.1). The section also introduces an emergent construct: meta-procedural knowledge and suggests that it is important for knowledge creation in virtual worlds (Section 5.4.2.2).

Table 5.7 presents the analysis of procedural knowledge creation outcomes. The cases are listed in the columns of the table and the individuals within each case are listed in the rows [31]. Procedural knowledge creation outcomes were evaluated by the researcher as either 'high' or 'low' based on analysing the relevant data codes and the case summaries created during analysis.

TABLE 5.7 CROSS CASE ANALYSIS: PROCEDURAL KNOWLEDGE CREATION OUTCOMES

	FOB	EXT	RIT	GLA	MZO	LOY
FOR THE FACILITATOR (*.FAC)	HIGH	LOW	LOW	LOW	HIGH	HIGH
FOR THE DEVELOPER (*.DEV)	LOW	HIGH	LOW	HIGH	HIGH	HIGH
FOR THE EDUCATOR (*.EDU)	LOW	LOW	HIGH	HIGH	LOW	LOW

The table shows that procedural knowledge creation outcomes were modest across the cases. In addition, the table also shows that procedural knowledge creation outcomes were higher for developers than for educators or project facilitators.

[31] The naming convention used to uniquely identify study participants is outlined in Section 4.5.2.3

5.4.2.1 Highlighting the difficulty of creating procedural knowledge

The analysis presented in this section highlights the particular need to create procedural knowledge in virtual worlds but reveals that procedural knowledge creation can be difficult and time consuming (even in a virtual world). As a result, there is a trade-off between procedural knowledge creation at the individual level and procedural knowledge creation at the team level in the study.

Several participants underlined *the need to create procedural knowledge in order to use Second Life effectively*. L.FAC believes that

> it's better to develop the skills ourselves so we can do excellent work

At GLA, there is also a strong emphasis on developing the skills necessary to effectively use Second Life. At RIT, it was only by grappling with Second Life's scripting language that a nuanced understanding of the extents of its capabilities (and its limitations) emerged. Similarly, G.DEV explains that it can be difficult to "get involved in the ideas of virtual worlds" when people "don't have the time or the interest or the skill… [when] they struggle with the technology". According to G.FAC, educators must learn to use Second Life fully if they are to realise the benefits of it and its complex suite of functionality. She likens this to those who fail to grapple with Blackboard and simply use it as a repository for information rather than as a learning support tool.

Further, participants argued that *Second Life facilitates the creation of procedural knowledge.* For example, F.FAC argued that anyone can "come in [to Second Life] regardless of skill" and "actually create something wonderful". Similarly, L.FAC indicated that their project had "obviously demonstrated" that people can learn "certain skills very effectively in a virtual world and those skills translate into a real world testing situation" (L.FAC). In fact, many of these educational projects were specifically designed to teach real world skills to students. For example, the project at LOY was designed to teach students how to police a border; the project at GLA was designed to teach nurses how to take patient histories and select and undertake physical examinations in real life; and the project at RIT was designed to teach students computer animation skills.

However, *procedural knowledge creation is difficult and time consuming (even in virtual worlds).* Second Life is difficult to master (E.FAC; M.FAC) and there is a very steep learning curve associated with learning how to use Second Life. Participants (e.g. E.FAC and F.FAC) spoke in terms of *years* when describing the amount of time it took to become expert. For example, F.FAC explained that

> I took a year to become extremely comfortable with all aspects of Second Life in terms of networking, community building and intermediate level design skills. I'd say it took another year for me to work on a number of small projects that allowed me to develop far more advanced, complex design skills in collaboration with others.

For this reason, E.FAC argues that

> the people who understand Second Life and have been in here have a real appreciation for how much work and effort it takes to become very knowledgeable in here

A deeper analysis reveals that *there is a trade-off between procedural knowledge creation at the individual level and procedural knowledge creation at the team level*. If teams adopted an individualistic approach to projects, particular individuals in those teams would succeed in developing high levels of procedural knowledge. If teams adopted collaborative approaches to projects, the teams themselves would develop high levels of procedural knowledge (but individuals within those teams would not). Each of these points is illustrated in turn.

Where procedural knowledge creation outcomes were lowest (FOB, EXT, RIT), teams traded off procedural knowledge creation at the individual level in order to achieve the goals of the project as efficiently as possible. In these cases, individualistic approaches were used and individual procedural knowledge creation outcomes were reduced. In these cases, one particular individual was more centrally involved in the project than the others. At EXT, E.DEV explains that he was very consciously and deliberately seeking to develop his own skills from the outset. He continually seeks out better and faster ways to complete his tasks. He explains that he never completes a given task in the same way twice and

is therefore continually challenged by his role[32]. Similarly at RIT, R.EDU developed significant skills with regard to how Second Life's scripting language could be utilised to create the educational materials he needed for his class of animation students.

Conversely, where procedural knowledge creation outcomes were highest (GLA, MZO, and LOY), collaborative approaches were used. In these cases, teams worked in a collaborative and communicative fashion. Regular, informal co-operative interactions were typical at GLA so that everyone stayed "in the loop" (G.EDU). As a result, knowledge creation outcomes were synergistic: each person discovered different things but "between us as a group, a community, we learned much more" (G.FAC). At LOY, L.FAC explains that the team originally set out to "understand the skill sets we would require" and then "perfected those skills" over a period of six months. The team can solve most new problems internally as it was designed to be "self contained" (L.FAC) and self reliant.

5.4.2.2 Meta-procedural knowledge and its role in knowledge creation

The analysis presented in this section suggests that *meta-procedural knowledge plays an important role in terms of facilitating knowledge creation in virtual worlds*. Meta-procedural knowledge is defined in this study as *knowledge about procedural knowledge*. The concept of meta-procedural knowledge is similar to Kuhn's (1999) concept of "meta strategic knowing" and to the concept of "knowing whether" (Hart *et al.,* 2001).

The concept of meta-procedural knowledge is suggested by a number of observations made by study participants during the study. First, a number of participants argued that they could easily leverage their existing skills to "break new ground" (F.FAC) in Second Life even where these skills were not directly relevant or obviously applicable to Second Life. For example, F.DEV explains

[32] The actual educational exhibits at EXT's Second Life island are a physical manifestation of this procedural knowledge creation: if one walks through the project in Second Life in the order in which the three components of the project were constructed, it is possible to discern the increased technical complexity and sophistication in the content that has been created

that he has been able to utilise his own "pretty set method for doing development projects". E.DEV also explains that if he needs to do something new in Second Life, he already knows how to go about it because of his previous experience both in Second Life and working as a developer. In other words, even if something quite new is being attempted, these individuals know how to approach the problem. Second, meta-procedural knowledge enabled study participants to better evaluate the technical feasibility of new ideas in advance of implementing them. R.FAC explained that this was true at RIT and it was also true at GLA, where the team has learned "how to operate" or "how to act or not act" (G.FAC). These observations suggest that *the process of procedural knowledge creation gets easier over time as the creation of meta-procedural knowledge gradually facilitates the performance of individuals and groups in terms of project implementation*. Proposition P7 therefore states that

[P7] Meta-procedural knowledge positively affects procedural knowledge creation outcomes in virtual worlds

5.4.3 An integrative analysis of knowledge creation outcomes

The purpose of this section is to compare and contrast declarative and procedural knowledge creation outcomes in the cases. The need for this analysis arises from the analysis of the data which suggests that declarative and procedural knwoeldge creation outcomes are related. The analysis considers knowledge creation outcomes across cases and roles in turn.

In relation to ***knowledge creation outcomes across cases***, Table 5.8 juxtaposes declarative knowledge creation outcomes (on the horizontal axis) and procedural knowledge creation outcomes (on the vertical axis) [33]. Each cell is numbered (Cell 1, 2, 3 and 4) and contains a grid. Each grid plots the 6 cases (FOB, EXT, RIT, GLA, MZO and LOY) on the horizontal axis against each of the 4 roles (FAC, DEV, EDU) on the vertical axis. Using this layout, it is possible to distinguish (i) declarative knowledge creation outcomes and (ii) procedural knowledge creation outcomes for each individual in the study. For example, Cell 1 shows that only one individual in the study reported low levels of declarative knowledge creation outcomes together with high levels of procedural knowledge creation outcomes.

TABLE 5.8 KNOWLEDGE CREATION OUTCOMES (across CASES)

	Low Declarative K.C. Outcome	**High Declarative K.C. Outcome**
High Procedural K.C. Outcome	FOB EXT RIT GLA MZO LOY FAC: ☑ ☐ ☐ ☐ ☐ ☐ DEV: ☐ ☐ ☐ ☐ ☐ ☐ EDU: ☐ ☐ ☐ ☐ ☐ ☐ (Cell 1)	FOB EXT RIT GLA MZO LOY FAC: ☐ ☐ ☐ ☐ ☑ ☑ DEV: ☐ ☑ ☐ ☑ ☑ ☑ EDU: ☐ ☐ ☑ ☑ ☐ ☐ (Cell 2)
Low Procedural K.C Outcome	FOB EXT RIT GLA MZO LOY FAC: ☐ ☐ ☑ ☑ ☐ ☐ DEV: ☑ ☐ ☐ ☐ ☐ ☐ EDU: ☐ ☐ ☐ ☐ ☐ ☐ (Cell 3)	FOB EXT RIT GLA MZO LOY FAC: ☐ ☑ ☐ ☐ ☐ ☐ DEV: ☐ ☐ ☑ ☐ ☐ ☐ EDU: ☑ ☑ ☐ ☐ ☑ ☑ (Cell 4)

[33] The naming convention used to uniquely identify study participants is outlined in Section 4.5.2.3

In the first instance, the table shows that *declarative knowledge creation outcomes were substantially higher than procedural knowledge creation outcomes across all cases*. More specifically (taking Cells 1 and 2 together), procedural knowledge creation outcomes were high in 9 instances and (taking Cells 2 and 4 together) declarative knowledge creation outcomes were high in 14 instances. Taken together, the analyses presented in Sections 5.4.1 and 5.4.2 indicate that it is easier and quicker to create new declarative knowledge than to create new procedural knowledge.

The table reveals that there is some degree of complementarity regarding procedural and declarative knowledge creation outcomes. First, the table does show that there is a level of consistency between declarative and procedural knowledge creation outcomes. This can be seen by comparing Cells 1 and 4 with Cells 2 and 3 in the table. This shows that 11 individuals reported the same level of knowledge creation outcomes across both types of knowledge (Cells 2 and 3) but that only 7 individuals reported mixed knowledge creation outcomes across both types of knowledge (Cells 1 and 4). Looking more closely at those individuals who reported mixed knowledge creation outcomes (Cells 1 and 4), in 6 of those 7 instances, declarative knowledge creation outcomes were high and procedural knowledge creation outcomes were low. This suggests that there is an association between declarative and procedural knowledge creation outcomes. Proposition 8 therefore states that

> **[P8] It is possible to create new declarative knowledge without creating substantial levels of procedural knowledge in virtual worlds**

Further, Proposition 9 states that

> **[P9] It is difficult to create high levels of procedural knowledge without creating high levels of declarative knowledge in virtual worlds**

In relation to ***knowledge creation outcomes across roles***, Table 5.9 individuals' knowledge creation outcomes summarised according to role. On the horizontal axis, the table lists declarative and procedural knowledge creation outcomes. On the vertical axis, the table lists roles within projects on the vertical axis. Each of the cells in the matrix can contain a maximum value of six (as six individuals in each role were interviewed in the study).

TABLE 5.9 KNOWLEDGE CREATION OUTCOMES (across ROLES)

ROLE	HIGH Declarative K.C. Outcomes	HIGH Procedural K.C. Outcomes
Facilitator (n=6)	3	3
Developer (n=6)	5	4
Educator (n=6)	6	2

The table reveals that (i) developers' knowledge creation outcomes were higher than any other group; (ii) project facilitators reported evenly balanced knowledge creation outcomes; and (iii) there were stark differences between educators' declarative knowledge creation outcomes and procedural knowledge creation outcomes. The discussion focuses on developers' and educators' knowledge creation outcomes in turn.

Focusing on developers, Table 5.9 shows that both declarative and procedural knowledge creation outcomes were high for developers. In fact, developers' knowledge creation outcomes were higher than any other group. This success appears to be driven by the fact that *the creation of procedural knowledge is a high priority for developers*. G.DEV explained that from his perspective each project was "technologically driven" and primarily motivated by a desire to identify and select the most suitable approach for a given technical challenge given the affordances of different pieces of software available to him. Through his role at GLA, he was now "as far advanced" as he could be. This theme also emerged at LOY, where L.DEV explained that he was inspired by talented Second Life content creators who could create effects in Second Life that the platform did not itself support. They could "fake it", he said. At LOY, the team would deconstruct and reconstruct impressive Second Life artefacts in order to discover how they had been created. L.DEV said that this was possibly the "most fun" thing that they did in order to boost their own skills.

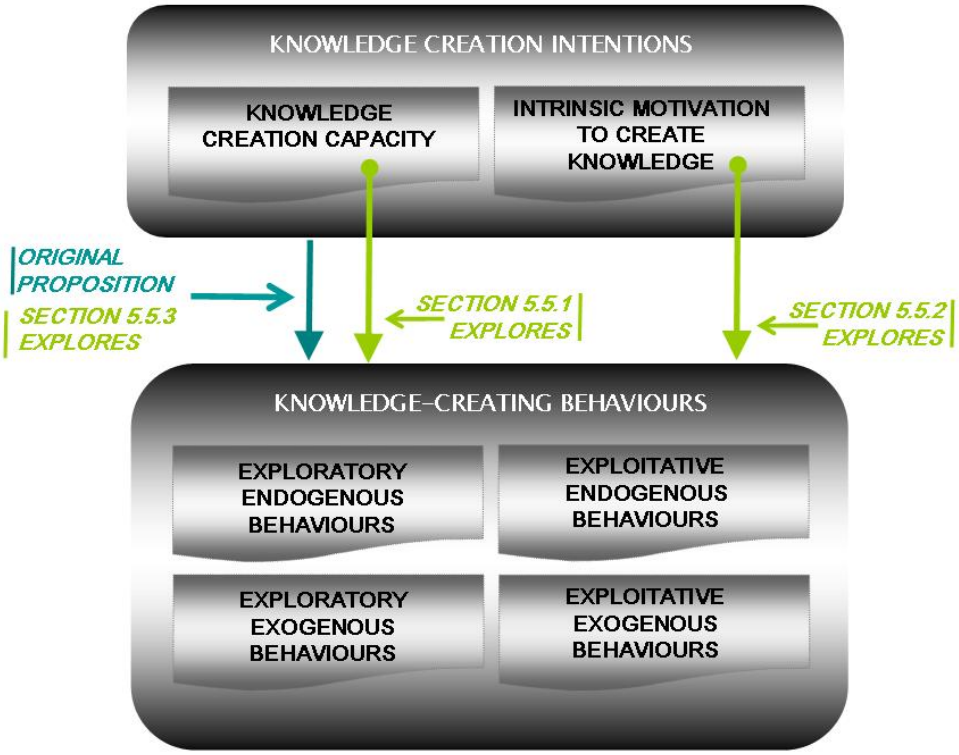
Focusing on educators, Table 5.9 shows that educators' perceived *declarative* knowledge creation appears to be higher than any other group. This finding may be attributed to the fact that educators had the least amount of knowledge creation capacity (stemming from prior related knowledge) to each of the projects they were involved in (cf. Section 5.2). Thus, the "starting point" of educators was not as advanced as their peers' and they therefore perceived that their own declarative knowledge had changed far more dramatically than their colleagues' did. However, the analysis also suggests that *the creation of declarative knowledge is a high priority for educators*. G.FAC explains that whilst educators must immerse themselves in Second Life, it is *more* important for educators to understand how to conceputalise "decent learning scenarios" (G.FAC) than to know how to implement them. At RIT, R.DEV explains that the RIT team does not ordinarily encourage educators to acquire *any* skills regarding Second Life except those that are necessary in order to effectively communicate and interact with students in the virtual world. At the same time, the team acknoweldges that their success thus far has largely been due to the quality of the ideas brought to them by educators. In other words, the team relies on educators to develop the understanding of how to educate in a virtual world – the meta declarative knowledge, so to speak – but does not encourage educators to work in the world.

At the same time, the table indicates that educators' *procedural* knowledge creation outcomes were lower than any other group. This may be explained by the fact that most educators felt that the creation of procedural knowledge in virtual worlds was difficult. Educators argued that Second Life's learning curve was problematically steep. In the two instances where educators reported high procedural knowledge creation outcomes, they had come from technical backgrounds and therefore did not feel that Second Life was technically difficult. In fact, G.DEV suggests that G.EDU was exceptional in terms of the extent to which she had understood what Second Life was capable of and notes that others struggle to see its potential, possibly he says, because they lack the technical skill to fully grasp it in the first place.

5.5 Knowledge creation intentions and knowledge-creating behaviours

The purpose of this section is to examine the preliminary framework's proposition that knowledge creation intentions affect knowledge-creating behaviours. Figure 5.12 recalls this proposition from Section 4.3 but shows the revised classification of knowledge-creating behaviours that emerges in Section 5.3.

FIGURE 5.12 Knowledge Creation Intentions And Knowledge-Creating Behaviours



K.C. Intentions	Behavioural intentions to create (declarative and/or procedural) knowledge
K.C. Capacity	Capability to create new knowledge stemming from prior related knowledge
K.C. Intrinsic motivation	An internal or authentic motivation to create knowledge
K.C. Behaviours	Behaviours which are taken in an attempt to create new knowledge
Exploratory endogenous behaviours:	Taken to create knowledge that is substantively different from existing knowledge and are carried out internally within the team or within the team's location in Second Life
Exploratory exogenous behaviours:	Taken in an attempt to create knowledge that is substantively different from existing knowledge and are carried out externally of the team or outside the team's location in Second Life
Exploitative endogenous behaviours:	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out internally within the team or within the team's location in Second Life
Exploitative exogenous behaviours:	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out externally of the team or outside the team's location in Second Life

In total, three line charts are used in this section. These charts leverage the data from previous sections of this chapter by presenting graphical summaries of particular 'slices' of it (cf. Table 5.3 and Table 5.5). Table 5.10 describes each line chart used in this section and explains how the data is clustered in each chart. For example, the table reveals that Figure 5.13 is *focused on* the association between intrinsic motivation to create knowledge and knowledge-creating behaviours and therefore *clusters* the data (on knowledge-creating behaviours) at the level of the individual *according to* intrinsic motivation to create knowledge.

TABLE 5.10 OVERVIEW OF ANALYSIS PRESENTED IN FIGURES 5.12-5.14

Figure	Is focused on…	Clusters…	According to…
Fig 5.12	The association between knowledge creation capacity (stemming from prior related knowledge) and knowledge-creating behaviours	Individuals	Knowledge creation capacity (stemming from prior related knowledge) ONLY
Fig 5.13	The association between intrinsic motivation to create knowledge and knowledge-creating behaviours	Individuals	Intrinsic motivation to create knowledge ONLY
Fig 5.14	The association between knowledge creation intentions and knowledge-creating behaviours	Individuals	Knowledge creation intentions (i.e. intrinsic motivation to create knowledge AND knowledge creation capacity)

5.5.1 The effect of knowledge creation capacity

The analysis presented in this section leverages Figure 5.13 in order to determine if *knowledge creation capacity affects knowledge-creating behaviours*. Figure 5.12 groups individuals according to their levels of knowledge creation capacity. The two lines in the figure show knowledge-creating behaviours for the two groups of individuals. The figure uses the classification of knowledge-creating behaviours presented in Section 5.3. As a result, each line is based on four data points (one data point for each of the four types of knowledge-creating behaviour in the classification)[34]. The green line shows knowledge-creating behaviours for thirteen individuals (n=13) who reported high levels of knowledge creation capacity. The red line shows knowledge-creating behaviours for five individuals (n=5) who reported low levels of knowledge creation capacity.

[34] The actual numerical values represented in the figure are provided in Appendix D. The appendix also clearly explains why the figure does not expressly include a scale on the Y axis.

FIGURE 5.13 Knowledge Creation Capacity: effect on Knowledge-Creating Behaviours

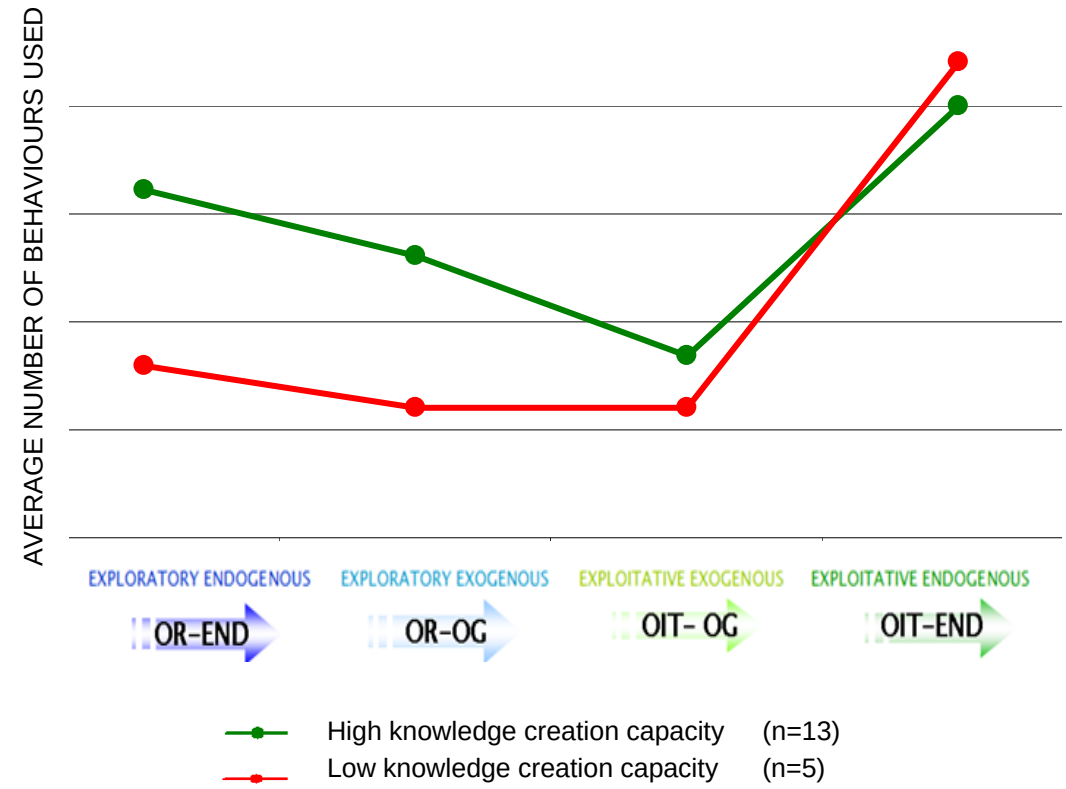


Figure 5.13 indicates that the green line is again 'higher' than the red line for all four types of knowledge-creating behaviour. This suggests that knowledge creation capacity (stemming from prior related knowledge) is positively associated with the number of knowledge-creating behaviours used in the cases. That is to say, individuals with high levels of prior related knowledge engaged in more kinds of knowledge-creating behaviours than individuals with lower levels of prior related knowledge. It is not intuitive that those who have the *most* experience and knowledge to draw upon in carrying out their projects would engage in *more* knowledge-creating behaviours than their more inexperienced counterparts. However, the analysis in Section 5.3 suggests that prior related knowledge (and procedural knowledge in particular) was important in terms of empowering individuals to utilise knowledge-creating behaviours in Second Life. This was because it is difficult to create procedural knowledge (knowledge about how to do things) in Second Life. This finding can be stated as follows:

> **[P10] Knowledge creation capacity positively affects the number of knowledge-creating behaviours used in virtual worlds**

One of the implications of this finding is that inexperienced virtual world users should ensure that they acquire sufficient procedural knowledge about Second Life in order to be able to work effectively (and to utilise knowledge-creating behaviours) within it.

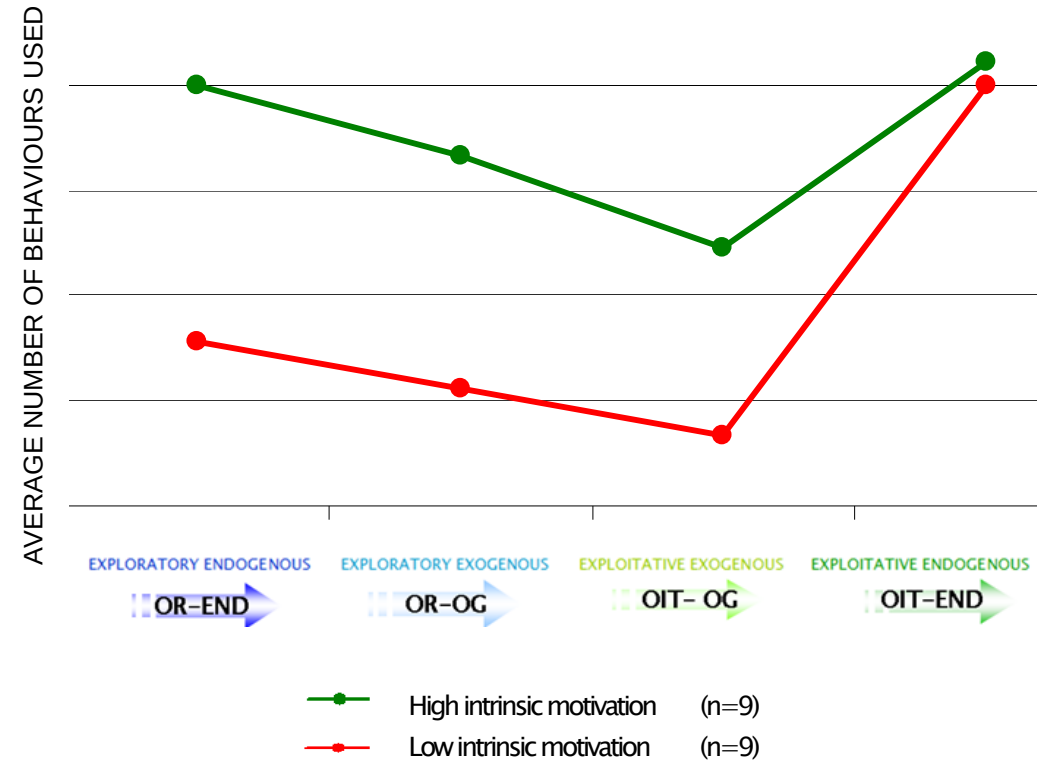
The green and red lines in Figure 5.13 also share approximately the same overall 'shape'. This suggests that knowledge creation capacity is not associated with the configuration of knowledge-creating behaviours used in the cases. In other words, individuals used a similar configuration of knowledge-creating behaviours irrespective of levels of knowledge creation capacity. This interpretation is supported by the analysis in Section 5.3, which indicates that the configuration of knowledge-creating behaviours used reflects differences in the amount of effort (rather than skill) required for the various knowledge-creating behaviours. Finding F1 states that

> *F1 Knowledge creation capacity does not affect the configuration of knowledge-creating behaviours used*

5.5.2 *The effect of intrinsic motivation to create knowledge*

The analysis in this section uses Figure 5.14 to investigate the effect of *intrinsic motivation to create knowledge on knowledge-creating behaviours*. Figure 5.14 groups individuals according to intrinsic motivation to create knowledge (classified by the researcher as 'high' or 'low'). The figure contains two lines each of which represents the knowledge-creating behaviours used by one of the groups (of individuals). The figure uses the classification of knowledge-creating behaviours presented in Section 5.3. Thus, each line is based on four data points (one data point for each of the four types of knowledge-creating behaviour in the classification)[35]. The green line shows knowledge-creating behaviours for nine individuals (n=9) who had high levels of intrinsic motivation to create knowledge. The red line shows knowledge-creating behaviours for nine individuals (n=9) who had low levels of intrinsic motivation to create knowledge.

FIGURE 5.14 Intrinsic knowledge creation motivation: effect on knowledge-creating behaviours



[35] The actual numerical values represented in the figure are provided in Appendix D. The appendix also clearly explains why the figure does not expressly include a scale on the Y axis.

Figure 5.14 indicates that the green line is 'higher' than the red line for all four types of knowledge-creating behaviour. This means that intrinsic motivation to create knowledge is positively associated with the number of knowledge-creating behaviours used in the cases. That is to say, highly motivated individuals engaged in more knowledge-creating behaviours than individuals with lower levels of intrinsic motivation to create knowledge. The analysis in Section 5.3 suggests that study participants frequently cited time constraints in terms of explaining why they did not engage in particular knowledge-creating behaviours. Therefore, it appears that highly motivated individuals are willing to "go the extra mile" in terms of investing their time and energy in knowledge-creating behaviours in Second Life. Proposition P11 states that

> **[P11] Intrinsic motivation to create knowledge positively affects the number of knowledge-creating behaviours used in virtual worlds**

The green and red lines in Figure 5.14 also share the same overall 'shape'. This means that the arrangement or form or pattern of knowledge-creating behaviours is similar in the two groups of individuals (i.e. regardless of levels of intrinsic motivation to create knowledge). That is to say, individuals used a similar 'configuration' of knowledge-creating behaviours irrespective of levels of intrinsic motivation. It appears that the configuration of knowledge-creating behaviours used in the cases is primarily a reflection of the amount of effort required to use different types of knowledge-creating behaviours. This is because the overall shape of the lines is commensurate with the analysis presented in Section 5.3. This analysis showed that exploitative exogenous (OIT-OG) behaviours were difficult to achieve (these behaviours are especially low for individuals with low levels of motivation) and exploitative endogenous (OIT-END) behaviours were found to be most easy to achieve (these behaviours are especially high for individuals with high levels of motivation). Finding F2 states that

> *F2 Intrinsic motivation to create knowledge does not affect the configuration of knowledge-creating behaviours used*

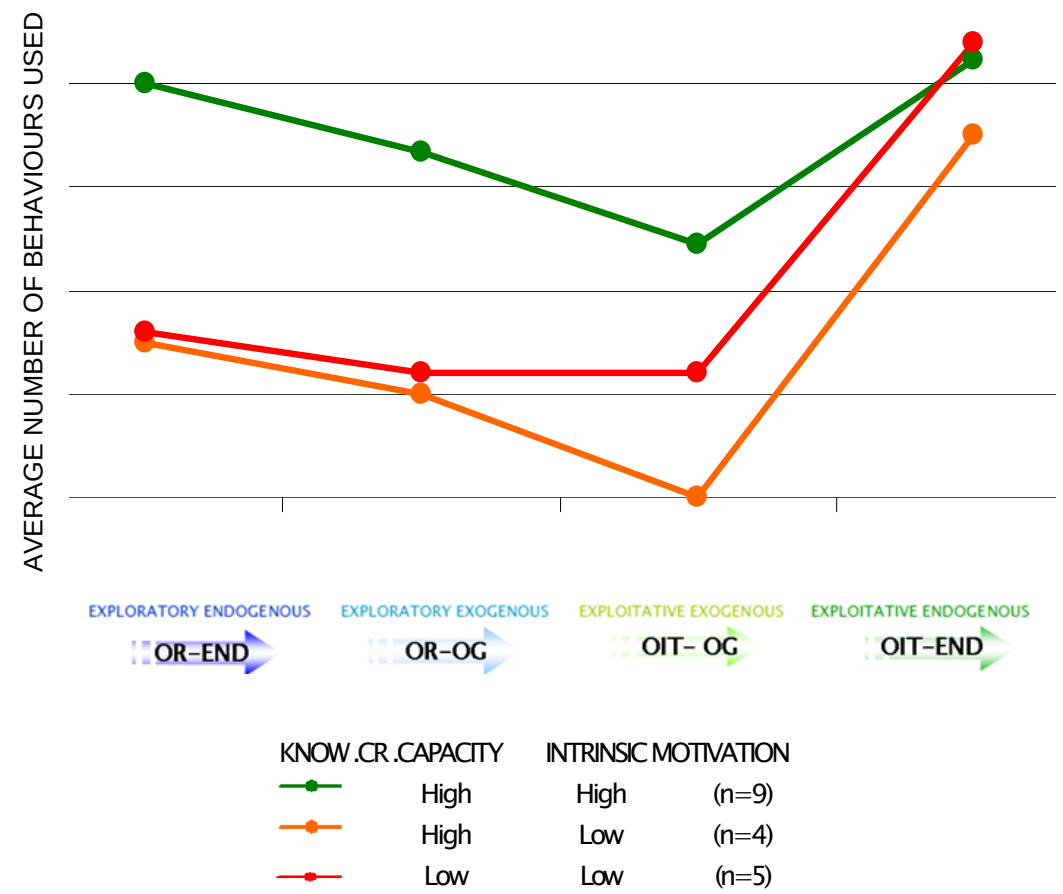
5.5.3 Examining the effect of knowledge creation intentions

The analysis presented in this section leverages Figure 5.15 in order to determine if *knowledge creation intentions affect knowledge-creating behaviours* in Second Life. The figure considers the influence of both (i) intrinsic motivation to create knowledge and (ii) knowledge creation capacity (stemming from prior related knowledge) on knowledge-creating behaviours in the cases. The rationale for this stems from the fact that the analysis presented in Section 5.3 reveals that there may be an association between knowledge creation capacity and intrinsic motivation to create knowledge.

Figure 5.15 clusters individuals' knowledge-creating behaviours according to their knowledge creation intentions. The figure uses the classification of knowledge-creating behaviours presented in Section 5.3. Each line is based on four data points (one data point for each of the four types of knowledge-creating behaviour in the classification)[36]. The green line represents the knowledge-creating behaviours of the first cluster, where nine individuals (n=9) reported high levels of intrinsic motivation to create knowledge and high levels of knowledge creation capacity. The orange line represents the knowledge-creating behaviours of the second cluster, where four individuals (n=4) reported low levels of intrinsic motivation to create knowledge and high levels of knowledge creation capacity. The red line represents the knowledge-creating behaviours of the third cluster, where five individuals (n=5) reported low levels of intrinsic motivation to create knowledge and low levels of knowledge creation capacity.

[36] The actual numerical values represented in the figure are provided in Appendix D. The appendix also clearly explains why the figure does not expressly include a scale on the Y axis.

FIGURE 5.15 Effect Of Knowledge Creation Intentions On Knowledge-Creating Behaviours



The most interesting observation about Figure 5.15 is the fact that the green and orange lines are virtually identical in shape. This reveals that individuals with more prior related knowledge used the same basic configuration of knowledge-creating behaviours but used less knowledge-creating behaviours within each category. Further, this trend was true regardless of individuals' levels of intrinsic motivation to create knowledge. This observation suggests that experienced Second Life users understood how to go about creating knowledge in Second Life. This interpretation is supported by the analysis presented in Section 5.3 which suggests that study participants benefited from drawing upon meta-procedural knowledge. Finding F3 states that

> *F3 Experienced Second Life users draw upon 'meta-procedural knowledge' when seeking to create knowledge*

Recalling the analysis presented in Section 5.5.1, it appears that what is manifesting in Figure 5.14 is that experienced individuals who lack an intrinsic

motivation to create knowledge know how to go about creating knowledge in Second Life but are perhaps less willing to "go the extra mile" in terms of using knowledge-creating behaviours.

Conversely, the 'shape' of the red line is at odds with the other lines. In other words, where individuals lacked prior related knowledge, they used a different configuration of knowledge-creating behaviours. Specifically, inexperienced users employed a more balanced range of knowledge-creating behaviours than their more experienced counterparts - irrespective of levels of intrinsic motivation. This suggests that inexperienced Second Life users did not necessarily know how to go about knowledge creation a virtual world and had to invest more energy in knowledge-creating behaviours than other users - irrespective of levels of intrinsic motivation. Finding F4 states that

> *F4 Inexperienced users found it difficult to draw upon 'meta-procedural knowledge' when attempting to creating knowledge in Second Life.*

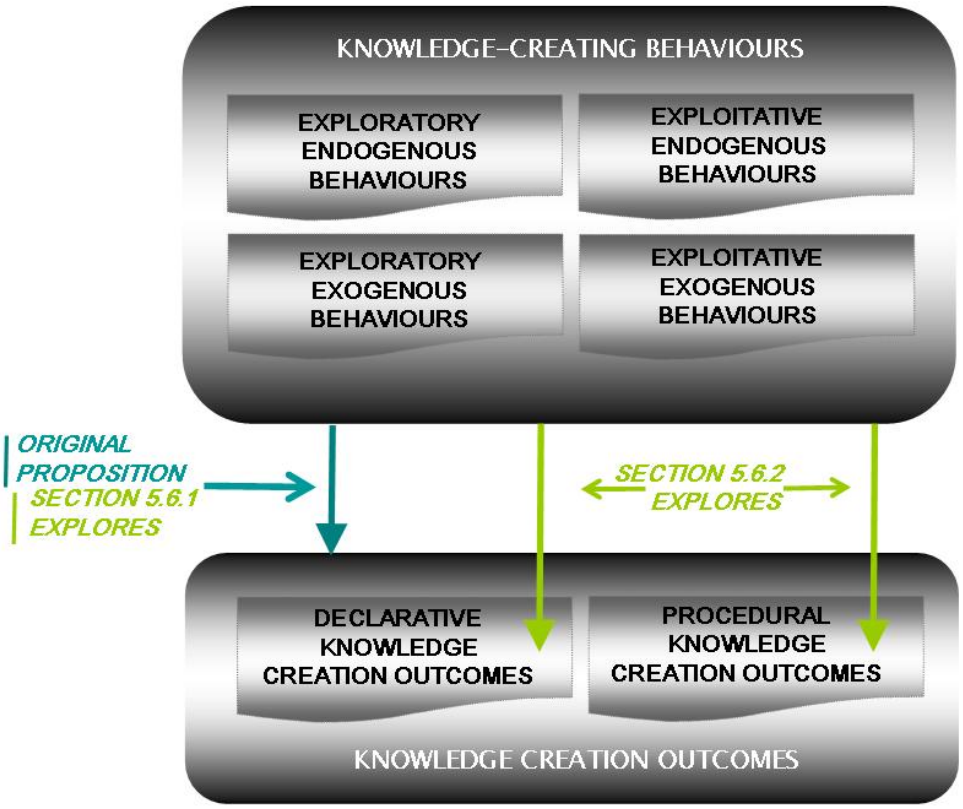
Reviewed together, the line charts have revealed a number of patterns in the data that are not otherwise apparent. The discussion presented in this section has observed a number of these patterns and has attempted to explain these patterns in light of the analysis presented in the first half of the chapter. In addition, the section has revealed a number of additional findings about knowledge-creating behaviours in virtual worlds. Finally, two specific propositions about the association between knowledge creation intentions and knowledge-creating behaviours have been articulated. Table 5.11 summarises the observations, explanations, findings, and propositions that are presented in this section; and also traces some of the attendant implications for virtual world users in terms of knowledge creation.

TABLE 5.11 OVERVIEW OF FINDINGS BASED ON FIGURES 5.12-5.14				
Fig	**Observation**	**Explanation**	**Finding**	**Implication(s)**
5.12	Knowledge creation capacity is positively associated with the number of knowledge-creating behaviours used in the cases	Prior related knowledge is important in terms of enabling individuals to carry out knowledge-creating behaviours in Second Life	*(P7) Knowledge creation capacity positively affects the number of knowledge-creating behaviours used*	Inexperienced virtual world users should acquire sufficient procedural knowledge in order to be able to work effectively in Second Life
	Knowledge creation capacity is not associated with the configuration of knowledge-creating behaviours used in the cases	The configuration of knowledge-creating behaviours used in the cases is primarily a reflection of the amount of effort (rather than skill) required to use different types of knowledge-creating behaviours	(F1) Knowledge creation capacity does not affect the configuration of knowledge-creating behaviours used	Virtual world users should consider the effort required to use different types of knowledge-creating behaviours
5.13	Intrinsic motivation to create knowledge is positively associated with the number of knowledge-creating behaviours used in the cases	Highly motivated individuals are willing to "go the extra mile" in terms of investing their time and energy in knowledge-creating behaviours in Second Life	*(P8) Intrinsic motivation to create knowledge positively affects the number of knowledge-creating behaviours used*	Virtual world teams should contain members who have high levels of intrinsic motivation to create knowledge
	Intrinsic motivation to create knowledge is not associated with the configuration of knowledge-creating behaviours used in the cases	The configuration of knowledge-creating behaviours used in the cases is primarily a reflection of the amount of effort required to use different types of knowledge-creating behaviours	(F2) Intrinsic motivation to create knowledge does not affect the configuration of knowledge-creating behaviours used	Virtual world users should consider the effort required to use different types of knowledge-creating behaviours
5.14	Where individuals had high levels of prior related knowledge, the configuration of knowledge-creating behaviours that they used was consistent - regardless of intrinsic motivation to create knowledge	Experienced individuals who lacked an intrinsic motivation to create knowledge knew how to go about creating knowledge in Second Life but were less willing to "go the extra mile" in terms of engaging in knowledge-creating behaviours in virtual worlds	(F3) Experienced Second Life users draw upon 'meta-procedural knowledge' when seeking to create knowledge	Experienced Second Life users should try to communicate or share their meta-procedural knowledge
	Inexperienced users employed a more balanced range of knowledge-creating behaviours than their more experienced counterparts irrespective of levels of intrinsic motivation	It was necessary for those with less relevant experience to engage in more knowledge-creating behaviours irrespective of levels of intrinsic motivation	(F4) Inexperienced Second Life users struggle to draw upon 'meta-procedural knowledge' when seeking to create knowledge	Inexperienced Second Life users should try to harness the meta-procedural knowledge of more experienced users

5.6 Knowledge-creating behaviours and knowledge creation outcomes

The purpose of this section is to examine the preliminary framework's proposition that knowledge-creating behaviours affect knowledge creation outcomes. Figure 5.16 recalls this proposition from Section 4.3 but shows the revised classification of knowledge-creating behaviours that emerges in Section 5.3.

FIGURE 5.16 Knowledge-Creating Behaviours and Knowledge Creation Outcomes



K.C. Behaviours	Behaviours which are taken in an attempt to create new knowledge
Exploratory endogenous behaviours:	Taken to create knowledge that is substantively different from existing knowledge and are carried out internally within the team or within the team's location in Second Life
Exploratory exogenous behaviours:	Taken in an attempt to create knowledge that is substantively different from existing knowledge and are carried out externally of the team or outside the team's location in Second Life
Exploitative endogenous behaviours:	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out internally within the team or within the team's location in Second Life
Exploitative exogenous behaviours:	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out externally of the team or outside the team's location in Second Life
K.C. Outcomes	Changes in declarative and procedural knowledge frameworks
Declarative K.C. outcomes	Changes in declarative (know-about) knowledge frameworks
Procedural K.C. outcomes	Changes in procedural (know-how) knowledge frameworks

In total, two line charts are used in this section. These charts leverage the data from previous sections of this chapter by presenting graphical summaries of particular 'slices' of it (cf. Table 5.5 and Table 5.8). Figure 5.17 examines the association between knowledge-creating behaviours and four possible knowledge creation outcome configurations. Figure 5.18 also examines this association but considers declarative and procedural knowledge creation outcomes separately.

5.6.1 Examining the effect of knowledge-creating behaviours

Figure 5.17 groups individuals according to their knowledge creation outcomes. In this study, two *types of knowledge creation outcome* were distinguished: declarative knowledge creation outcomes and procedural knowledge creation outcomes. Each type of knowledge creation outcome was evaluated by the researcher as either high or low for each person in the study (using the relevant codes that were generated during data analysis). This means that the figure distinguishes four groups of individuals:

(i) Those who had high procedural outcomes and high declarative outcomes
(ii) Those who had high procedural outcomes and low declarative outcomes
(iii) Those who had low procedural outcomes and high declarative outcomes
(iv) Those who had low procedural outcomes and low declarative outcomes

Each of the four lines in figure represents the knowledge-creating behaviours used by each of the four groups of individuals. The figure uses the classification of knowledge-creating behaviours presented in Section 5.3. As a result, each line is based on four data points (one data point for each of the four types of knowledge-creating behaviour in the classification)[37]. For example, the green line shows knowledge-creating behaviours for eight individuals (n=8) who had high procedural outcomes and high declarative outcomes.

At the outset, it is noted that the figure indicates that one of four possible knowledge creation outcome scenarios (where high procedural knowledge creation outcomes were associated with low declarative knowledge creation

[37] The actual numerical values represented in the figure are provided in Appendix D. The appendix also explains why the figure does not expressly include a scale on the Y axis.

outcomes) only occurred on one occasion. This scenario is represented as a dotted line and is seen as an 'outlier'.

FIGURE 5.17 Effect Of Knowledge-Creating Behaviours on Knowledge Creation Outcomes

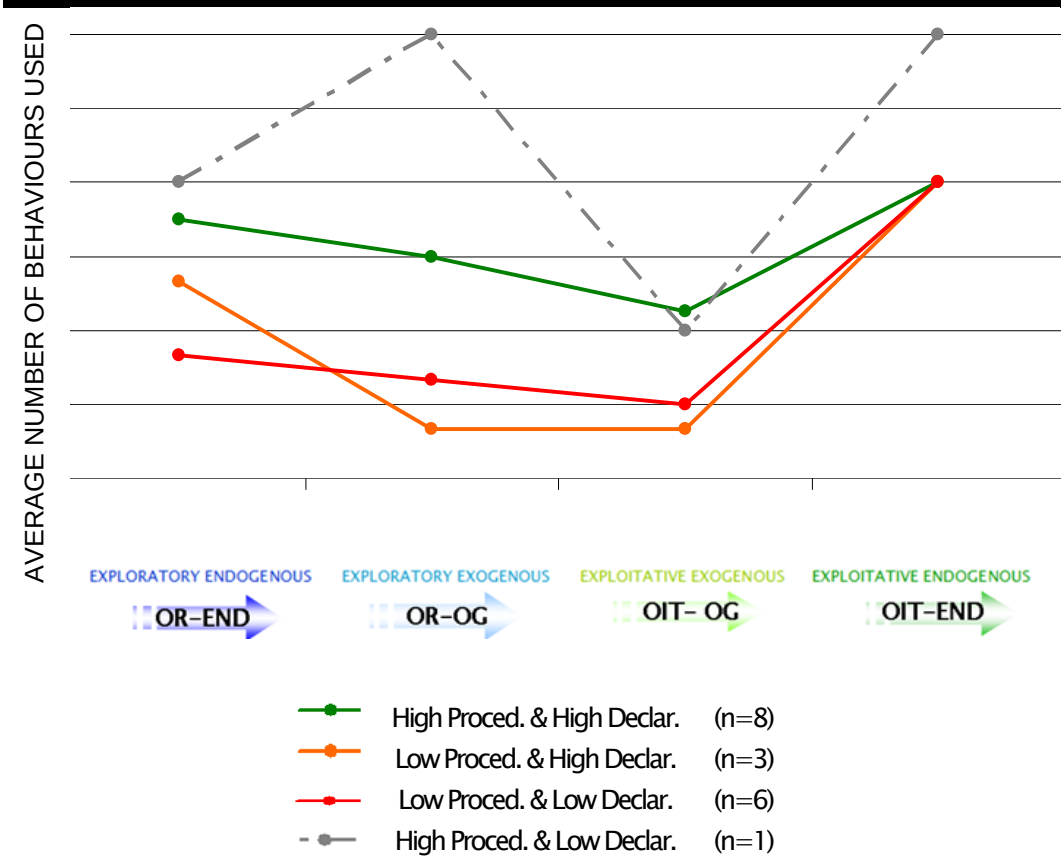


Figure 5.17 indicates that the green line is higher than the red and orange lines. This provides a strong indication that the number of knowledge-creating behaviours used is positively associated with knowledge creation outcomes in the cases. In other words, individuals who engaged in more knowledge-creating behaviours than other individuals had higher knowledge creation outcomes. The analysis suggests that the more time participants invested in virtual worlds, the more knowledge they created. Proposition P12 states that

> **[P12] The number of knowledge-creating behaviours used positively affects knowledge creation outcomes in virtual worlds**

Broadly speaking, the green, orange, and red lines in Figure 5.17 share the same overall 'shape'. This means that the arrangement or form or pattern of knowledge-creating behaviours is similar in the three groups of individuals. That is to say,

differences in knowledge creation outcomes are explained by the number of knowledge-creating behaviours rather than the type of knowledge-creating behaviours used. Finding F5 states that

> *F5The configuration of knowledge-creating behaviours used does not affect knowledge creation outcomes*

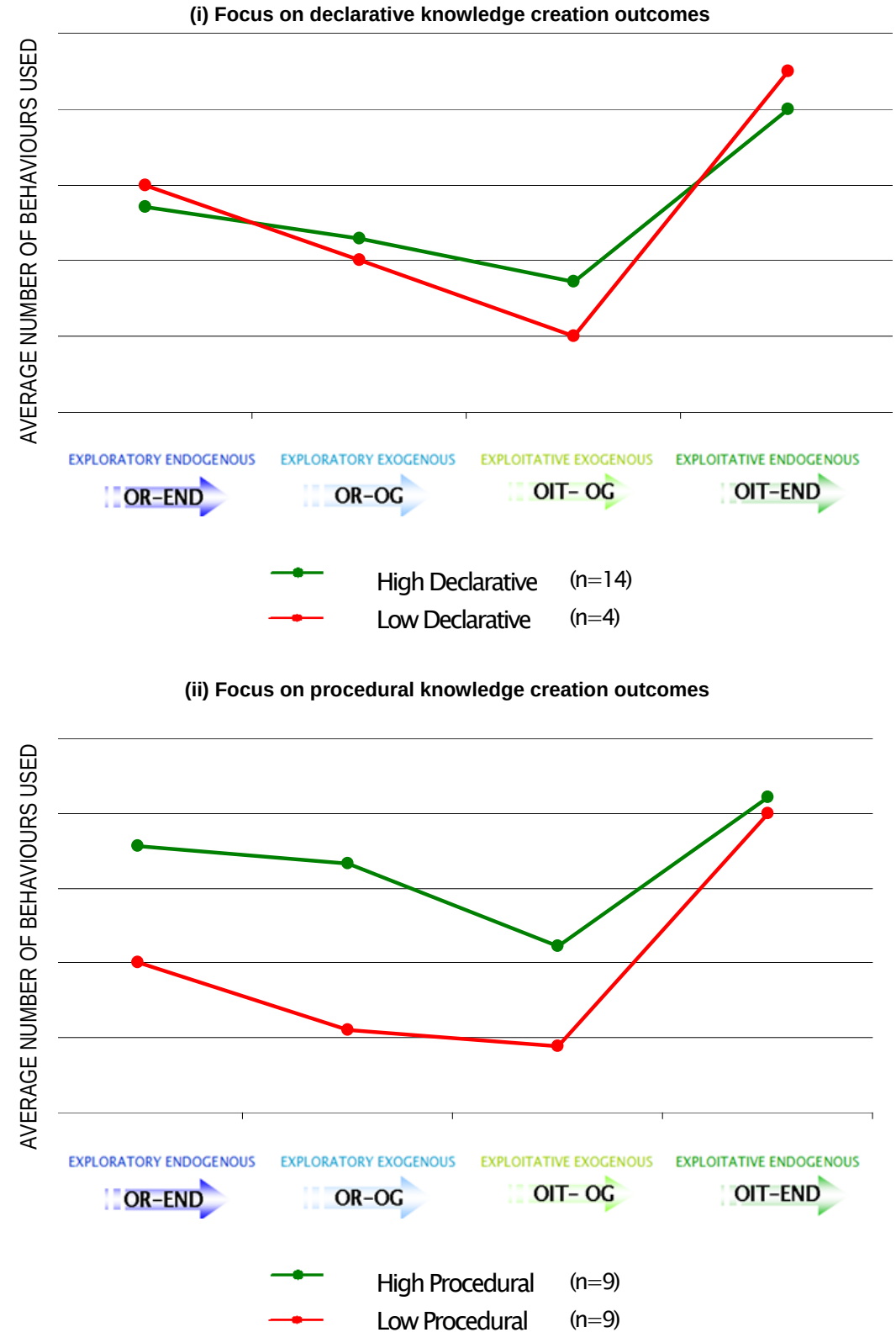
This is important because the analysis presented in Section 5.3 has suggested that some kinds of knowledge-creating behaviours are more difficult in virtual worlds than others. Taken together, these observations suggest that virtual world users seeking to create knowledge should engage in as many knowledge-creating behaviours as possible and should focus on the least difficult or most commonly used types of knowledge-creating behaviour (cf. Table 5.5).

5.6.2 Focusing on declarative and procedural knowledge creation outcomes in turn

The purpose of this section is to probe the association between knowledge-creating behaviours and knowledge creation outcomes more deeply. Having established that the number (but not the configuration) of knowledge-creating behaviours used affects knowledge creation outcomes, this section asks if this association is the same (or different) for declarative and procedural knowledge. To that end, Figure 5.18(i) groups individuals according to declarative knowledge creation outcomes and Figure 5.18(ii) groups individuals according to procedural knowledge creation outcomes. Knowledge creation outcomes in each group were classified by the researcher as either 'high' or 'low'. Therefore both of these figures contain two lines (one of 'high' and one for 'low' outcomes). The lines represent the knowledge-creating behaviours used by one of the groups. The figure uses the classification of knowledge-creating behaviours presented in Section 5.3. As a result, each line is based on four data points (one data point for each of the four types of knowledge-creating behaviour in the classification)[38].

[38] The actual numerical values represented in the figure are provided in Appendix D. The appendix also clearly explains why the figure does not expressly include a scale on the Y axis

FIGURE 5.18
KNOWLEDGE-CREATING BEHAVIOURS: EFFECT ON KNOWLEDGE CREATION OUTCOMES



In Figure 5.18(i), there are *insignificant behavioural differences* between groups with high declarative knowledge creation outcomes and groups with low declarative knowledge creation outcomes. Specifically, both the number and configuration (arrangement or pattern) of knowledge-creating behaviours are similar for both groups of individuals. Conversely, in Figure 5.18(ii) there are *substantial behavioural differences* between groups with high declarative knowledge creation outcomes and groups with low declarative knowledge creation outcomes. Specifically, there are differences in both the number and configuration (arrangement or pattern) of knowledge-creating behaviours for both groups of individuals. In particular, where procedural knowledge creation outcomes are high, there is comparatively less emphasis on exogenous knowledge-creating behaviours. This finding most likely reflects the fact that procedural knowledge creation outcomes were highest amongst developers who expressed a strong desire to work alone to develop skills and problem solve (cf. Section 5.3). Thus, Finding F6 states that

> *F6 The number of knowledge–creating behaviours used has a stronger (positive) effect on procedural knowledge creation than on declarative knowledge creation*

This finding can also be explained in terms of the analysis presented in Section 5.3 which reveals that procedural knowledge creation is more difficult and time consuming than declarative knowledge creation in virtual worlds. The significance of this finding stems from the fact that the analysis presented in Section 5.3 also highlighted the particular need to create procedural knowledge in Second Life in order to be able to use it effectively. This analysis has also suggested that the key to creating procedural knowledge in Second Life is to adopt collaborative rather than individualistic approaches to knowledge creation within teams.

The analysis presented in this section has revealed a number of patterns in the data that are not otherwise apparent. Table 5.12 summarises the observations, explanations, findings, and propositions that are presented in this section; and also traces some of the attendant implications for virtual world users in terms of knowledge creation.

TABLE 5.12 OVERVIEW OF FINDINGS BASED ON FIGURES 5.16-5.17				
Fig	**Observation**	**Explanation**	**Finding / Proposition**	**Implication(s)**
5.16	The number of knowledge-creating behaviours used is positively associated with knowledge creation outcomes in the cases	The more time participants invested in virtual worlds, the more knowledge they created	*(P12) The **number** of knowledge-creating behaviours used positively affects knowledge creation outcomes in virtual worlds*	Virtual world users should use many knowledge-creating behaviours in order to create knowledge
	The configuration of knowledge-creating behaviours used is not associated with differences in knowledge creation outcomes	Differences in knowledge creation outcomes are explained by the number of knowledge-creating behaviours rather than the type of knowledge-creating behaviours used	(F5) The **configuration** of knowledge-creating behaviours used does not affect knowledge creation outcomes	Virtual world users should engage in as many knowledge-creating behaviours as possible and to focus on the least difficult types of knowledge-creating behaviour
5.17	Behavioural differences were less pronounced for declarative knowledge creation outcomes than for procedural knowledge creation outcomes	Procedural knowledge creation is necessary in order to use Second Life effectively but is also more difficult and time consuming to create than declarative knowledge in virtual worlds	(F6) The number of knowledge-creating behaviours used has a stronger (positive) effect on procedural knowledge creation than on declarative knowledge creation	Virtual world users should adopt collaborative rather than individualistic approaches to knowledge creation within teams

5.7 Knowledge creation intentions and knowledge creation outcomes

This section investigates the emergent proposition that *knowledge creation intentions affect knowledge-creating behaviours*. The justification for investigating this proposition lies directly in the observations of study participants and in the analysis presented in the preceding sections of this chapter.

Anecdotally, study participants held that there was a direct connection between prior related knowledge and idea creation. For example, L.FAC explains that whilst it is easy to quickly "emulate great projects" in Second Life, if you wish to

> invent something new… you have to understand how the environment works and account for everything that's come before you. You need to know the script before you can break away from it

Similarly, E.EDU sees a clear association between prior related knowledge and idea creation. He observes that as E.FAC and E.DEV participate in projects, they are able to "see different ideas"; are "absolutely become more creative"; and become "much more effective and efficient" in the design of educational exhibits.

Further, the analysis suggests that knowledge creation capability (stemming from prior related knowledge) directly affects knowledge creation outcomes. For example, the analysis in Section 5.2 suggests that comfort (arising out of prior related knowledge of Second Life) is necessary in order to enable knowledge creation to take place. Similarly, the analysis in Section 5.4 suggests that meta-declarative and meta-procedural knowledge (which are created with reference to prior related knowledge) facilitate knowledge creation.

Table 5.13 is used to structure the analysis. The table groups individuals according to knowledge creation outcomes. In this study, two *types of knowledge creation outcome* were distinguished: declarative knowledge creation outcomes and procedural knowledge creation outcomes. In addition, each type of knowledge creation outcome was evaluated as either high or low for each person in the study. This means that the figure distinguishes four groups of individuals:

(i) Those who had high procedural outcomes and high declarative outcomes

(ii) Those who had high procedural outcomes and low declarative outcomes

(iii) Those who had low procedural outcomes and high declarative outcomes

(iv) Those who had low procedural outcomes and low declarative outcomes

The table considers the knowledge creation capacity (third column) and intrinsic motivation to create knowledge (fourth column) for each group of individuals.

TABLE 5.13 KNOWLEDGE CREATION INTENTIONS IN EACH K.C. OUTCOME SCENARIO

KNOWLEDGE CREATION OUTCOMES	N	KNOWLEDGE CR. CAP	INTRIN. MOTIV.
1. Hi DECLARATIVE - Hi PROCEDURAL	8	7 Hi (1 Lo)	7 Hi (1 Lo)
2. Hi PROCEDURAL – Lo DECLARATIVE	1	1 Hi (0 Lo)	1 Hi (0 Lo)
3. Lo PROCEDURAL – Hi DECLARATIVE	6	2 Hi (4 Lo)	0 Hi (6 Lo)
4. Lo PROCEDURAL – Lo DECLARATIVE	3	3 Hi (0 Lo)	1 Hi (2 Lo)

The table reveals that where knowledge creation outcomes were highest, knowledge creation capacity and intrinsic motivation were also highest. Further, low levels of intrinsic motivation were strongly associated with low procedural knowledge creation outcomes (cf. rows 3 and 4). This supports, at a high level, the emergent proposition that there is an association between knowledge creation intentions and knowledge creation outcomes.

An algorithmic approach was used to analyse Table 5.13 in more detail. This approach meant that the table could be analysed in a clear and logical fashion. The approach is as follows:

1. Inspect *procedural* knowledge creation outcomes (Rows 1,2 versus Rows 3, 4)
    i. Inspect knowledge creation capacity only (Col. 3)
    ii. Inspect intrinsic motivation only (Col. 4)
    iii. Inspect knowledge creation capacity and intrinsic motivation
2. Inspect *declarative* knowledge creation outcomes (Rows 1,3 versus Rows 2,4)
    i. Inspect knowledge creation capacity only (Col. 3)
    ii. Inspect intrinsic motivation only (Col. 4)
    iii. Inspect knowledge creation capacity and intrinsic motivation

Table 5.14 is structured according to the approach used to analyse Table 5.13. It summarises the observations and findings that were derived from the analysis and presents the researcher's interpretation of these findings together with an account of their attendant implications for practice.

Table 5.14 Knowledge creation intentions in each knowledge creation outcome scenario

DECLARATIVE KNOWLEDGE CREATION	**Knowledge creation capacity** (Col. 3)	**Intrinsic motivation to create knowledge** (Col. 4)	**Knowledge creation capacity & intrinsic motivation** (Col 3, 4)*
Rows 1, 3	**High** knowledge creation capacity was associated with high declarative knowledge creation outcomes for 9 of 14 individuals	**High** intrinsic motivation was associated with high declarative knowledge creation outcomes for 7 of 14 individuals	**High** intrinsic motivation and prior related knowledge was associated with high declarative knowledge creation outcomes for 7 of 14 individuals
Rows 2, 4	**Low** knowledge creation capacity was associated with low declarative knowledge creation outcomes for 4 of 4 individuals	**Low** intrinsic motivation was associated with low declarative knowledge creation outcomes for 2 of 4 individuals	There is no consistency in terms of knowledge creation capacity and intrinsic motivation to create knowledge for the 4 individuals with low declarative knowledge creation outcomes
Finding	(P13) Knowledge creation capacity (stemming from prior related knowledge) **positively affects** declarative knowledge creation outcomes in virtual worlds	(F7) Intrinsic motivation to create knowledge **is not associated with** declarative knowledge creation outcomes	(F8) High knowledge creation capacity AND high levels of intrinsic motivation **may be positively associated with** declarative knowledge creation outcomes
Interpretation	Some level of prior related knowledge is needed for declarative knowledge creation to take place. At the same time, declarative knowledge creation does not appear to require substantial levels of intrinsic motivation to create knowledge. This is because declarative knowledge creation is easier and less time consuming than procedural knowledge creation		
Implications	**Virtual world users seeking to create declarative knowledge must know enough about Second Life to be comfortable working within it in order to create declarative knowledge**		
PROCEDURAL KNOWLEDGE CREATION	**Knowledge creation capacity** (Col. 3)	**Intrinsic motivation to create knowledge** (Col. 4)	**Knowledge creation capacity & intrinsic motivation** (Col 3, 4)
Rows 1, 2	**High** knowledge creation capacity was associated with high procedural knowledge creation outcomes for 8 of 9 individuals	**High** intrinsic motivation was associated with high procedural knowledge creation outcomes for 8 of 9 individuals	**High** intrinsic motivation and prior related knowledge was associated with high procedural knowledge creation outcomes for 8 of 9 individuals
Rows 3, 4	**Low** knowledge creation capacity was associated with low procedural knowledge creation outcomes for 4 out of 9 individuals	**Low** intrinsic motivation was associated with low procedural knowledge creation for 8 out of 9 individuals	There is no consistency in terms of knowledge creation capacity and intrinsic motivation to create knowledge for the 9 individuals with low procedural knowledge creation outcomes
Finding	(P14) Knowledge creation capacity **is positively associated with** procedural knowledge creation outcomes	(P15) Intrinsic motivation to create knowledge **is positively associated with** procedural knowledge creation outcomes	(P16) High knowledge creation capacity AND high levels of intrinsic motivation **are strongly and positively associated with** procedural knowledge creation outcomes
Interpretation	Knowledge creation capacity (stemming from prior related knowledge) is important in terms of creating procedural knowledge. However, intrinsic motivation to create knowledge strongly affects procedural knowledge creation outcomes. This effect is strongest where individuals have high levels of prior related knowledge. This is because procedural knowledge creation appears to be more difficult and time consuming than declarative knowledge creation		
Implications	**Virtual world users seeking to create procedural knowledge must know enough about Second Life to be comfortable working within it. In addition, highly motivated individuals are more likely to succeed in the creation of procedural knowledge**		

* These cells were populated with reference to Table 5.15 and Tables 5.3 and 5.8

5.8 Conclusion: presenting a synthesis of findings

This chapter frames the presentation of the study's findings in terms of the preliminary framework that was used to guide the study. Each section of the chapter explores a particular aspect of that framework and the result is a revised framework of knowledge creation in virtual worlds that is

(i) closely linked to existing theory (e.g. the theory of planned behaviour; motivation theory; absorptive capacity theory; theory of organisational knowledge creation) and

(ii) grounded in the study's empirical findings on knowledge creation in six innovative educational projects from Second Life.

This section adds to and concludes the presentation of findings by synthesizing the conceptualisations of knowledge and knowledge creation that are developed from literature and then empirically investigated in this study.

At a high level, this study suggests that knowledge should be seen as a collection of frameworks, that contain declarative and procedural elements, and that are used (and are useful) in everyday life in an intentional and volitional manner. Further, the study suggests that the manner in which these frameworks are maintained and updated is seen to be fundamentally influenced by the extent to which there is an intrinsic motivation to do so. At the same time, the manner in which these frameworks are maintained and updated is thought to be significantly influenced by one's capacity to alter them, which arises out of one's prior experiences and prior related knowledge. Thus, the process of creating knowledge is highly idiosyncratic in nature. At the same time, it is recognised that knowledge is created (i.e. these frameworks are maintained and updated) by means of socially enacted (knowledge-creating) behaviours, which are experienced in a way that is indelibly tinted by those self same frameworks. Finally, this study recognises that the individual components of knowledge frameworks are neither independent nor equal. They are not independent as they exist and function as self-organising, and interconnected webs or matrices. They are not all equal; and some elements in particular are protean – they facilitate and guide the processes whereby knowledge frameworks are maintained and updated. These protean elements are described in

this study as meta-knowledge and this study distinguishes between meta-declarative and meta-procedural knowledge. In the absence of meta-knowledge, knowledge creation is especially difficult. The remainder of this section focuses on declarative (Section 5.8.1) and procedural (Section 5.8.2) knowledge creation in turn.

5.8.1 Creating declarative knowledge in virtual worlds

The study highlights the importance of creating declarative knowledge in the early stages of the cases and shows that study participants were successful, by and large, in creating declarative knowledge. The creation of declarative knowledge appears to have been a high priority for educators in particular.

Whilst the analysis shows that the number of knowledge-creating behaviours used is positively associated with declarative knowledge creation outcomes, the configuration of knowledge-creating behaviours used is not. In other words, the analysis does not establish whether or not there is a particular configuration or arrangement of knowledge-creating behaviours that leads to better outcomes. This suggests that it may be inappropriate to consider one-size-fits-all approaches to knowledge creation in virtual worlds. Further, the association between the number of behaviours used and declarative knowledge appears to be weaker than the association with procedural knowledge. This suggests that procedural knowledge creation requires more effort on the part of study participants. So, for example, study participants may be able to create new declarative knowledge by passively monitoring Second Life using mailing lists and forums. However, if study participants wish to create new procedural knowledge, this is more likely to happen inworld and will require more effort.

The study reveals the importance of establishing an overall vision of Second Life. Some participants viewed Second Life in terms of a theatrical metaphor. Some participants viewed Second Life as an early incarnation of the kinds of environments that have already been created by science fiction writers. The study also reveals the importance of establishing an overall vision of project goals in

Second Life. For some, this vision was clear at the outset and for others, it was necessary to develop this vision as the projects were carried out.

In particular, the analysis has suggested that participants used these metaphors and analogies as a kind of *meta-declarative knowledge.* The significance of this kind of knowledge is that once it had been established, teams could use it as a template to guide action and were then able to work in a more efficient manner. That is to say, metaphors and analogies were used as a means of constructing as well as articulating declarative knowledge and as a means of bridging the gap between existing knowledge and new knowledge. The case-oriented analysis suggests that timing is crucial. If meta-declarative knowledge is created too soon, teams can find themselves steaming ahead and working purposefully but with a kind of tunnel vision, where subsequent knowledge creation and knowledge creation at the individual level in particular is reduced. In this scenario, it is important that individuals and teams continue to engage with new (and old) ideas and remain open to alternative perspectives. On the other hand, if meta-declarative knowledge is not created quickly enough, the energy and focus of the team dissipates. In this scenario, it is important that teams prioritise declarative knowledge creation. Effectively, this means that teams allow sufficient time to explore new ideas and to allow ideas to mature and to crystallise.

The analysis suggests that virtual world users should use exploratory knowledge-creating behaviours when meta-declarative knowledge has not been well established and should use exploitative knowledge-creating behaviours once it has. Indeed, the analysis reveals that study participants focused on exploratory exogenous knowledge-creating behaviours when declarative knowledge creation was the priority (in the early stages of projects). For example, study participants often spent a lot of time exploring Second Life and exploring educational areas of Second Life specifically. These explorations were valuable as they allowed participants to literally ‘see’ what other educators (from all over the world) were doing in Second Life. It was also important to talk with other educators about their work: it was as important to understand what other educators intended to do

as it was to see what they had actually done. In other words, study participants felt that it was important to "talk the walk". It was also very common for study participants to take part in educational forums in Second Life. Social gatherings were important in terms of being up to date with what was happening in Second Life and in terms of making connections with other educators in Second Life. However, they were also important in terms of stimulating interest in and enjoyment of Second Life. As L.DEV put it, there's only so much fun you can have in Second Life on your own.

In fact, the key to unlocking meta-declarative knowledge creation in Second Life appears to be prior related knowledge. The analysis suggests that knowledge creation capacity (stemming from prior related knowledge) affects the attitudes, expectations and behaviours of study participants. In particular, the analysis shows that knowledge creation capacity (stemming from prior related knowledge) is positively associated with declarative knowledge creation outcomes. That is to say, if study participants were able to draw upon prior knowledge, this made it easier for them to develop their understanding of education in Second Life. This observation is in keeping with the manner in which knowledge is conceptualised in this study (i.e. as a capacity for action or an ability to interpret, authenticate, or personalise information and experiences that are developed through experience or study by means of ongoing, socially enacted processes). However, prior related knowledge appears to be especially significant in this study because of the sheer novelty of the environment: Second Life is a user-created space that is literally whatever its users imagine it to be.

Thus, study participants (like Second Life users in general), drew on a wide range of prior experiences to make sense of Second Life. Participants stated that they had drawn on previous experiences with music, art and theatre; and as developers or hackers[39], designers, educators, and consultants. These previous experiences were not obviously or directly relevant to Second Life but nevertheless afforded

[39] The term 'hacker' is contentious and can be used in a number of ways; it is used in this context to refer to a person who follows a spirit of playful cleverness and loves programming

participants a starting point or a basis upon which to construct knowledge about Second Life. It is perhaps for this reason that it was observed by L.FAC that educators in Second Life don't always realise that they already have the knowledge needed to carry out projects in Second Life; they "just have to think about it" a little bit. This suggests that virtual world users and user communities should therefore leverage prior related knowledge in so far as possible and consciously explore virtual worlds as metaphors in order to facilitate the gradual unravelling of the potential and limitations of virtual worlds.

5.8.2 Creating procedural knowledge in virtual worlds

The analysis has highlighted the importance of creating procedural knowledge or know-how in the latter stages of the cases; and indicates that the creation of procedural knowledge is a high priority for developers in particular. However, the analysis has also shown that procedural knowledge creation outcomes were moderate in the study. This suggests that even though Second Life was shown to support procedural knowledge creation, procedural knowledge is more difficult to create in Second Life than declarative knowledge. This helps explain why intrinsic motivation to create knowledge was more strongly associated with procedural knowledge creation outcomes than with declarative knowledge creation outcomes in the study.

There are a number of reasons why virtual world users need to ensure that procedural knowledge is being created as well as declarative knowledge. First, declarative knowledge is created as a by-product of procedural knowledge creation (but the creation of declarative knowledge can take place without procedural knowledge creation). Second, the analysis suggests that procedural knowledge is necessary in order to use Second Life effectively. For less experienced users, a lack of basic skills in Second Life was a serious impediment. For more experienced users, it was the development of practical skills in Second Life that enabled them to push, but not exceed, the boundaries or technical limits of Second Life. For this reason, educators overlook the creation of procedural knowledge in Second Life at their peril.

The analysis reveals that study participants adopted quite different approaches to procedural knowledge creation, but that they were firmly focused on endogenous knowledge-creating behaviours when procedural knowledge creation was the priority (in the latter stages of projects). On the one hand, the FOB and MZO teams have adopted quite formalised approaches. On the other hand, the teams at LOY and GLA have adopted approaches that are based on "playful cleverness".

Whilst overall approaches to procedural knowledge creation were varied, study participants became increasingly reliant on colleagues rather than on members of the Second Life community over time. The actual configuration of knowledge-creating behaviours does not appear to affect procedural knowledge creation outcomes. However, collaborative (as opposed to individualistic) behaviours led to better outcomes in the cases. It seems that the need to be comfortable is quite important in Second Life and that collaborative behaviours gave participants a measure of support from colleagues. For this reason, endogenous collaboration typically took the form of more experienced team members supporting more junior members by answering questions or providing input. In particular, it tended to involve educators collaborating with developers; and facilitators would mediate that process in order to ensure the effective communication of educator needs and technical constraints. At the same time, collaborative behaviours stimulated participants' interest in Second Life and motivated them to invest the time needed to create procedural knowledge in Second Life.

These observations suggest that collaborative endogenous knowledge-creating behaviours are important for procedural knowledge creation in virtual worlds. However, they also show that even though Second Life minimises spatial and temporal distance, participants tended to rely on, and collaborate with, real life work colleagues. It appears that participants either didn't have the time to use exogenous knowledge-creating behaviours or struggled to establish collaborative relationships with people outside of their own teams. Indeed, one of the topics highlighted at the 2010 VWBPE (Virtual Worlds Best Practices in Education) conference was that educators are often isolated from others in Second Life.

However, users feel that it is not possible to fully grasp Second Life unless you engage with, and participate in, Second Life as a community as well as a space.

Finally, the analysis also points to the significance of what is termed *meta-procedural* knowledge in this study. The significance of meta-procedural knowledge (or an understanding of how to go about (new) things) is that it appears to make the process of creating knowledge easier. Meta-procedural knowledge means that E.DEV knows how to go about things quickly in Second Life even though he's never done them before. He knows about what he needs to be able to do; and he knows where to look to find the information that will enable him to do it. Meta-procedural knowledge also means that F.DEV can use the same procedure to fulfil his role as a developer at FOB that he uses for any other project. The specifics are different; but the overall approach is the same. These examples illustrate that meta-procedural knowledge is derived from previous experience and that it facilitates knowledge creation. In addition, the examples illustrate that it is possible for individuals to benefit from the meta-procedural knowledge of colleagues (as the FOB team benefited from F.DEV's formal approach to the design and development of the project); and that meta-procedural knowledge can be embedded in formal work practices. As virtual worlds mature, best practices will continue to emerge that will allow the community as a whole to benefit from the experiences of those who have gone before them.

In summary, this section brings together the empirical findings of the study into a clear and concise account of knowledge creation in virtual worlds. The next chapter concludes the study by articulating the contributions of the study for both research and practice and by pointing out some important directions for future research.

6 CONCLUSION AND CONTRIBUTION OF THIS STUDY

6.1 Introduction

This chapter leverages the findings of the study (presented in Chapter Five) in order to articulate the study's contributions to both research and practice. To that end, Section 6.2 recapitulates the research objective for the study and the research approach adopted in the study. Section 6.3 articulates the study's contributions to research. In particular, the section presents a revised theoretical framework of knowledge creation in virtual worlds and illustrates its implications for future research. Section 6.4 presents and discusses the study's contribution to practice. In particular, it presents a practical guide for stimulating knowledge creation in virtual worlds. This guide leverages a theoretically based classification of four knowledge-creator archetypes and derives an actionable set of behavioural prescriptions for each archetype (the sage, the lore master, the artisan, and the apprentice) based on the study's findings. Section 6.4 considers the limitations of the study and Section 6.5 concludes the study.

6.2 Research objective and research approach

The research objective for this study was articulated based on a three pronged review of research in the areas of (i) virtual worlds, (ii) innovation, and (iii) knowledge management (presented in Chapters Two and Three). This review indicated that extant virtual world research is centrally concerned with developing an understanding of the impact of virtual world affordances on communication and collaboration; innovation and creativity; and knowledge and knowledge creation. In terms of articulating a research agenda for the study, the analysis presented in Chapter Three systematically argued in favour of the development of an integrated approach for the investigation of innovation and knowledge by means of focusing specifically on knowledge creation. As a result, the research objective for this study was "to investigate knowledge creation in innovative virtual world projects".

A preliminary framework of knowledge creation was derived from existing research. This framework consisted of three constructs: knowledge creation

intentions; knowledge-creating behaviours and knowledge creation outcomes. The framework posited that knowledge creation intentions affect knowledge-creating behaviours; and that knowledge-creating behaviours affect knowledge creation outcomes.

In order to carry out the investigation of knowledge creation in innovative virtual world projects, the researcher engaged in an extended participant observation in Second Life that focused specifically on the educational community therein. In particular, six innovative educational projects that had recently been completed in Second Life were selected (using a criterion sampling strategy) as case studies. Three individuals from each case were selected for inclusion in the study on the basis of the role they occupied within the projects. Project facilitators, developers and educators were interviewed for each case.

The analysis presented in Chapter Five was constructed using data collected from the case studies. In addition, this analysis was fundamentally informed, and enriched, by the participant observation that was also carried out during the study. In particular, the study's findings were articulated in terms of the preliminary framework used to guide the study (presented in Section 4.3).

6.3 Contributions of the study to research

This section articulates the study's contribution to research at three levels. First, the section focuses on the study's contributions to knowledge creation research at a high level (Section 6.3.1). Here, the study's main contribution is seen to lie in making a case for developing a knowledge-based view of innovation and leading the way by illustrating how this can be accomplished by focusing future research efforts on knowledge creation. The section then focuses on the study's contributions to research at a more fine-grained level. Here, the study's findings are presented in the form of a revised framework of knowledge creation in virtual worlds that is used as a vehicle to enumerate and explain the study's specific contributions to research (Section 6.3.2). Finally, the section considers the study's contributions to virtual world research (Section 6.3.3).

6.3.1 Contributions of this study to knowledge creation research

This study recognises that innovation is a topic of enduring and increasing importance for organisations (Drucker, 1998) and that the capacity to innovate is "the most important determinant of firm performance" (Crossan and Apaydin, 2010, p. 1154). However, it reveals that scholars have spent decades focusing on the implementation of ideas when the *creation* of ideas is critically important. At the same time, the study recognises that knowledge is the key driver of competitive advantage (Porter and Millar, 1985; Winter, 1987; Quinn, 1992; Blackler, 1995; Nonaka and Takeuchi, 1995; Dunford, 2000; Gao *et al.,* 2008; Taminiau *et al.,* 2009) but reveals that researchers have spent decades focusing on the storage and retrieval of information rather than the *creation* of knowledge.

The study argues in favour of utilising a knowledge-based view of innovation (cf. Agarwala-Rogers, 1976; Tushman, 1977; Senker, 1995a; Senker, 1995b; Senker, 2008; Verona, 1999; Gopalakrishnan and Bierly, 2001; Brockman and Morgan, 2003). The study's main contributions to research lie in

(i) Recognising that knowledge creation is one of the main sources of the competitive advantage of the firm (Almeida et al., 2002; Leonard-Barton, 1990; Nonaka, 1991; Spender, 1996; Teece, 1998; Von Krogh,

1998; Zollo and Winter, 2002; Jakubik, 2008; Martin-de-Castro et al., 2008);

(ii) Demonstrating that it is also essential for, and central to, innovation (Leonard-Barton and Sensiper, 1998; Popadiuk and Choo, 2006; Nonaka and Takeuchi, 1995; Swan *et al.,* 1999; Nonaka *et al.,* 2000; Gold *et al.,* 2001; Popadiuk and Choo, 2006; Lam, 2006); and

(iii) Leading future research efforts in this area by developing a new theory of knowledge creation.

One of the study's most significant contributions to research is the *reconceptualisation of the knowledge creation construct* (cf. Colquitt and Zapata-Phelan, 2007). This reconceptualisation is based on extant literature in Knowledge Management (cf. Alavi and Leidner, 2001; Boisot, 1998; Davenport and Prusak, 1998; Heffner and Sharif, 2008; Orlikowski, 2002; Robert, 2009; Schubert et al., 1998; Tuomi, 1999; Watson, 1999) and a number of influential philosophies of knowledge. In particular, it reflects contemporary social constructionist (cf. Berger and Luckmann, 1969) and pragmatist (cf. Scheffler, 1986, pp. 8-9; Rorty, 1991) views of knowledge. This reconceptualisation can be used to underpin future research on knowledge and knowledge creation.

The distinction between declarative and procedural knowledge is a key element of this study. The study argues that existing theories of knowledge creation (cf. Nonaka 1991, 1994; Nonaka et al., 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka et al., 2000; Nonaka and Toyama, 2003) have encountered conceptual and empirical problems because they distinguish between tacit and explicit knowledge (cf. Adler, 1995; Gourlay 2006; Jakubik 2008; Spender 1996; Rice and Rice, 2005). On the other hand, the distinction between declarative and procedural knowledge has been overlooked by researchers, even though it is well established (cf. Ryle, 1945; Anderson, 1976, 1983; Nahapiet and Ghoshal, 1998) and more accurately reflects the neural implementation of knowledge in the brain (Anderson and Lebiere, 1998, p. 21). By demonstrating the merits of basing a new theory of knowledge creation on this distinction, the

study redirects future research back to declarative and procedural *forms* of knowledge rather than the tacit and explicit *dimensions* of knowledge.

Using this approach, a variety of new insights into knowledge creation in virtual worlds is revealed. These are enumerated and explained in the next section.

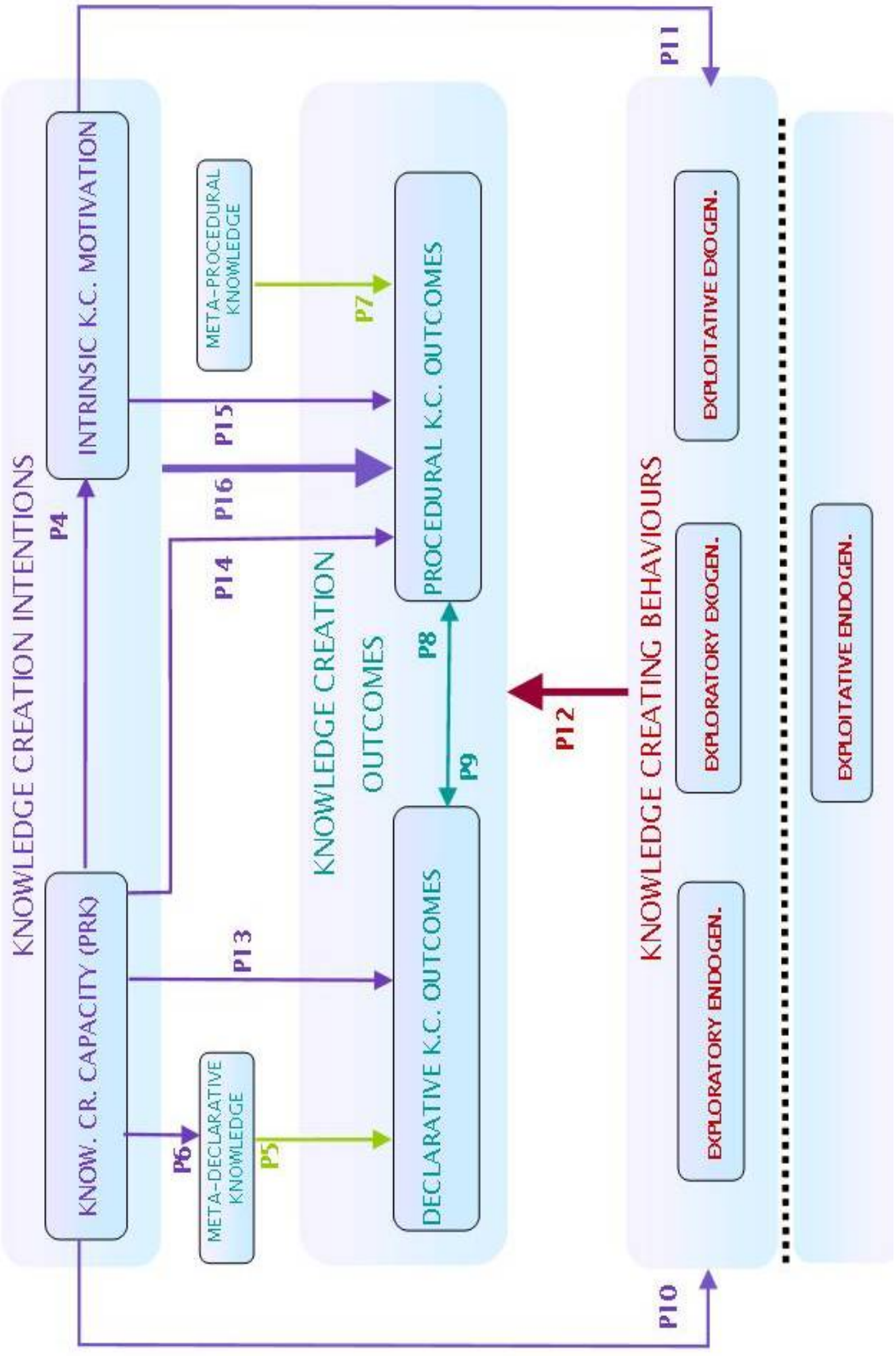
6.3.2 A revised framework of knowledge creation in virtual worlds

This study leverages well-established theories to construct a preliminary framework of knowledge creation (e.g. the theory of planned behaviour; motivation theory; absorptive capacity theory; theory of organisational knowledge creation). This framework contributes a set of theoretically-grounded *propositions about the relationships and processes* that affect knowledge creation to research (cf. Colquitt and Zapata-Phelan, 2007). In addition, this framework has been used in this study to successfully develop an applied, refined and empirically-based theory of knowledge creation in virtual worlds (Figure 6.1).

Future research is needed to establish the strength of both the preliminary framework and the revised framework of knowledge creation in other research settings (e.g. in different environments, with different groups, and at different levels of analysis). In particular, there is a need to establish how knowledge is created at the community level given that this study's participants believed that the collective knowledge of the Second Life educational community facilitated their own knowledge creation efforts. There is also a need to develop a framework of knowledge creation that operates at multiple levels of analysis given that this study suggests that individuals' knowledge creation strategies were partly decided based on the knowledge creation needs of the teams within which they operated.

In the meantime, this section explores the specific contributions of the framework to our understanding of knowledge creation, underscoring the potential of reconceptualising knowledge creation in terms of declarative and procedural knowledge to guide future research.

FIGURE 6.1 Revised Theoretical Framework Of Knowledge Creation In Virtual Worlds



… FIGURE 6.1 CONTINUED

1. KNOWLEDGE CREATION INTENTIONS:
(Behavioural intentions to create (declarative and/or procedural) knowledge)

(a) DEFINITIONS

Knowledge creation capacity	Capability to create new knowledge stemming from prior related knowledge
Intrinsic motivation to create knowledge	An internal or authentic motivation to create knowledge

(b) PROPOSITIONS (PURPLE ARROWS)

P4 Prior knowledge of and comfort in the environment are necessary for the development of intrinsic motivation to create knowledge in virtual worlds

P6 Knowledge creation capacity (stemming from prior related knowledge) positively affects the creation of meta-declarative knowledge in virtual worlds

P10 Knowledge creation capacity positively affects the number of knowledge-creating behaviours used in virtual worlds

P11 Intrinsic motivation to create knowledge positively affects the number of knowledge-creating behaviours used in virtual worlds

P13 Knowledge creation capacity (stemming from prior related knowledge) positively affects declarative knowledge creation outcomes in virtual worlds

P14 Knowledge creation capacity is positively associated with procedural knowledge creation outcomes in virtual worlds

P15 Intrinsic motivation to create knowledge is positively associated with procedural knowledge creation outcomes in virtual worlds

P16 High knowledge creation capacity AND high levels of intrinsic motivation are strongly and positively associated with procedural knowledge creation outcomes in virtual worlds

2. META-KNOWLEDGE
(A form of knowledge about knowledge , a kind of knowing whether)

(a) DEFINITIONS

Meta-declarative knowledge	knowledge about declarative knowledge
Meta-Procedural knowledge	knowledge about procedural knowledge

(b) PROPOSITIONS (LIME ARROWS)

P5 Meta-declarative knowledge positively affects declarative knowledge creation outcomes in virtual worlds

P7 Meta-procedural knowledge positively affects procedural knowledge creation outcomes in virtual worlds

3. KNOWLEDGE-CREATING BEHAVIOURS
(Behaviours taken in an attempt to facilitate knowledge creation)

(a) DEFINITIONS

Exploratory endogenous	Taken to create knowledge that is substantively different from existing knowledge and are carried out internally within the team or within the team's location in Second Life
Exploratory exogenous	Taken in an attempt to create knowledge that is substantively different from existing knowledge and are carried out externally of the team or outside the team's location in Second Life
Exploitative endogenous	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out internally within the team or within the team's location in Second Life
Exploitative exogenous	Taken in an attempt to create knowledge that is not substantively different from existing knowledge carried out externally and are carried out externally of the team or outside the team's location in Second Life

(b) PROPOSITIONS (RED ARROW)

P12 The number of knowledge-creating behaviours used positively affects knowledge creation outcomes in virtual worlds

4. KNOWLEDGE CREATION OUTCOMES
(Changes in declarative and procedural knowledge frameworks)

(a) DEFINITIONS

Declarative outcomes	Changes in declarative (know-about) knowledge frameworks
Procedural outcomes	Changes in procedural (know-how) knowledge frameworks

(b) PROPOSITIONS (BLUE ARROWS)

P8 It is possible to create new declarative knowledge without creating substantial levels of procedural knowledge in virtual worlds

P9 It is difficult to create high levels of procedural knowledge without creating high levels of declarative knowledge in virtual worlds

6.3.2.1 Knowledge creation outcomes

In Section 5.8, it is argued that "*knowledge should be seen as a collection of frameworks, that contain declarative and procedural elements, and that are used (and are useful) in everyday life in an intentional and volitional manner*"; knowledge is created when "*these frameworks are updated*". This is illustrated in Figure 6.1, which represents knowledge creation outcomes as changes in declarative and procedural knowledge frameworks.

The study illustrates the merit of conceptualising knowledge in these terms in a number of ways. First, the study illustrates that distinguishing between declarative and procedural knowledge (whilst acknowledging that knowledge has tacit and explicit dimensions) affords new possibilities in terms of measuring knowledge creation outcomes. By definition, tacit knowledge is difficult to recognise and articulate. Yet researchers are likely to rely on perceptual measures of knowledge creation outcomes in the future. This study shows that individuals (i) can successfully articulate declarative and procedural knowledge creation outcomes, (ii) can evaluate the usefulness of this knowledge, and (iii) can articulate anticipated future knowledge creation needs. These findings are particularly important for pragmatist studies, where the significance of knowledge is seen to lie in its utility rather than its truthfulness *per se*.

Second, the study finds that knowledge creation outcomes are associated such that (i) declarative knowledge can be created independently of procedural knowledge but (ii) procedural knowledge tends to be created in conjunction with declarative knowledge. These findings reveal that in virtual worlds at least, knowledge is created in action and idea generation is not a purely cognitive activity. That is to say, virtual worlds are used to stimulate knowledge creation using procedural approaches like experimentation, simulation and piloting. These findings therefore suggest that future researchers can maximise knowledge creation outcomes by developing tools and techniques that stimulate the creation of know-how rather than know-what.

6.3.2.2 Meta-knowledge

It is argued in Section 5.8 that *"the individual components of knowledge frameworks are neither independent nor equal. They are not independent as they exist and function as self-organising, and interconnected webs or matrices. They are not all equal; and some elements in particular are protean – they facilitate and guide the processes whereby knowledge frameworks are maintained and updated. These protean elements are described in this study as meta-knowledge and this study distinguishes between meta-declarative and meta-procedural knowledge.* This is illustrated in Figure 6.1, which highlights the role of declarative and procedural meta-knowledge in knowledge creation.

This study highlights the importance of meta-knowledge by suggesting that "*in the absence of meta-knowledge, knowledge creation is especially difficult*". In particular, the analysis suggests that meta-declarative knowledge plays a role in *guiding* knowledge creation and that meta-procedural knowledge plays a role in *simplifying* knowledge creation. Whilst it is acknowledged that the concept of meta-knowledge, is similar to the concepts of "meta-cognitive knowing" and "meta-strategic knowing" (cf. Kuhn, 1999), a review of extant literature reveals that meta-knowledge has largely been overlooked in existing research in the fields of innovation and knowledge management. Thus, this study makes a significant contribution to existing research by revealing the importance of meta-knowledge in facilitating knowledge creation. Future research is needed to fully distinguish meta-knowledge from other forms of knowledge and to investigate new techniques that can be used to support knowledge creation by means of mobilising meta-knowledge.

6.3.2.3 Knowledge-creating behaviours

In Section 5.8, this study suggests that "*knowledge is created by means of (socially enacted) knowledge-creating behaviours*". This study therefore develops a taxonomy of knowledge-creating behaviours. This taxonomy is based on existing research on exploratory and exploitative knowledge-creating behaviours (cf. March, 1991). Using this taxonomy, the study offers empirically-grounded

insights into how exploratory and exploitative behaviours are actually balanced in a virtual world context. This is an important question for organisational innovation, where existing research suggests that organisations should either balance these behaviours synchronously ("organisational ambidexterity" approaches) or should cycle through periods of exploration and exploitation ("punctuated equilibrium" approaches) (cf. Gupta *et al.,* 2006). Furthermore, the study extends this classification by decomposing each category into endogenous and exogenous behaviours. This extension is particularly useful to researchers seeking to explore the impact of organisational boundaries (within and across organisations) on innovation (e.g. Lam, 2006; Yayavaram and Ahuja, 2008). As the following paragraphs illustrate, the nature of the study's findings well illustrates the merit of using this taxonomy in future studies.

First, the study finds that both exploratory and exploitative behaviours are important for innovation and knowledge creation. The finding therefore contradicts the views of a number of authors who deny that exploitative behaviours lead to innovation and knowledge creation (e.g. Rosenkopf and Nerkar, 2001; cf. Gupta *et al.*, 2006) and direct future researchers to further investigate the manner in which exploitative behaviours specifically lead to knowledge creation and innovation.

Secondly, the study supports the view that the *number* of knowledge-creating behaviours used affects knowledge creation outcomes. However, the analysis presented in Section 5.3.2 fails to establish whether there is an overall configuration of knowledge-creating behaviours that can lead to optimal knowledge creation outcomes. As one participant observed, Second Life is "still in beta". There is therefore a need for further empirical research to investigate overall configurations of knowledge-creating behaviours. It may be possible to leverage the taxonomy of knowledge-creating behaviours presented in this study to identify optimal configurations of in more established settings (e.g. traditional online settings and real world settings) and then to investigate the extent to which they can be 'translated' into virtual worlds. That being said, the study reveals that

exploitative *exogenous* behaviours *are* important for knowledge creation but exploitative *endogenous* behaviours are not. The analysis suggests that the higher the proportion of these behaviours, the lesser the likelihood that significant knowledge creation will take place. The immediate significance of this finding is that it suggests a means of actually predicting knowledge creation outcomes by examining knowledge-creating behaviours. In particular, there is a need for future comparative research to establish whether this is the case and if so, its implications for innovation.

Finally, the analysis presented in Section 5.3.4 reveals that exploratory (exogenous) behaviours were more important in the early stages of projects as they facilitated the creation of declarative knowledge whereas both exploratory and exploitative (endogenous) behaviours were more important in the later stages of projects as they facilitated the creation of procedural knowledge. This analysis therefore directs researchers to further investigate cycles of exploration and exploitation and in so doing, to further clarify the interactions between exploratory and exploitative behaviours with endogenous and exogenous behaviours.

6.3.2.4 Knowledge creation intentions

In Section 5.8, this study suggests that "*the manner in which knowledge frameworks are updated is fundamentally influenced by the extent to which there is an intrinsic motivation to do so. Further, it is significantly influenced by one's capacity to alter them, which arises out of one's prior experiences and prior related knowledge. Thus, the process of creating knowledge is highly idiosyncratic in nature*". This is illustrated in Figure 6.1 which shows, at a glance, that both intrinsic motivation to create knowledge and knowledge creation capacity are both very heavily implicated in determining knowledge creation outcomes in this study.

Whilst the importance of intrinsic motivation to create knowledge has been recognised studies of individual creativity (e.g. Amabile, 1983; Amabile, 1996,

Amabile *et al.,* 1996), the role of motivation in knowledge management research has largely gone unrecognised. Indeed, Malhotra (2003) argues that there is "pervasive confusion about the role of knowledge workers' motivation and commitment in KMS implementations and sparse, if any, theoretical or empirical research on these issues" (p. 115). This study's findings therefore make a significant contribution to research by (i) highlighting the role of intrinsic motivation to create knowledge and (ii) specifying in more precise terms the influence of intrinsic motivation to create knowledge on different types of knowledge (i.e. declarative and procedural knowledge).

At the same time, the study highlights the importance of knowledge creation capacity in determining knowledge creation outcomes. Whereas Cohen and Levinthal (1990) argue that an organisation's *ability to evaluate and utilise new information* is "largely a function of prior related knowledge" (p. 128), this study suggests that prior related knowledge is actually central to the *creation of knowledge*. Furthermore, the study reveals that some level of knowledge creation capacity is necessary in virtual worlds if users are to develop an intrinsic motivation to create knowledge.

Taken together, these findings reveal that it is just as important to leverage prior related knowledge and stimulate intrinsic motivation to create knowledge as it is to manage knowledge-creating behaviours in organisations. This is especially true in the case of procedural knowledge creation, where the strengths of the associations were strongest in this study.

6.3.3 Contributions of this study to virtual world research

At a fundamental level, virtual worlds go to the heart of IS research, given that the "very idea of an information system is to provide a means and an environment for human communication" (Lyytinen, 1985, p. 61). In particular, virtual worlds are of particular interest for pragmatist IS research, which holds that the true value of IT and information systems is their potential to support human communication and collaboration (Ågerfalk *et al.,* 2008, p. 1). This study makes a number of important contributions to research in this area by presenting empirical evidence (in Section 5.3) that corroborates, extends and challenges existing research in this area.

In the first instance, the study lends empirical support to the argument that virtual worlds do in fact alter interpersonal communication and collaboration (e.g. Chaturvedi et al., 2011; de Freitas and Veletsianos, 2010; Messinger et al., 2009). The study also extends research in this area by contributing a set of empirically grounded observations into how these alterations actually occur in virtual worlds. For example, the study reveals that one of the truly unique characteristics of virtual worlds is their capacity to support symbolic (non-linguistic) forms of communication (Section 5.4.1.1). The study shows that the ability to create and share interactive, multimedia objects in the virtual worlds offers the chance to 'demonstrate' concepts and ideas in ways that are simply not possible in many other online environments. In other words, virtual worlds afford users a unique opportunity to "walk the talk". This is an important finding as it suggests that virtual worlds may be useful in terms of supporting the sharing of tacit knowledge – something which Nonaka and Konno (1998) suggest can only happen in face-to-face settings. Thus, whereas previous research has focused primarily on linguistic communication (Goh and Paradice, 2005) or the use of nonverbal signs like body language and gestures in virtual worlds (Yee and Bailenson, 2007; Carey, 2007), this finding directs future researchers to focus on the potential of virtual worlds to enable new forms of information visualization and non-linguistic and symbolic communication that can aid knowledge sharing.

However, the study's empirical findings *challenge* the findings of existing research. For example, one of this study's key findings is that communication in virtual worlds is not just 'multimodal', it is 'multiplatform'. This meant that users engage in simultaneous verbal and written communication with multiple individuals and groups who may or may not be co-located with the user's avatar in the virtual world. In the second instance, it means that users also frequently 'tab' in and out of Second Life in order to use (a variety of) external applications while they are 'inworld'. Indeed, it is not uncommon for users who are working in multiple virtual worlds, to 'tab' in and out of different avatars that are logged into different virtual worlds.

These empirical observations suggest the existence of a fundamental trade-off between (i) new forms of multimodal and multiplatform communication in virtual worlds and (ii) users' experiences of immersion and co-presence in virtual worlds. In particular, they call into question a growing body of research that is based on the assumption that presence (a sense of "being there") and co-presence (a sense of "being there with others") leads to feelings of immersion in virtual worlds (cf. Mennecke *et al.*, 2011; Traphagan *et al.*, 2010; Giovacchini, Kohler *et al.,* 2009; Selverian and Ha Sung, 2003; Schroeder, 2002).

In effect, the study directs future researchers to critically evaluate theories of embodiment, situatedness and presence in virtual worlds. In particular, they suggest the need for future research to establish the extent to which immersion in virtual worlds is actually caused by a kind of "cognitive absorption" (cf. Agrawal, 2000) or a sense of 'flow' (cf. Csíkszentmihályi, 1975) triggered by the complexities of communicating with others in virtual worlds. At the same time, these observations direct future research to investigate the efficacy of media synchronicity theory – which focuses on the state in which individuals are working together at the same time with a common focus (cf. Dennis *et al.,* 1999) – as a useful starting point for developing new theories of immersion and presence in virtual worlds.

6.4 Contributions of this study to practice

Fundamentally, this study suggests that knowledge is best viewed as a collection of frameworks that are (intentionally and volitionally) used in everyday life to guide action. In this view, knowledge (in its declarative and procedural forms) is created when these frameworks change and evolve a self-organizing manner as a result of our actions. From this perspective, the key to unlocking innovation and knowledge creation in organisations lies in managing the process whereby knowledge frameworks evolve and change over time rather than in attempting to translate knowledge using different means of expression (i.e. in attempting to make 'tacit' knowledge 'explicit'). In particular, this can be achieved using strategies designed to facilitate the purposeful alteration of existing knowledge frameworks, using particular types of (knowledge-creating) behaviours, based on anticipated future needs. Based on these insights, the study's contribution to practice is articulated as a practical guide for stimulating knowledge creation in virtual worlds. This guide utilises a theoretically based classification of four knowledge-creator archetypes (the sage, the lore master, the artisan, and the apprentice) and derives an actionable set of behavioural prescriptions for each archetype.

6.4.1 A practical guide for stimulating knowledge creation in virtual world

The raison d'être of knowledge management is to understand how knowledge can be operationalised in organisations (Marr and Spender, 2004, p. 183). This section presents a practical guide for stimulating knowledge creation in virtual worlds (see Table 6.1). This guide is designed with virtual world users in mind. Thus, individuals and teams can use the table to evaluate their existing knowledge frameworks and adopt appropriate strategies accordingly. However, the guide can also be used to guide future research on knowledge creation. From this perspective, the guide can be viewed as a kind of design science 'artifact' (cf. Hevner, 2004); and the next step for research is to test the utility of this artifact, perhaps by using the guide to inform the design of new tools and systems to support knowledge creation in virtual worlds.

First, the table presents a classification of four knowledge-creator archetypes (the sage, the lore master, the artisan, and the apprentice). This classification revisits a set of four theoretically-based, knowledge creation archetypes that are derived from existing literature (cf. Figure 3.2) and empirically validated in the study.

Second, the table translates the study's findings into a set of prescriptions for each archetype. These prescriptions are designed in the context of this study with virtual worlds in mind but with future studies, it should be possible to craft similar recommendations for other electronically mediated collaborative setting.

Specifically, Table 6.1 uses the taxonomy of knowledge-creating behaviours (cf. Table 5.4) to prescribe particular behaviours for particular knowledge creator archetypes. The table also suggests particular tactics to stimulate knowledge creation in virtual worlds based on the study's findings about motivating knowledge creation in virtual worlds (cf. Sections 5.2 and 5.7). Individuals and teams can therefore use the table to adapt their approach to knowledge creation.

TABLE 6.1STIMULATING KNOWLEDGE CREATION IN VIRTUAL WORLDS				
Knowledge Creator Archetypes				
	The Sage	**The Lore Master**	**The Artisan**	**The Apprentice**
Characterisation	**High** levels of declarative knowledge ("know what") and procedural knowledge ("know-how")	**High** levels of declarative and **low** levels of procedural knowledge	**Low** levels of declarative and **high** levels of procedural knowledge	**Low** levels of declarative knowledge ("know what") and procedural knowledge ("know-how")
Key issues	*Idée fixe*	Delegation and/or hypothetical thinking	(Blind) repetition or inability to customise one's approach	Inhibition or failure to engage with knowledge creation
Illustration	FOB, GLA, LOY	RIT	EXT	MZO
Corresponding knowledge-creating behavioural strategies				
	Opportunistic co-operation	**Purposeful self-reliance**	**Opportunistic self-reliance**	**Opportunistic co-operation**
Characterisation	Embraces both exploratory and exploitative knowledge-creating behaviours	Embraces exploitative knowledge-creating behaviours	Embraces exploratory knowledge-creating behaviours	Embraces both exploratory and exploitative knowledge-creating behaviours
	Embraces co-operative behaviours with 'outsiders' rather than individualistic or self-reliant behaviours	Embraces individualistic behaviours	Embraces co-operative behaviours	Embraces co-operative behaviours with colleagues rather than individualistic or self-reliant behaviours
Illustration	✦Community participation ✦Collaboration	✦Experimentation ✦Pilot projects ✦Imitation	✦Inworld exploration ✦Community participation ✦Exogenous collaboration ✦Brainstorming	✦Inworld exploration ✦Community participation ✦Collaboration
Overall aim	Dual knowledge creation focus, based on **improvisation**	Procedural focus, based on **active participation**	Declarative focus based on **diversity**	Dual knowledge creation focus, based on **incrementalism**
Rationale	To encourage the knowledge creator to put aside 'certainties', to slow down and to explore both alternate views and methods	To empower the knowledge creator by forcing them to apply their own knowledge in action. This will allow for the emergence of more nuanced knowledge	To encourage the knowledge creator to contemplate the true significance and potential of their skills	To establish the comfort and ease of the knowledge creator and to encourage the knowledge creator to build upon the knowledge of others
Tactics	**Rekindle** the sage's intrinsic interest in knowledge creation. This can be achieved by embracing a sense of technical challenge and is often stimulated through interaction with others and through hedonic participation in virtual worlds	**Awaken** an intrinsic motivation to create procedural knowledge. This can be achieved by embracing a sense of technical challenge and is often stimulated through interaction with others and through hedonic participation in virtual worlds	**Enlighten** the knowledge creator by exploring previously unconsidered possibilities and potential applications of their skills	**Empower** the apprentice to effectively create knowledge. This can be achieved by providing adequate training at the outset and encourage the apprentice to draw upon previous experiences even if their relevance is not obvious

6.4.1.1 The Sage

The sage has a deep understanding of virtual worlds (declarative knowledge) and a lot of expertise in terms of using virtual worlds (procedural knowledge). The key issue facing the sage's efforts to create knowledge is the notion of the *idée fixe*. In other words, the sage can work quickly and effectively but may be overly reliant on existing knowledge and slow to consider alternative methods or approaches. As a result, the sage may be unwilling to embrace cognitive change. The team at FOB can be seen to exhibit the traits of the sage. F.FAC comes to the project as an advanced virtual world developer in her own right with a rich, conceptual, and theoretically saturated understanding of virtual worlds. At the same time, F.DEV comes to the project with significant experience as a community leader in Second Life and also as a developer in both Second Life and the real world.

The sage may benefit from a knowledge creation behavioural strategy that is referred to in Table 6.1 as **opportunistic co-operation**. This means that the sage should embrace both exploratory and exploitative knowledge-creating behaviours but should focus primarily on engaging with both 'outsiders' and weak ties. In practical terms, the sage should engage in knowledge-creating behaviours that are based on cooperation and collaboration such as:

(i) Community participation and

(ii) Exogenous and endogenous collaboration.

These knowledge-creating behaviours in particular will force the sage out of her established routines and modes of thinking. However, it is acknowledged that it can be difficult to establish these kinds of relationships in virtual worlds.

The rationale for recommending this course of action for the sage is that it will encourage the sage to "slow down" and will lead her to challenge her own 'certainties'. By engaging in opportunistic co-operation, the sage is attempting to ground knowledge creation through heedful interrelating (Weick and Roberts, 1993). Swanson (2004) explains that through heedful interrelating, individuals fashion their actions in accordance with presuppositions that constitute

complementary (if not entirely shared) mental representations of the situation (p. 555). Ultimately, the sage needs to develop her capacity to improvise: she already knows the script and is attempting to break away from it. It is important to rekindle the sage's intrinsic motivation to create knowledge. This can be accomplished by encouraging the sage to embrace technical challenge in virtual worlds or by encouraging hedonic participation in virtual worlds.

6.4.1.2 The Lore Master

The Lore Master has a deep understanding of, and familiarity with, virtual worlds (declarative knowledge) but has not developed substantial levels of skill or expertise in terms of using virtual worlds (procedural knowledge). The key issue for the Lore Master is the fact that she has not gotten her hands dirty, so to speak. As a result, her knowledge is not nuanced; she struggles to understand the constraints of what is possible and is prone to 'hypothetical' thinking – thinking in terms of what is theoretically possible rather than in terms of what can be accomplished from a practical perspective. Perhaps this individual has been able to rely on more skilful or technically minded colleagues. Perhaps this team has opted to outsource some of the technical parts of their work. R.EDU can be seen to exhibit traits of the Lore Master. R.EDU is an experienced animator with a clear conceptual understanding of what he is trying to accomplish in Second Life but he lacks skills within Second Life and therefore struggles to overcome unforeseen technical problems.

The Lore Master may benefit from a knowledge creation behavioural strategy that is referred to in Table 6.1 as **purposeful self-reliance**. This strategy refers to one of two knowledge-creating behavioural configurations that were empirically identified in this study (cf. Section 5.3.4). Purposeful self-reliance means that the Lore Master should embrace exploitative knowledge-creating behaviours as she already understands virtual worlds conceptually. In practical terms, the lore master needs to focus on active participation as a means of creating procedural knowledge. The lore master should therefore engage in behaviours such as:

(i) Experimentation,

(ii) Pilot projects, and

(iii) Imitation.

In particular, the lore master should focus on individualistic knowledge-creating behaviours as they will empower the Lore Master to develop an applied understanding of virtual worlds that is grounded in both action and previous experience. It is only once the Lore Master grounds her knowledge in actual practice that she can develop a nuanced understanding of the true possibilities of virtual worlds. It is especially important to awaken the Lore Master's intrinsic motivation to create procedural knowledge because procedural knowledge creation requires so much time and effort in comparison with declarative knowledge creation. In particular, the Lore Master may be overwhelmed by the challenge of developing skills in the virtual world. Therefore, the Lore Master may benefit from interaction with others and hedonic participation.

6.4.1.3 The Artisan

The artisan is highly skilled in terms of using virtual worlds but has not contemplated the potential significance of her capabilities; she is perhaps unaware of what her skills enable her to do. The key issue for the artisan is that she is more concerned with "what is", rather than "what is possible". That is to say, the artisan needs to pay attention to the "organising vision", the continually evolving construction in discourse that emerges from the heterogeneous collective and serves to legitimise and mobilise actors around innovations (Swanson, 1997). When this does not occur, the artisan has a tendency to re-use the same approach for different contexts, to blindly repeat, even if it is not the most suitable approach.

In fact, the study's findings suggest that the artisan archetype rarely occurs in virtual worlds because of the fact that procedural knowledge creation tends to result in the creation of declarative knowledge. This point is well illustrated at EXT where E.EDU asserts that working on the project had "broken [him] out of a rut" and "made [him] come up with new and creative ways" to educate. He argues

that his colleagues have both become "much more creative" with each new project completed in Second Life.

The artisan may benefit from a knowledge creation behavioural strategy that is referred to in Table 6.1 as **opportunistic self-reliance**. This strategy refers to one of two knowledge-creating behavioural configurations that were identified in this study (cf. Section 5.3.4). Opportunistic self-reliance means that the artisan should embrace exploratory knowledge-creating behaviours as she already understands virtual worlds at a practical level. The overall aim for the artisan is to develop declarative knowledge by means of focusing on accessing diverse opinions and perspectives in the virtual world. In practical terms, the artisan should engage in knowledge-creating behaviours such as:

(i) Inworld exploration,
(ii) Community participation,
(iii) Exogenous collaboration, and
(iv) Brainstorming.

In particular, the artisan may benefit from using cooperative knowledge-creating behaviours, particularly with 'outsiders'. The rationale for recommending this course of action is that it will encourage the artisan to contemplate the true significance of their skills and capabilities. By bringing the artisan into contact with other virtual world users, they will benefit from exposure to the ideas of others and may develop a fuller appreciation for the value of their own skills. Ultimately, it is important that the artisan becomes enlightened with respect to exploring the potential applications of their skills and abilities.

6.4.1.4 The Apprentice

The apprentice is new to virtual worlds and has neither a deep understanding of virtual worlds nor any substantial skills in the virtual world. Given the novelty of virtual worlds, the majority of virtual world users begin as apprentices. The key issue for the apprentice is the danger of being overwhelmed in the virtual world. In this case, she may fail to fully engage in Second Life or may even withdraw from the virtual world. Many of Second Life's users fall into this category

initially. Indeed, a large proportion of the participants, as well as the researcher herself, struggled with Second Life at the beginning. It is partly for this reason that user attrition rates in virtual worlds are so high.

The apprentice may benefit from a knowledge creation behavioural strategy that is referred to in Table 6.1 as **opportunistic co-operation**. The apprentice in the virtual world is quite vulnerable to experiences of discomfort and fear which can stifle knowledge creation. Therefore the overall aim for the apprentice is to encourage an incremental approach to knowledge creation. By co-operating with colleagues or with other virtual world users, the apprentice can draw upon the previous experiences of others and will find it easier to establish achievable goals. A number of participants benefited from this kind of approach when they first came to Second Life. Ultimately, the apprentice is attempting to create both declarative and procedural knowledge. Therefore the apprentice should engage in both exploratory and exploitative knowledge-creating behaviours. In practical terms, the apprentice should engage in knowledge-creating behaviours such as:

(i) Inworld exploration (both opportune and purposeful),
(ii) Community participation, and
(iii) Collaboration (endogenous or exogenous).

The key is to empower the apprentice to create knowledge quickly and effectively. It is therefore important that the apprentice receives adequate training at the outset. It is also important to encourage the apprentice to draw on previous experiences, even those that are not obviously relevant. It is by means of these previous experiences that apprentices develop meta-knowledge. Finally, the apprentice (like the sage), can benefit from opportunistic co-operation as it helps the apprentice to ground her knowledge creation in a process of heedful interrelating (Weick and Roberts, 1993).

Having articulated both the study's contribution to research and to practice, the next section considers some of the limitations of the study.

6.5 Limitations of the study

Despite the best efforts of the researcher, no research study is without its limitations. This section therefore considers the limitations of this research and discusses the measures that were used to reduce the impact of these limitations. In particular, discussion considers the use of a qualitative approach, the use of the case study method, and the collection of retrospective data during interviews.

Whilst a qualitative approach was deemed most appropriate for the study in light of its exploratory nature, a number of authors have identified weaknesses inherent in qualitative research. Whilst the labour intensiveness of qualitative research is well documented, the researcher was in no way prepared for the reality of working "on the ground" in Second Life for such an extended period of time. Certainly, the analysis that has emerged in the study is seen to have been facilitated, shaped, and affirmed by the researcher's lived experience in Second Life. However, the onerous nature of this task simply cannot be adequately expressed in words. In addition, the demands of processing and coding data were substantial both in terms of the amount of time taken and in terms of the mental challenge associated with the task. Even though the researcher had created both a preliminary framework and a series of data displays well in advance of data collection, the researcher endured considerable and frequent data overload. Most importantly, the legitimacy and credibility of qualitative research conclusions are commonly questioned and suffer a perceived lack of rigour (Miles and Huberman, 1994). In this study, a range of techniques were used to ensure the trustworthiness of the research (cf. Section 4.4.7); not least of which is the extent to which both (i) the research protocol and (ii) the evolution of the theoretical framework have been documented in this thesis.

Similarly, the use of the case study method was also deemed most suitable in carrying out this study. In particular, the main strength of the case study is its ability to allow the triangulation of descriptions and interpretations (Stake, 2005, p. 443) by means of dealing with "a full variety of evidence" (Yin, 1994, p. 8). The use of multiple cases in particular is recommended for theory generation and

building (Benbasat *et al.,* 1987; Eisenhardt, 1989). Nevertheless, the case study method suffers a perceived lack of rigour (Yin, 1994). Therefore, this study utilises a series of tactics to ensure the trustworthiness of the study's findings. In addition, the case study method is also routinely criticised for its limited generalisability (Yin, 1994; Stake, 2005). However, Stake (1995) argues that the foremost concern in case studies is to generate knowledge of the particular (from which analytic generalisation is possible). Thus, both Yin (1994) and Stake (1995) argue that analytical (rather than statistical) generalisation is possible with case studies insofar as the research setting is adequately described. In the context of this study, thick description plays an important role in establishing the extent to which the study's findings can be generalised to theory. In particular, the decision to select cases from within Second Life's educational community has additional implications for the generalisability of the study's findings. However, it is possible to extend the generalisability of its findings to other projects in Second Life insofar as individuals in educational and non-educational projects occupy similar kinds of roles (such as 'developer', 'educator', 'facilitator').

Further, the sampling strategy used in this study called for the identification of innovative virtual world projects. As the notion of "successfully implemented" is central to the concept of innovation, it was therefore necessary to collect data on case studies that had already been completed in Second Life. Even though it was possible to experience the completed projects as an avatar in Second Life, it was necessary to carry out interviews after projects had already been completed. One of the key difficulties encountered in executing this study stemmed from the fact that participants therefore found it difficult to accurately recall knowledge-creating behaviours in detail. To quote E.FAC,

> it's really hard to be frank, for me to quantify and to work out precisely what I picked up where, and when, along the way

Consequently, there is a need for 'real-time' and longitudinal studies of knowledge creation in real life settings in order to enhance our understanding of knowledge-creating behaviours. In addition, there was also a lost opportunity to 'observe' case studies (projects) being carried out in real-time in the virtual world.

For this reason, the researcher visited a number of ongoing educational projects in Second Life during participant observation. This in turn, had implications for the study in terms of 'observer effects' (which are discussed in detail in Section 4.5.2.2).

6.6 Conclusions and further research

As indicated in this chapter, this study's main contributions to research lie in (i) recognising that knowledge creation is one of the main sources of the competitive advantage of the firm; (ii) demonstrating that knowledge creation is central to innovation; and (iii) leading future research in pursuing a knowledge-based view of innovation by developing a new theory of knowledge creation. This theory is based on a fundamental reconceptualisation of the knowledge creation construct that departs from prior theorisations of knowledge creation by distinguishing between declarative and procedural *forms* of knowledge rather than between the tacit and explicit *dimensions* of knowledge. Future research is needed both to test the theory, to expand the generalisability of the theory, and to enrich the theory. Nevertheless, this chapter suggests that this theory can and should be used to guide future research of knowledge creation. In particular, this study suggests the need for future research to explore ways to stimulate knowledge creation in practice by:

- Managing knowledge-creating behaviours

  This can be achieved by investigate the utility of this study's practical guide for stimulating knowledge creation and by leveraging the study's taxonomy of knowledge-creating behaviours to gain further insights into the interactions between different kinds of knowledge-creating behaviours and specifically investigate the association between exploitative endogenous knowledge-creating behaviours and knowledge creation outcomes
- Developing tools and techniques to leverage knowledge creation intentions (both knowledge creation capacity and intrinsic motivation to create knowledge)
- Investigating the enabling role of meta-knowledge in knowledge creation.

Finally, it is recalled that this study was initially motivated by the premise that our next "major architectural project" is "to imagine, build, and enhance an interactive and ever changing cyberspace" (Pierre Lévy, 1997, p. 10). The study reaffirms that both the Internet in general and virtual worlds in particular have the capacity to profoundly affect our sense of self; our relationships with others; and our actions and interactions. In particular, the study reveals that virtual worlds can indeed be used to create powerful immersive experiences that can stimulate innovation and knowledge creation. The study therefore calls up future researchers to continue to investigate our capacity to use virtual worlds to design fully immersive experiences; to create new visualization tools; and to support new kinds of non-linguistic and symbolic communication. In the end, the strength and power of virtual worlds lies in the fact that they are literally worlds of pure imagination; they can be used to not only create simulations of the real world but also to invent simulacrums of realities that could never actually exist in this world. It is for this reason that their capacity to stimulate creativity in thought and action is unrivalled by any other kind of electronic environment. As this study's participants were keen to underline, in a virtual world, literally anything is possible.

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7 APPENDICES

7.1 Appendix A Glossary of virtual world terminology

TERM	EXPLANATION
Animation override (AO)	An Animation Override (or AO) is a scripted object that you wear. You load it with animations and it uses those animations to replace your default ones automatically. So when you walk, sit or stand, it plays the animations you choose
Avatar	An avatar is a computer user's representation of himself/herself or alter ego whether in the form of a three–dimensional model used in computer games,[1] a two–dimensional icon (picture) or a one–dimensional username used on Internet forums and other communities
Avatar rendering cost	Using a point score, Avatar Rendering Cost shows how each avatar affects the rendering performance of the Viewer
Bling	Jewellery and attachments for avatars which contains scripted, particle based shimmering "bling" effects
Bot	An autonomous program that can interact with computer systems or users. These programs are typically depicted in virtual worlds as humanoid avatars
Blue mars	Blue Mars is another virtual world
Build	To create/make something out of primitives or prims in Second Life
Camera control	The camera control feature allows the user to manipulate their view of Second Life. The camera follows the avatar but can also be used to zoom in on and around objects that are not proximal to the avatar
Chat bot	A chatbot (or chatterbot, or chat bot) is a computer program designed to simulate an intelligent conversation with one or more human users via auditory or textual methods. In Second Life, chat bots are often represented as humanoid avatars
Client	(also see viewer) The client is the application used to view Second Life
Cyberpunk	Cyberpunk is a science fiction genre that features advanced science, such as information technology and cybernetics, coupled with a degree of breakdown or radical change in the social order. Cyberpunk plots often center on a conflict among hackers, artificial intelligences, and mega corporations, and tend to be set in a near–future Earth
Draw distance	The distance you can see in the far distance
Estate	An estate is a collection of regions with a particular set of shared rules
Friendship	When two residents become friends, their contact information is added to each other's friend list and the residents can now see each other's online/offline status, have the option to track each other's location in Second Life, and have the option to edit each others objects
Furry	A furry or "anthro" (short for anthropomorphism) is an avatar that has both human and animal qualities. In Second Life, "furry" avatars are those which use prim attachments to reflect upon a certain animal or mythical creature while keeping the basic humanoid framework. An example is a fox that has five fingers and walks on two legs in a bipedal fashion.
Grid	Linden labs operate four grids where a grid is an integrated system providing a networked collection of servers some of which are simulators that implement the presentation of land
Griefing	Griefing is a term which applies to activities designed to make another player's life or experience in Second Life unpleasant
Group	A group is an organisation consisting of two or more residents. A resident can be a member of up to 25 different groups. Groups can use group instant messaging and group voice chat. Groups can also own land and items. Members in special roles can send notices to group members
Heads up display (HUD)	A heads up display can be used in Second Life to display information (for example, a health meter might be used for inworld combat systems) or as control panels for scripted attachments such as Animation Overrides (AOs) or other devices
Hyper–gridding	Hyper–gridding allows the user to link their opensim (their own private virtual world) to other opensims (private virtual worlds) on the Internet.

	Hyper–gridding allows for seamless agent transfers among those opensims. The Hypergrid is effectively supporting the emergence of a Web of virtual worlds
Instant messaging	Instant messaging allows two residents to have a private conversation. Whilst local chat is limited to residents within a particular distance of an avatar, instant messaging is grid wide. A conference is similar to group chat and allows the resident to have a private grid wide conversation with multiple contacts
Inventory	A user's inventory is the collection of all the stored Second Life items that you own or have access to. The original copy of the inventory is stored in Second Life databases. A copy of the item list is downloaded to the client computer and saved in the cached data for the software. Inventory items can include objects such as clothing, furniture, building; scripts; notecards; snapshots; landmarks etc
Inworld	Being connected to the Second Life servers and present in the Second Life world (also: online), anything that takes place within the virtual environment of Second Life
Island	A Sim or group of Sims that are detached from the Linden Lab owned Mainland and only accessible by teleportation
Lag	Lag is the colloquial name for slow reaction time when using Second Life. Lag can be caused by client computer issues (e.g. limited processing power or graphics cards), server side issues and issues relating to the network connection
Land	Land in Second Life is measured in square meters. A parcel is the smallest unit of land available within Second Life and must be at least sixteen meters squared. A region is a named area hosted by a single simulator and is of fixed size (256m x 256m). An estate is a collection of regions with a particular set of shared rules.
Landmark	Landmarks are inventory assets that contain precise locations in Second Life. Their main purpose is to enable teleportation to that location
Linden Lab	Linden Research, Inc. (known as Linden Lab) was founded in, 1999 by Philip Rosedale to create a revolutionary new form of shared experience, where individuals jointly inhabit a 3D landscape and build the world around them. Philip Rosedale is the former CTO of RealNetworks, where he pioneered the development and deployment of streaming media technologies
Linden Scripting Language, LSL	Linden Scripting Language (LSL) is the programming language used by Residents in Second Life. LSL scripts can control the behavior of in–world objects. LSL has syntax similar to C
Local chat	Text based and inworld voice allow residents to chat with other nearby residents
Machinima	Machinima is a neologism based on the phrase machine cinema. The term is used to distinguish between traditional animation techniques (which use specialised 3D animation software) and animation projects that record the action in real–time interactive 3D environments, such as single–player video games or Second Life
MMORPG	Massively multiplayer online role playing game; online role playing games where thousands of players share a single world
Notecard	A notecard is an inventory item containing text and/or embedded textures, snapshots, objects, or other notecards. Items embedded in notecards have copy/modify/transfer permissions
OpenSimulator	Often referred to as Opensim, OpenSimulator is an open source server platform for hosting virtual worlds
Parcel	A parcel is the smallest unit of land available within Second Life and must be at least sixteen meters squared
Permissions	Residents can control the permissions of objects created or imported into Second Life. When purchasing objects, the ability to copy, modify or share objects is frequently limited by object creators. Land owners can operate sophisticated permissions controls to control access to and freedoms on land. For instance, build rights can be disabled on public land to prevent griefing

Primitive or prim	A primitive or prim is a single–part object. Objects made from prims are usually created in–world using the built–in object editing tool
Profile	Each user account in Second Life has a Profile, which can be viewed with the Profile window. Certain information is filled in automatically, but most of it is entered or made visible by the user. Each profile consists of seven tabs: a Second Life tab which lists information about the avatar, a web tab, an interests tab, a picks tab (listing favourite places in Second Life), a classified tab (for listing classified advertisements), a first life tab and a (private) notes tab
ReactionGrid Inc	ReactionGrid is a company which has adopted OpenSimulator as a platform that specialises in developing virtual worlds for business, art and education
Region	A region is a named 256m x 256m area hosted by a single simulator process. In common usage, the term "simulator" or "sim" may also refer to a region, but a single server process can host multiple regions. Regions can be flagged as PG, Mature, or Adult
Resident	Users of Second Life are known as residents
Rez	Rez in Second Life means to create or to make an object appear. Rezzing an object/prim can be done by dragging it from a resident's inventory or by creating a new one via the edit window. The term "rezzing" can also be used for waiting for a texture or object to load, such as "Everything is still rezzing." or "Your shirt is still rezzing for me"
Rezzer	An inworld application that is scripted in such a way as to allow a user or users to rez an object or collection of objects at the click of a button. Rezzers are used for many things in Second Life, including the creation of virtual holodecks in Second Life so that users can easily customize a particular space for multiple purposes
Shared media	Shared Media is a new feature introduced with Viewer 2. It's more powerful and flexible than the older parcel media, letting you put Internet content on any prim surface you can change, with new browser–like controls, and without the land restrictions
Sim	A sim host or sim node; it refers to the physical server machine. Each server can run multiple simulations or processes where each simulation or process simulates a single region
Simulator	The term simulator refers to a process running on a sim (sim host) to simulate a single region. A sim host can run multiple simulations (can simulate multiple regions) at once
Slurl	Slurls provide direct teleport links to locations in Second Life; a landmark is a slurl as a web address is to a hyperlink
Steampunk	Steampunk is a sub–genre of science fiction, alternate history, and speculative fiction that came into prominence in the, 1980s and early, 1990s. The term denotes fictional works set in an era or world where steam power is still widely used. It has prominent elements of either science fiction or fantasy; and it often features anachronistic technology or futuristic innovations as Victorians may have envisioned them. Based on a Victorian perspective on fashion, culture, architectural style, art, etc., this technology may include such fictional machines as those found in the works of H. G. Wells and Jules Verne or real technological developments like the computer
Streaming media	Music and video that may be heard and viewed on a parcel. Each parcel may have one video and one audio stream set at any one time. Users can turn streaming media on or off
Teleport	A Teleport is an instant change of your locations
Tiny	Tinies, or tiny avatars, are smaller–than–normal avatars usually found in the form of cute creatures
Viewer	(also see client) The viewer is client software used to view Second Life. Linden lab maintains an official Second Life viewer. Multiple open source viewers also exist, the most commonly used open sources viewer is Emerald

7.2 Appendix B Invitation to participate in the study

Hello all,

My name is Niamh O Riordan. I am currently undertaking a Ph.D. in the Business Information Systems (BIS) department at University College Cork (UCC), Ireland (www.ucc.ie). The purpose of this study is to shed light on innovation and knowledge creation in virtual world communities. Despite substantial anecdotal evidence of the high levels of innovation taking place in virtual worlds, little research has directly or empirically examined this phenomenon. The study specifically targets the educational community within Second Life.

I am currently soliciting data for my research and would be delighted and most grateful to speak with anyone involved in Second Life education projects. Specifically, I plan to investigate twelve Second Life education projects that

(i) Were carried out by or for third level institutions,
(ii) Were developed by at least three individuals, and
(iii) Can be reasonably well recalled by those individuals.
I would like to carry out a number of inworld interviews with participants in such projects and to visit the project inworld (where possible).

All information collected will be strictly confidential. All participants will receive a report of key findings. Any subsequent publications will be subject to a full review by all participants. All comments and sources of information are most welcome.

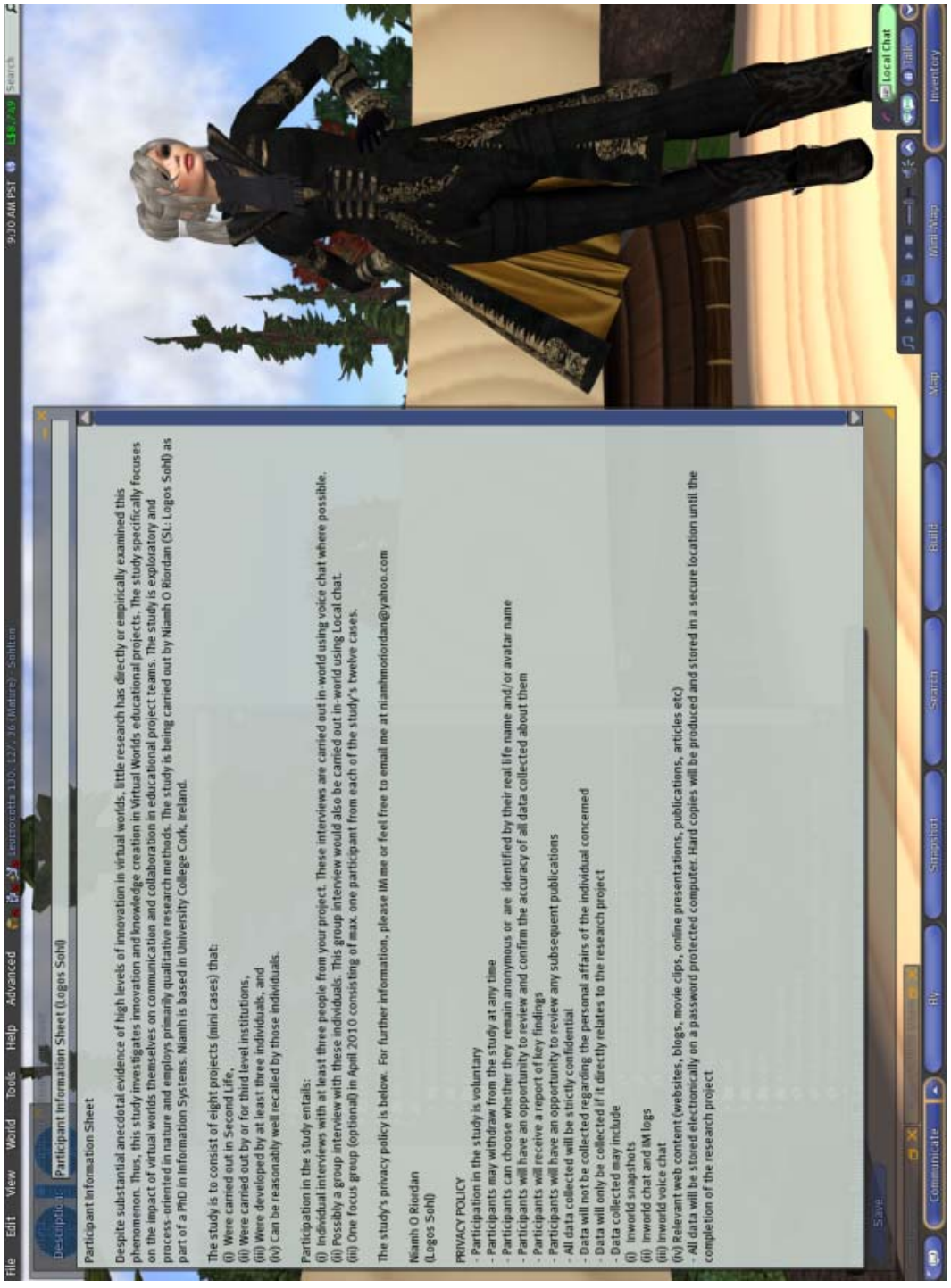
If you would like to be included in this study or if you have any questions, I would ask you to please contact me at your earliest convenience. In addition, if you know of others who might be willing to assist me, please feel free to forward this message to them.

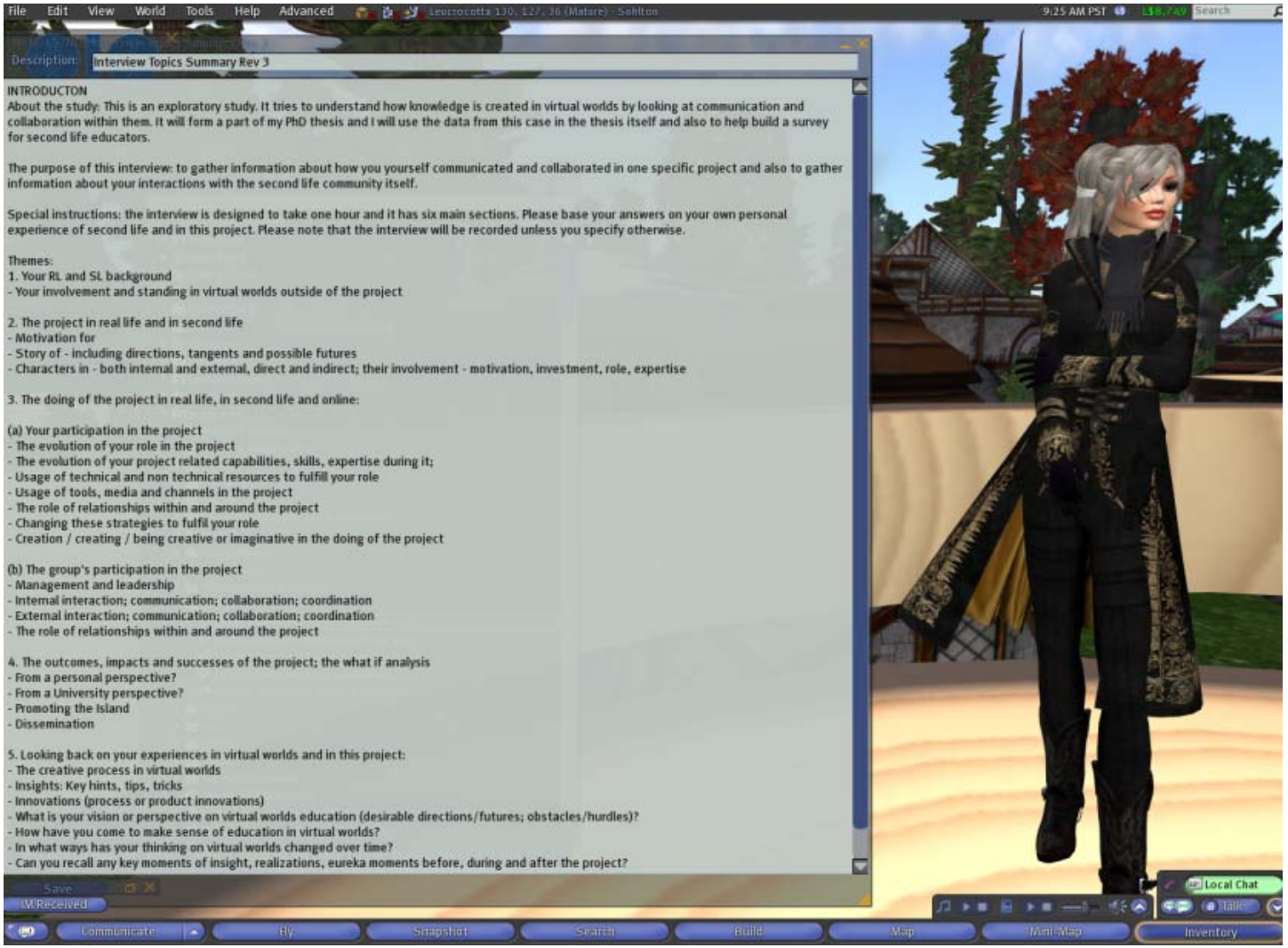
Apologies for the intrusion and thanking you in advance,

Niamh O Riordan
Ph.D. Student, University College Cork
SL avatar: Logos Sohl

7.3 Appendix C Samples of data collection and analysis documentation

7.3.1 Snapshots of participant information sheet and inworld interview guide




File Edit View World Tools Help Advanced
9:25 AM PST
Description: Interview Topics Summary Rev 3
INTRODUCTON
About the study: This is an exploratory study. It tries to understand how knowledge is created in virtual worlds by looking at communication and collaboration within them. It will form a part of my PhD thesis and I will use the data from this case in the thesis itself and also to help build a survey for second life educators.
The purpose of this interview: to gather information about how you yourself communicated and collaborated in one specific project and also to gather information about your interactions with the second life community itself.
Special instructions: the interview is designed to take one hour and it has six main sections. Please base your answers on your own personal experience of second life and in this project. Please note that the interview will be recorded unless you specify otherwise.
Themes:
1. Your RL and SL background
- Your involvement and standing in virtual worlds outside of the project
2. The project in real life and in second life
- Motivation for
- Story of - including directions, tangents and possible futures
- Characters in - both internal and external, direct and indirect; their involvement - motivation, investment, role, expertise
3. The doing of the project in real life, in second life and online:
(a) Your participation in the project
- The evolution of your role in the project
- The evolution of your project related capabilities, skills, expertise during it;
- Usage of technical and non technical resources to fulfill your role
- Usage of tools, media and channels in the project
- The role of relationships within and around the project
- Changing these strategies to fulfil your role
- Creation / creating / being creative or imaginative in the doing of the project
(b) The group's participation in the project
- Management and leadership
- Internal interaction; communication; collaboration; coordination
- External interaction; communication; collaboration; coordination
- The role of relationships within and around the project
4. The outcomes, impacts and successes of the project; the what if analysis
- From a personal perspective?
- From a University perspective?
- Promoting the Island
- Dissemination
5. Looking back on your experiences in virtual worlds and in this project:
- The creative process in virtual worlds
- Insights: Key hints, tips, tricks
- Innovations (process or product innovations)
- What is your vision or perspective on virtual worlds education (desirable directions/futures; obstacles/hurdles)?
- How have you come to make sense of education in virtual worlds?
- In what ways has your thinking on virtual worlds changed over time?
- Can you recall any key moments of insight, realizations, eureka moments before, during and after the project?
Save
IM Received
Local Chat
Communicate
Fly
Snapshot
Search
Build
Map
Mini-Map
Inventory

7.3.2 Samples of field notes

CASE FIELD NOTE FOBH RT, 2010 02 03 WS550080
So this is a memo following the interview last night with FOBH/RT, NM, it's about the FOB project. This has been by far and away my best interview so far. I did use an interview guide that I had changed, it now deals more with themes and is more reflective of individual experiences of the people I am talking to because I have found that they're just not in a position to answer some of the questions that were on the other guide, they're at a bit of a loss, and it's theme based as opposed to question based. I don't know if it's that it worked well or if it's that her background is also in research and therefore she was more au fait with the questions that I asked.

Anyway, the interview was amazing, it was great. Her background is impressive, the build is impressive, the cyborg is amazing and refers to herself and to her college as being one of the leaders here in virtual worlds education and I think she's quite self aware and she's not wrong, it's certainly the most impressive thing that I've seen so far. The things that stood out for this with her was the explicit consideration of the deliberate involvement in the community that she engaged in, she took many years to get involved in the dragon community and that was important in her teaching and in her role in this project. Also, the way that she included members from that community in this build because they had experience that enabled her to work far more effectively and quickly than the novice academics being brought in to do surveys, she just realised that was I think she said cost ineffective, it wasn't cost effective I think is what she said.

Also, everything they did was the plan was meticulous, I asked her about, directions, tangents, changes and she said there weren't any. They knew what they did, they designed the course for Second Life, the two were designed in tandem which is also something that we don't see, usually a lot of the projects are about aspects of courses and using Second Life to demonstrate aspects of courses, here is an entire course that was mirrored or mapped onto Second Life. Also it had four designers for the course which again is not something we usually see, usually we see one course person working with one developer so lots more people involved in this build and I wonder what that meant for the success of the build. She explicitly mentions the fact that the people she works with in the dragon world, I can't remember the name of it now, knew who she was in real life just as she knew who they are in real life. She had never met some of them, particularly TL who I will try to interview who is meant to be gifted but she's talked to him on the phone also most of their interactions are done in and through Second Life which is good to hear and talking about the new tools that are out there we did sort of talk of the evolution of tools, I think I prompted that in light of using google moderator, which I don't like by the way and ether pad and all these things people are beginning to use and she expressed the sentiment that I hold as well that they kind of kill the immersion they might be effective tools but really they are outside the world and really we need these tools inside the world.

She talks a bit about the development of the project in terms of years. First coming here in 2003, then spending a year getting into the community and then a year doing something else and then a year doing this, the time frame is years and that's not uncommon here. She speaks with great scorn about people such as myself who come into Second Life to teach in it with hardly any understanding of it and she's a little bit dismissive of the educational community itself in terms of its knowledge and expertise. Certainly the other people I've spoken to in Second Life who are doing good things and I'm thinking of RIT now the people in charge of these projects have involvement in communities outside of the educational community and that's often where they cut their teeth. I had a unique opportunity here to look at R's first build which was the ancient Tahitian hut based on a Cook drawing and I could see definitely an evolution of stuff but at the same time I got a sense of even that early build is clever enough in terms of how it's laid out and also that was my first clue as to her background which is incredibly diverse, it also gave me a heads up that this K.W. is a person she's been working with for a long time because K.W. is credited in the notecards at that build for being involved in the scripting and I think in finding textures that were needed and KW is the one who is charged to go into Second Life and learn it and K also comes back and teaches N about it and N does mention that both of them are lucky to have good backgrounds in graphics and multimedia.

N is the second person that I speak to to talk about trust, I think the other one is EXT/TB or EXT/DFS and she talks about the need for trust, that without this it's very hard to do anything and I ask her if establishing trust is about real life identity disclosure and disclosure is the word she uses so I use that word and she says no, definitely not, she doesn't really think about it. There are a few things in the

interview that she clarifies, she really wants to clarify certain things and I need to go back to those and underline those points because they are things that are important for her. The cyborg, she had mentioned in the chat that she wants to attach voice and I mention that I've seen avatars with voice attached and she said actually the trick is to attach the voice so the voice will walk with the avatar around the build and so that's something she's currently trying to work on and the cyborg itself was a tangent, a deviation from the original plan but that it was in fact only because the technology became sophisticated enough to enable it and she does refer to this later on a few times that well not a few times but she does bring it up again that all the time what's limiting them is what the technology can do, when the technology can do something else, then they can work with that.

She mentions that she has her own business as an avatar design specialist and she has a separate identity and she mentions that she has numerous alts for different things and when she said that about having an avatar company I went looking at my jeans and I was just mortified. Even if I knew enough to be able to choose which clothes to buy I would be very happy but at the moment I'm also happy that I haven't engaged to build somebody for me, she's my avatar and she might be a little bit rough around the edges but I made her, she is mine. And I'm not happy with this idea of having somebody else make me this seems a little bit sacrilegious to me. She uses the word advanced or complex in relation to levels of building skills that she possesses a few times and she talks about the evolution from simple things to advanced things, she's very self aware in terms of her level. She describes herself as an intermediate scripter she knows her level, she knows her strengths and weaknesses and she also has an eye for the strengths and weaknesses of others and does not think twice about involving them in her work.

She also mentions that she was keen to develop herself in Second Life independently from herself at E. College and this was something that came up at the legal issues for Second Life talk recently, it also came up with EXT/TL, I asked her about her avatar and who owned it, well I didn't ask her about that but that's what she talked about and there is this thing about who owns what in the virtual world, who owns the avatar, who owns the avatar's buildings, what does the college own when they hire you to work in Second Life and what do they not own and she's quite clear and other people have been as well that it's basically your professional life in Second Life is owned by the college as your professional work in real life bar your teaching is owned by them and your personal or social life in Second Life is not affected. I am beginning to think that I really do have to consider using two separate avatars and I really don't want to, I don't see why I should need to do this, I don't see why I should need to fracture my personality. Did I just say that? Not fracture my personality. But I am, I do just want to be Logos Sohl, I don't want to have alternative pools of contacts, I traverse the real life as me and I have many different faces that I wear and I don't see why I can't do that in Second Life as well. I do understand that there will be a time when I need to do this because my avatar will have run out of resources and my inventory will be too big etc but that's find, having avatar work horses is different from having avatar schizophrenia.

OBSERVATION FIELD NOTE VWBPE Participation and scale WS550125

As I get ready to do the reviewing for the VWBPE Practice based section for which I am now the stream lead I am forced to question my assumption that in virtual worlds community is small because it has to be. Here is a massive bunch of people organising I would also like to point out that I am using Google Docs, Google mail, my own email, and Google Groups to do this as well as word and excel and it's actually quite cumbersome to figure out what I'm meant to do…

OBSERVATION FIELD NOTE Snow crash Informs Second Life WS550430

This is just a thing for myself I'm reading Snow Crash right now, I am shocked at how much of Second Life is informed by it I have noted that I bought Snow Crash and Rainbow's end on the basis of people recommending and I have noted that all the time people refer to Second Life's history and traditions and it's a little bit like an oral culture in that way but very much if you want to understand Second Life it's with these cultural artefacts that you need to begin because they inform the minds of the people who create the world.

REFLECTIVE FIELD NOTE, 2010 03 12 WS550247

Just to give you an indication of what this is like last night I had a brain wave that I would bring the water filter into my room because that way I wouldn't keep sitting here dehydrating for hours on end because that's what happens, I want water and I'm thinking about water and then I don't go and then it's four hours later and I still haven't had water and I have to drag myself away to get it.

7.3.3 Samples of memos

FIELD MEMO, 2010 03 19 Info Literacy WS550292.WMA
I'm thinking about the information seeking thing yesterday and of course I am getting better at seeking information, knowing what to look for and a long time ago at the NCI place, no it wasn't there, it was somewhere else, I met somebody who swore everything he was wearing was a freebie and I was like how the hell do you do this and I looked ridiculous and he said well here look here's a few blogs he gave me a few blogs and I subscribed to them and didn't really know what I was doing when I did that but today when I went in to properly look at the google reader again, I keep going in to properly look at it and then not quite properly understanding it I spotted because I was looking I wanted to subscribe to the blog by the woman from yesterday, S, so I was googling that and I found out that feature is already in the google reader that it plugs in your blogger.com followers followings whoever you're following and so I looked in and sure enough there it was and so I discovered again that those blogs from that guy from so long ago were there and I opened up one of them and was looking at all the freebies…

ANALYTICAL MEMO, 2010 03 19 WS550296.WMA
That's the first session commented on the first day. In fact I wonder if there's any point going through the second because I think I'll be saying all the same things. I saw theatre productions and so I went to see a theatre show. People talk about you just have to eventually throw yourself in and just do it. Nothing bar experience is important. The talk yesterday about information search strategies and now I'm interested in the outcomes of the search strategies. Utility is important. You won't search for it unless you have a need for it. Language is important. You can't find it if you don't know oh I just pressed the wrong button, damn. You can't find it if you don't have the right language. Something you know one of the techniques we use is to watch experts work and you can do that by attending the builder's brewery session you are literally tapping into their stream of consciousness as they talk out what they're doing and show it to you. It is a demonstration. I hear about steam punk, I hear a good talk about I about that and so I want to find out about steam punk and I go looking for it. So the stimulation of creativity, sorry curiosity, and ability to search and find what you're looking for, the time to put into it and the wherewithal to process it. That goes on. And finding your niche is a big thing. For educators using virtual worlds for education because that's something they've decided is relevant to them but I wonder if it's an expression of their virtual selves more so than it is an expression of the functionality of the platform although I'm sure I'd be shot if I said that out loud.

ANALYTICAL MEMO NB WS550073.WMA
Framework number two came to me this morning as I was walking back from town okay it works like this people come into the virtual world first they have differing levels of knowledge and aspirations in timers of what they want to achieve, they learn by doing, trial and error it is the only way do to anything in virtual worlds, often there's a lot of hesitancy initially a lot of watching and observing as people try to get ideas and try to create mental models for how this might work they're looking for ideas for best practice they're looking to see what's being done and at this point they might be quite involve din the community, social relationships at this point are very important [2010 05 31 This part has recently been bourn out by studies done with LL data] because they keep the motivation going when the returns of the involvement aren't clear in terms of a professional purpose. A lot of people at this time also begin to discover that they can use it to fulfil their own career ambitions and it becomes a sort of a self serving interest for them after a while and otherwise they stay in the main community so basically you have trial and error kicking in after a certain amount of time and all the while the community is involved and sharing knowledge and sharing wisdom. As people become more expert and as their knowledge becomes more advanced they need the community less and less [2010 05 31 this does not necessarily mean that they leave it; they may stay involved for other reasons for instance reputational reasons, hedonic reasons, to become a community leader for example] because the insights the community has to offer are insights they themselves have already acquired and this is very much what I felt about last night's meeting where I felt that the woman speaking at ISTE had nothing to tell me I didn't already know and also she wasn't going to tell me how to do the things she was suggesting just that they were important to do and so it was no use to me so I think that's actually the thing. Over time the community becomes of less use because you already know the stuff they're talking about you've already learned it. Now chances are you've picked it up through the community through observation and interaction [2010 05 31 Or asynchronously using the tools the community uses to preserve its

knowledge and these are often online rather than inworld] with the community and from your own experience but that's why the interest tails off and that's why you find people in the end they're working on their own [2010 05 31 See the SL forum thread entitled LOST FOR WORDS for numerous compelling examples of people who see no one in world but continue clearly to participate via the forums] more satisfied with their trial and error and they can carry on with that so it's a curve where the network has initially very little and then higher involvement and then less involvement towards the end as people become more proficient [2010 05 31 Now again looking at Lost for Words you then see the loss of motivation due to lack of social interaction and that again ties back to the LL endorsed research from last week tying social metrics most strongly to predicting continued usage] and in the end it becomes more self directed learning, people know how to find what they need without using the community [2010 05 31 Or they only go to the same places because they are happy with them] and they know how to traverse the various tools that are out there often the people who succeed are also the ones who bring a lot of previous experience of technology to bear on their experiences here because there is just so much to learn that if you don't have some sort of conceptual background it's very hard. This is true of education, it's slightly different for the community at large [2010 05 31 Which is hedonically oriented] where the community itself works in different ways and is less formalised but I am looking at educators in terms of their work and they have formal meetings, agendas and are there for formal things so for educators at least this is how it works.

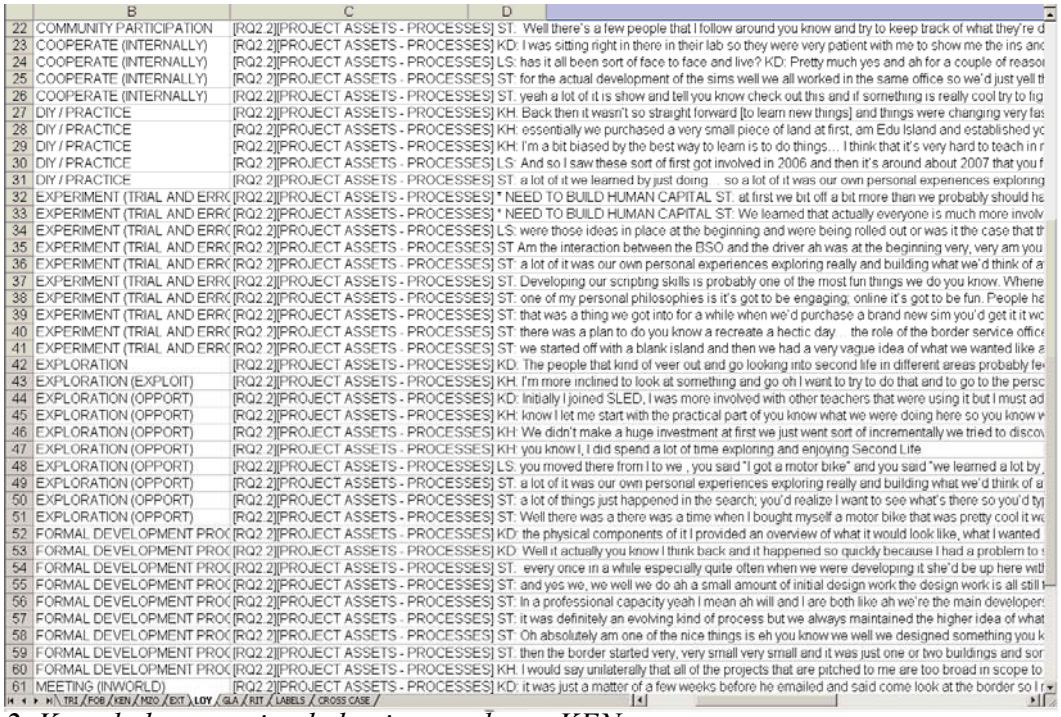
PATTERN CODE, 2010 02 11 MOTIVATION WS550089.WMA
This is my first pattern code memo. I think that motivation is strong affected by the community itself it's it's strongest impact. I also think that the community does not provide the knowledge and skills for people to do their job they are largely getting this knowledge themselves in a self directed fashion[40]. Some people do use the community but it's more limited and people are self directed learners here. I do however think that knowledge and innovation are different that the people how are truly innovative tend to be aware of the bigger picture of virtual worlds and what works for them that possibly comes from an involvement in the community at some sort of a meta level understanding of how to leverage the technology that doesn't come from the immediate know how that people need to do their jobs.

[40] 2010 05 30 As the thread on content creation in sl from the SL forum from yesterday does indicate, working in teams or small groups or with other individuals and friends who are more experienced is also an effective way to speed up the learning process.

7.3.4 Extracts of coded data

This section presents a series of extracts from the Microsoft Excel spreadsheet that was used to code knowledge-creating behaviours in the study. For each of the snapshots, the left most column of the spreadsheet lists distinct types of knowledge-creating behaviours in one particular case. The right most column of the spreadsheet associates each code with the original transcript data.

1. Knowledge-creating behaviour codes at LOY:



	B	C	D
22	COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: Well there's a few people that I follow around you know and try to keep track of what they're d
23	COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	KD: I was sitting right in there in their lab so they were very patient with me to show me the ins anc
24	COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	LS: has it all been sort of face to face and live? KD: Pretty much yes and ah for a couple of reaso
25	COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: for the actual development of the sims well we all worked in the same office so we'd just yell t
26	COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST. yeah a lot of it is show and tell you know check out this and if something is really cool try to fig
27	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: Back then it wasn't so straight forward [to learn new things] and things were changing very fas
28	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: essentially we purchased a very small piece of land at first, am Edu Island and established yc
29	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: I'm a bit biased by the best way to learn is to do things… I think that it's very hard to teach in r
30	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	LS: And so I saw these sort of first got involved in 2006 and then it's around about 2007 that you f
31	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: a lot of it we learned by just doing… so a lot of it was our own personal experiences exploring
32	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	* NEED TO BUILD HUMAN CAPITAL ST: at first we bit off a bit more than we probably should ha
33	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	* NEED TO BUILD HUMAN CAPITAL ST: We learned that actually everyone is much more involv
34	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	LS: were those ideas in place at the beginning and were being rolled out or was it the case that th
35	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST Am the interaction between the BSO and the driver ah was at the beginning very, very am you
36	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: a lot of it was our own personal experiences exploring really and building what we'd think of a
37	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST. Developing our scripting skills is probably one of the most fun things we do you know. Where
38	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: one of my personal philosophies is it's got to be engaging; online it's got to be fun. People ha
39	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: that was a thing we got into for a while when we'd purchase a brand new sim you'd get it it wc
40	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: there was a plan to do you know a recreate a hectic day… the role of the border service office
41	EXPERIMENT (TRIAL AND ERR(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: we started off with a blank island and then we had a very vague idea of what we wanted like a
42	EXPLORATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	KD: The people that kind of veer out and go looking into second life in different areas probably fe
43	EXPLORATION (EXPLOIT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: I'm more inclined to look at something and go oh I want to try to do that and to go to the persc
44	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	KD: Initially I joined SLED, I was more involved with other teachers that were using it but I must ad
45	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: know I let me start with the practical part of you know what we were doing here so you know w
46	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: We didn't make a huge investment at first we just went sort of incrementally we tried to discov
47	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: you know I, I did spend a lot of time exploring and enjoying Second Life
48	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	LS: you moved there from I to we , you said "I got a motor bike" and you said "we learned a lot by,
49	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: a lot of it was our own personal experiences exploring really and building what we'd think of a
50	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: a lot of things just happened in the search; you'd realize I want to see what's there so you'd tyj
51	EXPLORATION (OPPORT)	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: Well there was a there was a time when I bought myself a motor bike that was pretty cool it wa
52	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	KD: the physical components of it I provided an overview of what it would look like, what I wanted
53	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	KD: Well it actually you know I think back and it happened so quickly because I had a problem to s
54	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST. every once in a while especially quite often when we were developing it she'd be up here with
55	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: and yes we, we well we do ah a small amount of initial design work the design work is all still h
56	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: In a professional capacity yeah I mean ah will and I are both like ah we're the main developers
57	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: it was definitely an evolving kind of process but we always maintained the higher idea of what
58	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: Oh absolutely am one of the nice things is eh you know we well we designed something you k
59	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	ST: then the border started very, very small very small and it was just one or two buildings and sor
60	FORMAL DEVELOPMENT PRO(	[RQ2.2][PROJECT ASSETS - PROCESSES]	KH: I would say unilaterally that all of the projects that are pitched to me are too broad in scope to
61	MEETING (INWORLD)	[RQ2.2][PROJECT ASSETS - PROCESSES]	KD: it was just a matter of a few weeks before he emailed and said come look at the border so I r

2. Knowledge-creating behaviour codes at KEN:



	B	C	D
4	COLLABORATE (EXTERNAL)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: I think probably definitely the most challenging was the common reading experience one and the reason that one was so challe
5	COLLABORATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: Honestly I've been a little discouraged over the past six months or so because we haven't had that much that's new and actuall
6	COLLABORATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: Most of the projects that I've been involved on have involved working with two or three other people just because of the size and t
7	COLLABORATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: the next thing that I did was this play in the library and that was actually something that Beth and I worked on as well as anothe
8	COLLABORATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: The other challenging things that I've run into with all the projects is just working with other people in general to get the exhibit u
9	COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	1.2 AB: we would approach different units on campus I mean for the most part we were doing a lot of just sort of general PR about w
10	COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	1.3 LS: So initially a lot of your activities were around introducing people in the college to Second Life AB: Right yes just generally
11	COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	2.5 AB: And it was really shortly after our island went live fortunately that oz found us based on any time we did anything on the isla
12	COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	ab recognized that consumption was less important than the project AB: [building] was kind of fun I mean I was thrilled to pieces wh
13	COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: we have a list serve for example of all the folks who were involved in the project or even those who are casually interested and I t
14	COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: we've tended to document the things we've been involved with through [our] blog. We've tried to document along the way and doi
15	COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: some of my co-workers were playing around with Second Life and they said oh you have to do this it's so much fun and I said I
16	COMMUNITY (OUTREACH)	[RQ2.2][PROJECT ASSETS - PROCESSES]	[2010/02/27 8:42] Logos Sohl: Did you have a clear vision at that point of what UK ought to be thinking of at that point? [2010/02/27
17	COMMUNITY (OUTREACH)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: we have had periodic meetings and we have island wide events that we all try to participate in our first year was probably a lot of
18	COMMUNITY (OUTREACH)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: we try to have a different exhibit every two to three months and there have been a number of different people who have come in v
19	COMMUNITY (OUTREACH)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: [similar to GLA] Jin fact we did a conference exhibit or presentation in September where we just talked about what it is we've be
20	COMMUNITY (OUTREACH)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: as far as boosting the participation a lot of the things that we do it really depends on what the exhibit is as far as how we adverti
21	COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	LS: how did you get to know those experienced builders? AB: I guess through just those happy accidents again some folks would a
22	COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	LS: know the more time you spent in here the more people you met did any of those people figure in how you acquired skills AB: ye
23	COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	[2010/02/27 9:04] Logos Sohl: Do you engage with a lot of folks in the building community isl? I know I've seen you at the immersic
24	COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	[2010/02/27 9:58] OZ: The project that isn't here was not at UK. It was a learnning community elsewhere. They built a city based on
25	COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: then from there I moved into I have a great idea for an exhibit and I've never built anything from scratch but Id like to try and JJ w
26	COLLABORATE (EXTERNAL)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: well that's also been an evolution for sure when I first got into second life I was very involved in library projects I wasn't as involve
27	COOPERATE (INTERNAL)	[RQ2.2][PROJECT ASSETS - PROCESSES]	[2010/02/27 9:00] OZ: Most of my work here I did alone, but in consultaiton with the planning committee. [2010/02/27 9:00] OZ: W
28	COOPERATE (INTERNAL)	[RQ2.2][PROJECT ASSETS - PROCESSES]	[2010/02/27 9:29] OZ: Well, I find that knowing the tools and resources helps me find alternate solutions. Here's an example… [201
29	COOPERATE (INTERNAL)	[RQ2.2][PROJECT ASSETS - PROCESSES]	[2010/02/27 10:07] OZ: Well, I love to share my expertise. I love the creative energy here. So I like to help others when I can. [2010/
30	COOPERATE (INTERNAL)	[RQ2.2][PROJECT ASSETS – PROCESSES]	AB: Oz held a couple of building classes for our folks and has been a real source of information for whenever any of us have had que
31	COOPERATE (INTERNAL)	[RQ2.2][PROJECT ASSETS - PROCESSES]	Am as far as people and using resources, B or A I kind of fluctuate between her names, she is my primary go to person. I would say
32	DELEGATE	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: And then am the last thing that I've done and I haven't really been very active since this point because I'm also in school so it's b
33	DELEGATE	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: B has been one who really encourages people to get involved and she has said many times she will say I don't want to be the o
34	DELEGATE	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: it was during one of our elections where Beth said hey lets have a political party and she asked me if I would be interested in do
35	DELEGATE	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: Well initially we were hanging out for the most part and we slowly got pulled into more so offering advice for the meth lab thing th
36	DELEGATE	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: when I first came in I had this conception that only certain people on the island could do these kinds of projects. I didn't feel I co
37	DELEGATE	[RQ2.2][PROJECT ASSETS - PROCESSES]	INTEREST THEN PROJECT NOW REGROUP AB: I think now we've settled into more discrete projects kind of taking on a life of the
38	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	2.0 BOTH OF THESE HAVE THEIR OWN SPECIFIC IDEAS BASED ON THEIR BACKGROUNDS AND RELATED TO THEIR INTEF
39	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	2.1 LIBRARY AB: the very first thing on the island was the library because I was one of the early builders I was a total novice and the
40	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	2.2 AB: I built a few other things on the island we decided about what kinds of things we wanted initially before we opened to the pub
41	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	2.4 AB: we had a couple other sort of basic infrastructure type constructions in the island most of it I guess that I built and a few of t
42	DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	THIS ISN'T CAPITAL BUILDING, THIS IS CONSUMPTION CF. SCHULTZ AB: we really wanted to build it ourselves we didn't want to
43	EXPERIMENT (TRIAL AND ERROF	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: I did a lot of online tutorials, I attended a few building classes, I experimented, I used the sand boxes at other islands and just p
44	EXPERIMENT (TRIAL AND ERROF	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: I have done searches within Second Life to try to find information on things there was one point and I cant remember exactly wh
45	EXPERIMENT (TRIAL AND ERROF	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: one of the most important things for me has been knowing how to do an effective search to find what I need really you have to kr
46	EXPLORATION INWORLD (OPPO	[RQ2.2][PROJECT ASSETS - PROCESSES]	EH: I fumbled around for about two months and I ended up learning how things work by asking a lot of questions, I spoke to a lot anc
47	MEETINGS (REAL WORLD)	[RQ2.2][PROJECT ASSETS - PROCESSES]	[2010/02/27 8:50] OZ: Ah. Well we had a planning committee. [2010/02/27 8:51] OZ: Basically we talked about what we might like
48	MEETINGS (REAL WORLD)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: Honestly I've been a little discouraged over the past six months or so because we haven't had that much that's new and actuall
49	OBSERVE (IMITATE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	AB: LS: the initial idea you had the ideas for the admission center, on what basis did you how did you decide at that time that those
50	PILOT PROJECT	[RQ2.2][PROJECT ASSETS - PROCESSES]	2.3 AB: he was interested in looking at just the technology itself and the potential for education he was a fairly inexperienced builder

3.Knowledge-creating behaviour codes at GLA:



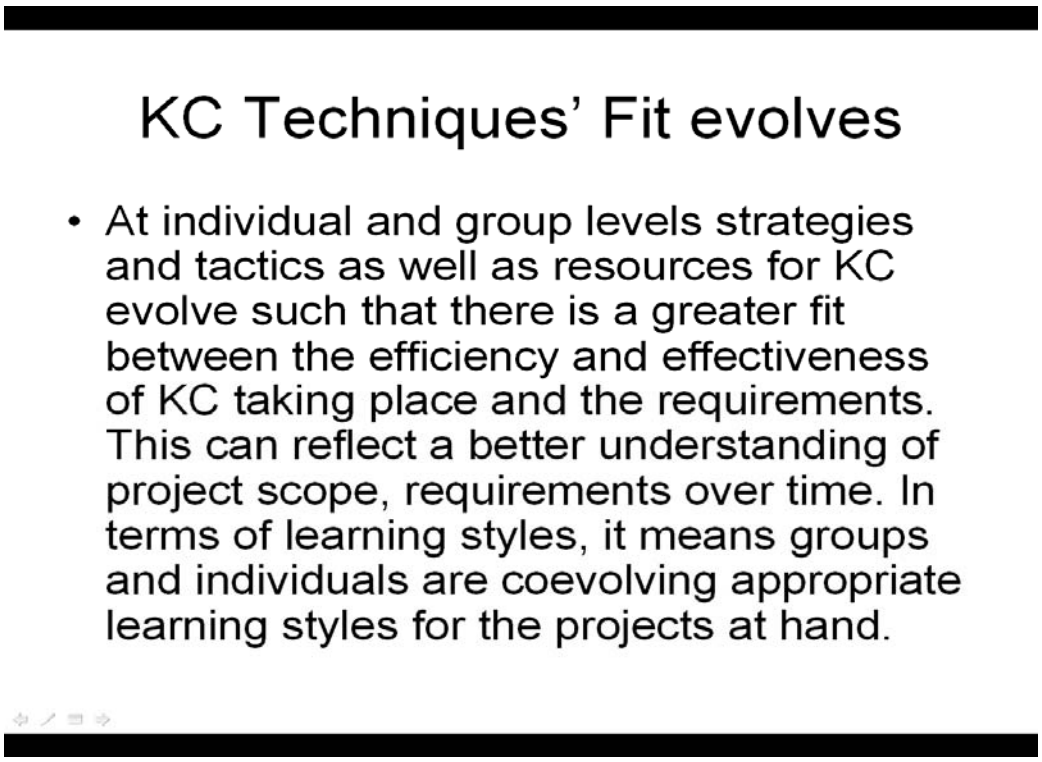
B	C	
COLLABORATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COLLABORATE: AB: K--- is a lecturer here AB: So this is really her project it's my, I'm doing the technical concepts on it, the ide
COLLABORATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COLLABORATION: [2010/01/15 8:40] GG: I didn't yet quite know how to stimulate & involve people in academia, how to reach the
COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COLLABORATE *Trying to grow: KP: Beyond that, there are, my calling cards is full of people throughout the world where we eithe
COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	OUTREACH: [2010/01/15 8:24] GG: the principal wanted this and gave it to Robert Crawford, who was .. lemme think [2010/01/15
COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	OUTREACH: [2010/01/15 8:31] GG: ok, at that time there were 7 academic schools (2 now merged into one, there's actuall a roy
COMMUNICATE (PR)	[RQ2.2][PROJECT ASSETS - PROCESSES]	PRACTICE: AB: Am I did a lot of the technical development, yeah, yeah I guess [45.05] AB: Am well the wall you see around you
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE (COMPETITIO) [2010/01/15 8:40] GG: so, another .. how do I call it [2010/01/15 8:40] GG: I didn't think it would b
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE (peer support) (KP mentions keeping GG up to date; so does GG) [2010/03/25 9:11] Logos Sohl: I do think the stu
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	OBSERV: AB: This is a typical, the floor's all gone, a lot of stuff's gone but it was my first attempt at building a conceptual copy o
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	OUTREACH: AB: we're long time colleagues and she said come along it's not what you think and am I went along and realized it v
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	OUTREACH: And I was only, I was just trying to get a few folk interested in it, there was a small night class going but and then lik
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	OUTREACH: EVENING CLASS [2010/01/15 8:56] GG: oh, this reminds me [2010/01/15 8:56] GG: in the early days, we did son
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	OBSERV: KP: Yeah completely and what I've done is taken some of the other people in the uni who are interested to see other pe
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	RESEARCH: KP [3.27]: well basically one my other colleagues had used it with [pre registration?] students and when I first saw i
COMMUNITY OUTREACH	[RQ2.2][PROJECT ASSETS - PROCESSES]	OBSERV: then I show it to the educational people who think, who usually seem to think it's good let's do this we sort of refine it a
COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPLORE: JUMP IN AND EXPERIENCE (IT): [2010/03/25 8:35] Logos Sohl: I was just about to ask "have you since decided wha
COMMUNITY PARTICIPATION	[RQ2.2][PROJECT ASSETS - PROCESSES]	PARTICIPATION: then I started going to different educational areas joined certain groups like the virtual worlds education roundtabl
COOPERATE (EXTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COLLABORATE *Trying to grow: KP: Beyond that, there are, my calling cards is full of people throughout the world where we eithe
COOPERATE (EXTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	IMITATE: Eh, so what we're looking for and some people have done this down south, is a web interface where the lecture can just
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPErATE [good for motivation, enjoyment; there's a group of 5 or 6 here *evidence of divisions] here: KP [33.10]: First thing is
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE [2010/01/15 9:13] GG: we email like you wouldn't believe [2010/01/15 9:13] Logos Sohl: what about skype [2010
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE (COMPETITIO) [2010/01/15 8:40] GG: so, another .. how do I call it [2010/01/15 8:40] GG: I didn't think it would b
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE (GO TO GUY) [2010/01/15 9:16] Logos Sohl: and do you guys ever help one another out [2010/01/15 9:17] Logos
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE (GO TO GUY) HELP DESK [2010/02/11 4:10] KP: (Saved Thu Feb 11 12:09:20 2010) i should say that Ferdinand i
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE FACILITATE (chaperone) *ALSO EXT, TRI: [2010/03/25 9:08] GW: Its often a processs of a) unpicking what they w
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE: basically that's exactly it I get used to using it myself you know how to negotiate the actual area and then I investig
COOPERATE (INTERNALLY)	[RQ2.2][PROJECT ASSETS - PROCESSES]	RESEARCH (knoweldge base) [2010/01/15 9:16] Logos Sohl: and do you guys ever help one another out [2010/01/15 9:17] Logo
DELEGATE	[RQ2.2][PROJECT ASSETS - PROCESSES]	SUPPORT: [2010/03/25 9:24] GW: being able to support lecturers and development staff in doing this too. We woul not have move
DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	OBSERVE: [2010/03/25 8:51] GW: I was also very interested for myself in knwoing how SI worked[2010/03/25 8:51] GW: and I w
DIY / PRACTICE	[RQ2.2][PROJECT ASSETS - PROCESSES]	OBSERV: AB: This is a typical, the floor's all gone, a lot of stuff's gone but it was my first attempt at building a conceptual copy o
EXPERIMENTATION (TRIAL AND	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENT (from the CU There website) Technological innovations always precede coherent teaching about them, innovators a
EXPERIMENTATION (TRIAL AND	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENT (TRIAL AND ERROR)Evolution through practice and a social dimension; G.CONT says that "the more I used it, the
EXPERIMENTATION (TRIAL AND	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENT: [2010/03/25 9:23] GW: What worekd was people willing to jump in and just try stuff, and not be too concerned if s
EXPERIMENTATION (TRIAL AND	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENTI tried a few things myself I thought about how does that fit with what they'd be doing over all the modules em how w
EXPERIMENTATION (TRIAL AND	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPLORATION: [2010/03/25 9:23] GW: In many ways we have been lucky, it is a luxury really to be able to explore
EXPLORATION (PURPOSE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE: basically that's exactly it I get used to using it myself you know how to negotiate the actual area and then I investig
EXPLORATION (PURPOSE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENT *v effective as AB is v happy with her* KP [45.12]: Okay so I think probably as I got used to the environment myself
EXPLORATION (PURPOSE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENT (TRIAL AND ERROR)Evolution through practice and a social dimension; G.CONT says that "the more I used it, the
FORMAL TRAINING	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE: training Andy is a strategic inter departmental cooperation to stimulate empowered individuals to run with this
FORMAL TRAINING	[RQ2.2][PROJECT ASSETS - PROCESSES]	OBSERVE: [2010/03/25 8:51] GW: I was also very interested for myself in knwoing how SI worked[2010/03/25 8:51] GW: and I w
MEETINGS (REAL WORLD)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COMMUNICATE: 2010/01/15 9:11] Logos Sohl: and how do you guys communicate then? [2010/01/15 9:12] Logos Sohl: irl? isl?
METAPHOR / COGNITIVE TEMPL	[RQ2.2][PROJECT ASSETS - PROCESSES]	METAPHOR: LS: And is it you haven't worked with chat bots yourself anywhere else before this AB: Not until I started investigatir
OBSERVE (IMITATE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	COOPERATE: basically that's exactly it I get used to using it myself you know how to negotiate the actual area and then I investig
OBSERVE (IMITATE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENT (TRIAL AND ERROR)Evolution through practice and a social dimension; G.CONT says that "the more I used it, the
OBSERVE (IMITATE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPERIMENT *v effective as AB is v happy with her* KP [45.12]: Okay so I think probably as I got used to the environment myself
OBSERVE (IMITATE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	EXPLORE: LS: ... problem based learning you said you'd seen it, had you seen it in Second Life or had you seen it somewhere el
OBSERVE (IMITATE)	[RQ2.2][PROJECT ASSETS - PROCESSES]	RESEARCH/INWORLD: AB: Yeah I guess am you pick up on [keywords?] and you're looking for serious examples of scripting or

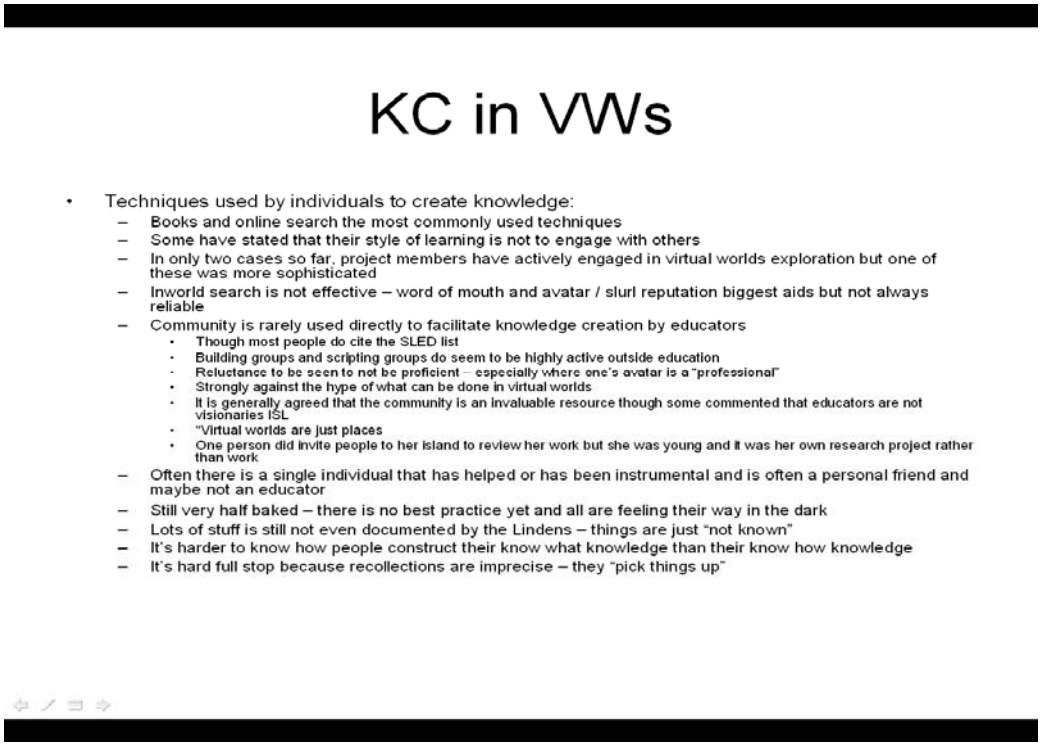
TRI / FOB / KEN / MZO / EXT / LOY / GLA / RIT / LABELS / CROSS CASE / CROSS Q TEMP / CROSS QUESTION

4. Illustration of an early cross-case analysis knowledge-creating behaviours constructed in Microsoft Excel (2003).

	B	C	D	E	F	G	H	I	J	K	L
61	**TYPE**	**TECHNIQUE**	**TRI**	**FOB**	**KEN**	**MZO**	**EXT**	**LOY**	**GLA**	**RIT**	**Total**
62	**Exogenous exploratory**										
63		Communicate (PR)			✓	✓		✓	✓	✓	5
64		Exploration inworld (opport	✓	✓	✓			✓	✓	✓	6
65		(Community) Outreach	✓		✓			✓	✓	✓	5
66		Community participation		✓	✓	✓		✓		✓	5
67		Research		✓	✓	✓	✓		✓		5
68		Subtotals	3	3	5	3	1	4	4	4	26
69	**Endogenous exploratory**										
70		DIY / Practice	✓	✓	✓	✓		✓	✓	✓	7
71		Self directed learning	✓		✓	✓		✓	✓	✓	6
72		Brainstorm (real world)	✓	✓	✓		✓	✓			5
73		Brainstorm (inworld)		✓			✓				3
74		Subtotals	3	3	3	3	2	3	2	2	21
75	**Exogenous exploitative**										
76		Collaborate (externally)		✓	✓	✓	✓	✓			5
77		Recruit	✓	✓			✓	✓	✓		5
78		Exploration Inworld (purpos	✓	✓				✓	✓		4
79		Observe (imitate)			✓	✓		✓	✓		4
80		Transact/outsource compo	✓	✓		✓	✓				4
81		Cooperate (external)		✓		✓				✓	3
82		Purchase artifacts				✓		✓			2
83		Formal training								✓	1
84		Subtotals	3	5	2	5	3	5	3	2	28
85	**Endogenous exploitative**										
86		Experiment (trial and error)	✓	✓	✓	✓		✓	✓	✓	7
87		Collaborate (internally)	✓	✓	✓	✓		✓	✓		6
88		Cooperate (internal)		✓	✓	✓		✓	✓	✓	6
89		Meetings (real world)	✓	✓	✓		✓			✓	5
90		Metaphor / cognitive template		✓		✓		✓	✓	✓	5
91		Pilot project(s)		✓	✓	✓		✓			4
92		Formal development process		✓		✓		✓		✓	4
93		Meetings (inworld)		✓			✓	✓			3
94		Delegate		✓	✓						2
95		Subtotals	3	9	6	6	2	7	4	5	42
96	**Totals**	Number of techniques use	12	20	16	17	8	19	13	13	118
97		Number of codes recorded	18	39	57	44	33	69	63	40	

7.3.5 Examples of key themes emerging during data analysis





7.3.6 Extract from detailed case write up at GLA

This is an extract of the detailed case write up that was carried out during the data analysis phase of the study. The extract constitutes a description and evaluation of seventeen instances of eight knowledge-creating behaviours at GLA.

BEHAVIOUR	ANALYSIS
Co-operation	**Description:** Co-operative learning was used during initial evening classes. There are regular, informal co-operative interactions; "we sit in the pub and iron things out before they're an issue" (G.PM). When knowledge bases fail, they are "each other's first line" (G.PM); G.PM is "kept in the loop" because "sometimes we need his expertise" (G.CONT). G.DEV's original six month placement with G.PM was effectively an interdepartmental co-operative initiative. At the SOH, a 'subgroup' meets to "share information" and discuss what each member is doing: "Oh, I want to do that as well. How did you do it?" (G.CONT)
	Evaluation: Co-operation is used extensively and successfully across departments at GLA. "we were *all* learners… no-one was an expert [but] between us as a group, a community, we learned much more than we'd have done with a traditional approach" (G.CONT). The interdepartmental training initiative shrewdly transferred skills in the organisation. None of the instances of co-operation identified take place in Second Life itself
Collaboration	**Description:** Co-operation and collaboration are the hallmark of GLA's Second Life project. A competition asked people to "give an idea for use of SL in your teaching and learning and we'll support it with money and manpower". G.PM and G.FAC collaborate extensively; as do G.DEV and G.CONT, the latter working primarily inworld. G.CONT is "a sort of glue" (G.PM) facilitating collaboration between educators and developers. Her work is a process of "unpicking what [educators] want" and "helping support services understand" (G.FAC)
	Evaluation: Collaborative behaviours are very successful, but few take place inworld. G.CONT says it is "far more engaging… [and] much easier to visualize things when we're doing it; we can just build and show each other straight away…"
Research	**Description:** Many project activities have a research component: e.g. learning outcomes research was a condition of the competition. Inworld and online research is also used. G.CONT "started [by] researching different health areas to get an idea of what people were doing and what Second Life was capable of…"; she looked for published research. G.DEV looks for "serious examples of scripting or graphic design"; he has a 'thing' for nice builds. G.DEV says they "get ideas" through "looking at stuff on with from the web… [and] one or two email lists"
	Evaluation: Tight linkages between teaching and research encourage ongoing project assessment. Individuals use research after some initial introduction to crystallise and evaluate the feasibility of their ideas. G.CONT describes being "a bit like 'how am I going to use this' and then seeing "things [she] thought she could use". It is a proactive activity but is not fully purposeful.
Outreach	**Description:** OUTREACH is extensively used at GLA from the start to "stimulate understanding" and "get a few folk interested" (G.DEV). Behaviours used included the 'spamming of internal mail'; a college wide competition; open days; evening classes; the creation of a SOH blog and a series of Machinima videos;
	Evaluation: OUTREACH is very successful. It boosts participation and facilitates the crystallization of project ideas. G.FAC, G.CONT and G.DEV all became involved based on outreach behaviours (G.FAC: email; G.CONT: open day; G.DEV: meeting). The effect snowballs: G.CONT brings G.DEV in and an interest group is created at SOH
Practice	**Description:** G.CONT used google and watched videos but then "just spent

	time in [Second Life], clicked things, looked through the menus, moving and things". G.DEV shows me his first build in Second Life: "it was my first attempt at building a conceptual copy of a ward in a virtual world… this was me learning to build in Second Life, this is where I learned it, and the prims, everything is a bit boxy as you can see so I'm just learning how to [build]". G.FAC also became a builder in her own time
	Evaluation: G.CONT "spend a lot of time in" Second Life and the more she used it, the "more [she] got used to it and the more ability [she] had to technically do". G.DEV "learned a lot… a lot of technical programming concepts, Lindens' internal scripting language, how it ties up with graphics, mono" etc. G.FAC felt it was not strictly necessary but she "wished to learn so that [she] could understand the technology and the environment better"
Experiment (trial and error)	**Description:** Experimentation at GLA is iterative and evolutionary. G.CONT would "try a few things" and then look for ways to "build or enhance" it. Experiments are inspired by inworld exploration and have a collaborative dimension: "you learn something new, I learn something… I [might] discover something on my travels, I'll tell [G.DEV] about it… we come back together [and decide to] change that or do this"
	Evaluation: What worked at GLA was "people willing to jump in and just try stuff, and not be too concerned if something *didn't* work" (G.FAC). G.PM says "technological innovations always precede coherent teaching about them, innovators and early adaptors just have to self teach by trial and error, inventing and painting the wheel as they go". G.CONT says "it's just about really trial and error"; through it "other ideas came in" that 'spurred' her on
Explore	**Description:** All of the case study participants are involved in exploration; for instance, G.DEV likes to explore 'good builds'. G.CONT is engaged primarily in educational exploration; reporting back on 'discoveries' made during her 'travels' to G.DEV and the SOH special interest group
	Evaluation: Exploration is used to stimulate idea generation. G.FAC suggests that "it is a luxury to be able to explore"; G.CONT describes seeing other projects and using ideas from them to inform the construction of her own projects
Observation (Product)	**Description:** Observation is used to 'stimulate [outsiders'] understanding' in order to 'convince them' that it is "an avenue they could use" (G.CONT). G.DEV demonstrates his own work in the virtual world; G.CONT takes people to see other people's work and arranged "wee chats"
	Evaluation: Showing "the idea of a conceptual space where you teach in the virtual… was really useful… people got the idea that this had possibilities" (G.DEV). "There is an element of seeing is believing… [people] see the pedagogy shining through… it convinces them…" (G.CONT)
Observation (Process)	**Description:** G.FAC would visit the island when G.PM was building and "just kind of watch, see how he did things… [then] I'd ask and he'd tell me how he made things". G.FAC was "just fascinated in seeing 'things' appear!" G.PM and G.DEV would also often "work side by side"
	Evaluation: This form of knowledge creation behaviour is similar to "work shadowing" and is a form of mentoring. Like product observation, it is accompanied by dialogue; in this case, a question and answer dialogue
Recruit	**Description:** GLA entrusted their Second Life project to a registered SL solution provider (G.PM) who suggested he could "do it alone". The initial scope was to "realise their Second Life presence and arrange for what was needed"
	Evaluation: GLA quite consciously hired in the necessary expertise to implement a project "alone" with a very broad scope but in fact a series of outreach behaviours were used to ensure the project was developed co–operatively and collaboratively.
Imitate	**Description:** G.DEV suggests that he would get technical ideas by "looking at a lot of YouTube videos and thinking 'that's quite nice'". G.DEV is also aware of the fact that "some people have done" one of his next project stages "down south". G.CONT had "seen it [the use of problem based learning in Second Life) and then did it"

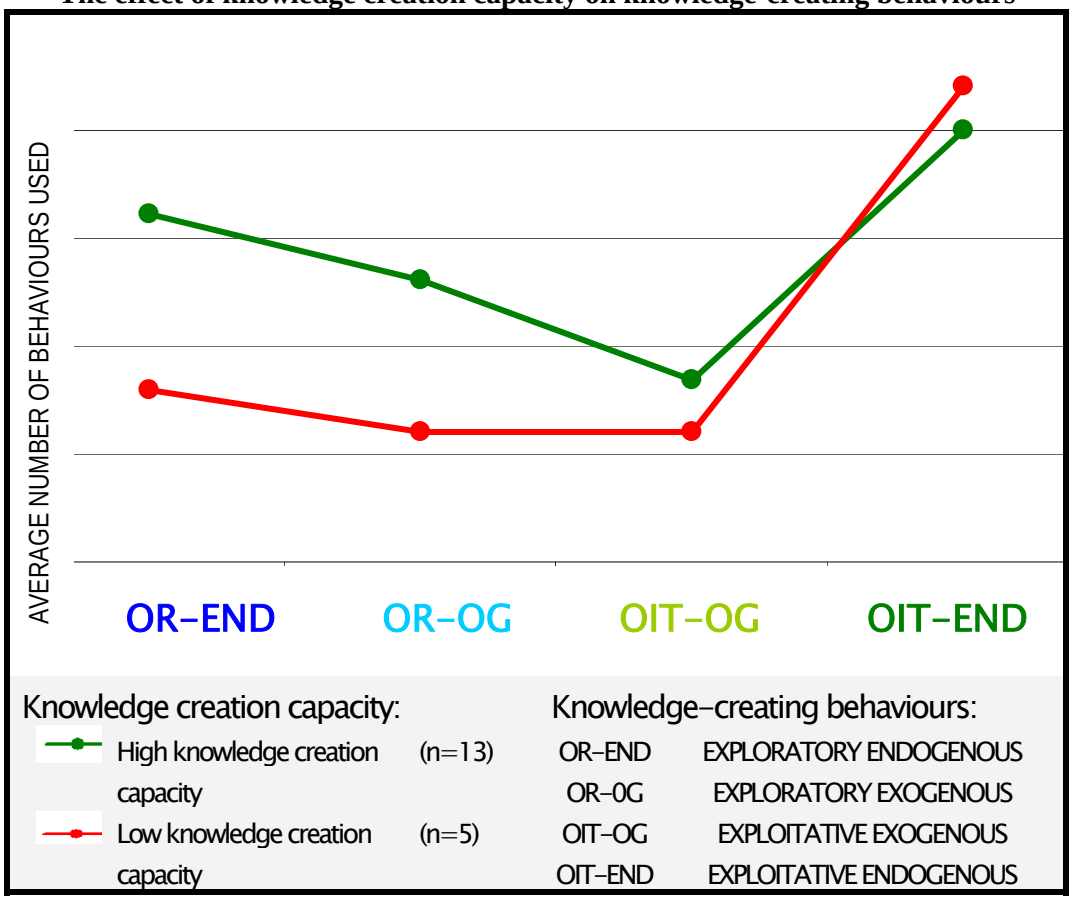
	Evaluation: Imitation can be used as a behaviour to suggest ideas at the earliest design stages or it can be used later on to support the refinement of ideas and the adaptation of projects. Imitation must be preceded by observation which can occur through exploration or research
Support	**Description**: Support is available to both lecturers and development staff at GLA.
	Evaluation: G.FAC suggests that one of the things that worked at GLA was being able to support the project team: "we would not have moved this quickly. In many ways I am no longer needed. The lecturers have engaged in it now and are off and doing for themselves"
Metaphor	**Description**: G.DEV broke his goal into requirements and then looked at the affordances of each potential software solution, knowing that there are "different ways of approaching it". He "knew about the technology [and] knew it was do–able" but there were "no pre–existing links being made" so he "just started thinking of everything as being a web service" to design the solution
	Evaluation: G.DEV was effectively assembling software in novel ways to solve a problem that hadn't (to his knowledge) been solved before and was able to use a metaphor to achieve that aim. He says it "wasn't massively complicated"

7.4 Appendix D Tabular displays used to generate line charts

This appendix is concerned with Figures 5.12-5.14 and Figures 5.16 – 5.17. The x-axis in these charts distinguishes between four types of knowledge-creating behaviours. The y-axis in these charts depicts the average number of knowledge-creating behaviours used by different groups of individuals. It was necessary to calculate average values because of differences in the sizes of these groups of individuals. The y-axis in these charts does not display the numerical values that were used to generate the charts. The reason for this is to avoid any possible confusion between the *actual* number of knowledge-creating behaviours used and the *average* number of knowledge-creating behaviours used. This section therefore reproduces each chart and clearly illustrates how the figures used to create it were generated.

FIGURE 5.12

The effect of knowledge creation capacity on knowledge-creating behaviours



ORIGINAL TABULAR DISPLAY:

KNOWLEDGE CREATION CAPACITY (FROM PRIOR RELATED KNOWLEDGE)	OR-END	OR-OG	OIT-OG	OIT-END	n
High	21	17	11	26	13
Low	4	3	3	11	5

The figures in the transformed display were calculated by dividing each value in the original display by the corresponding value of n (where n represents the number of individuals within that particular group). For example

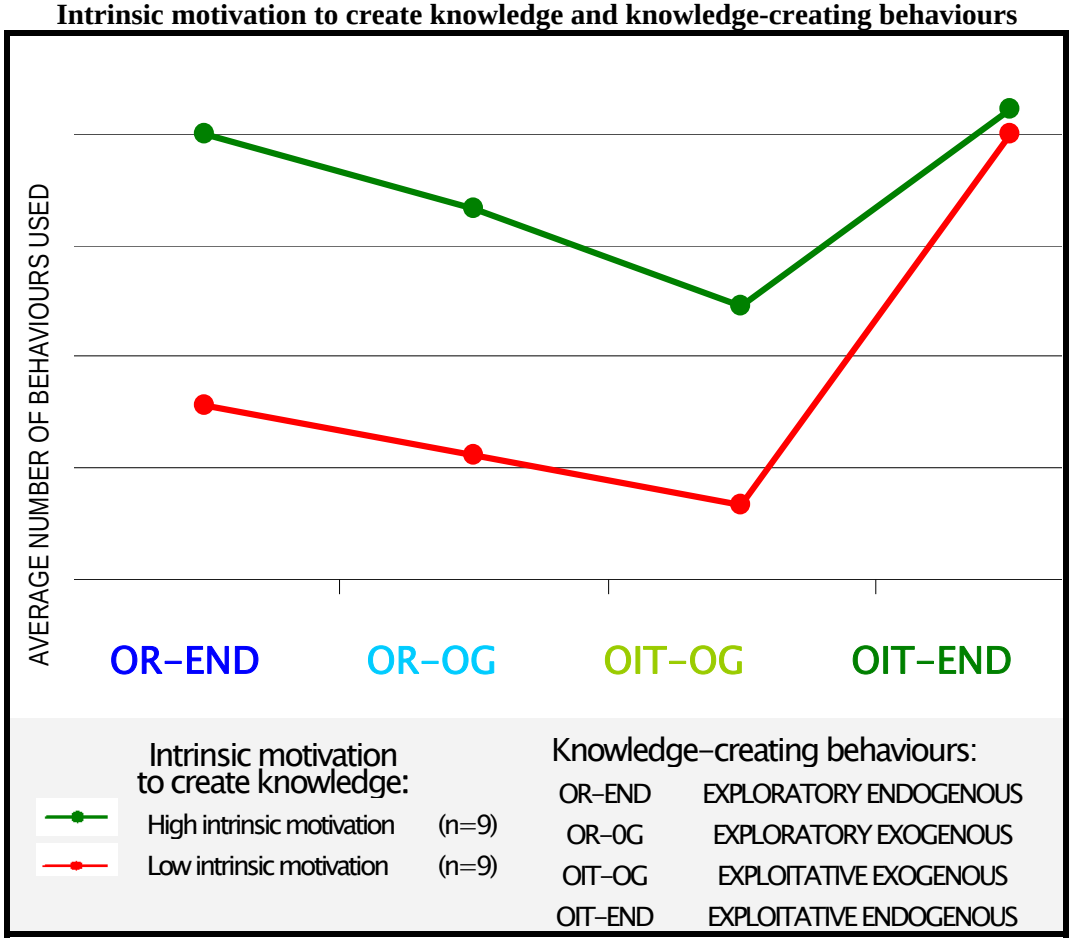
$$21 \div 13 = 1.615385$$

TRANSFORMED TABULAR DISPLAY (USED TO GENERATE CHART):

KNOWLEDGE CREATION CAPACITY (FROM PRIOR RELATED KNOWLEDGE)	OR-END	OR-OG	OIT-OG	OIT-END
High	1.615385	1.3076923	0.846154	2
Low	0.8	0.6	0.6	2.2

FIGURE 5.13

Intrinsic motivation to create knowledge and knowledge-creating behaviours



ORIGINAL TABULAR DISPLAY:

INTRIN MOTIVATION TO CREATE KNOWLEDGE	OR-END	OR-OG	OIT-OG	OIT-END	n
High	18	15	11	19	9
Low	7	5	3	18	9

The figures in the transformed display were calculated by dividing each value in the original display by the corresponding value of n (where n represents the number of individuals within that particular group). For example

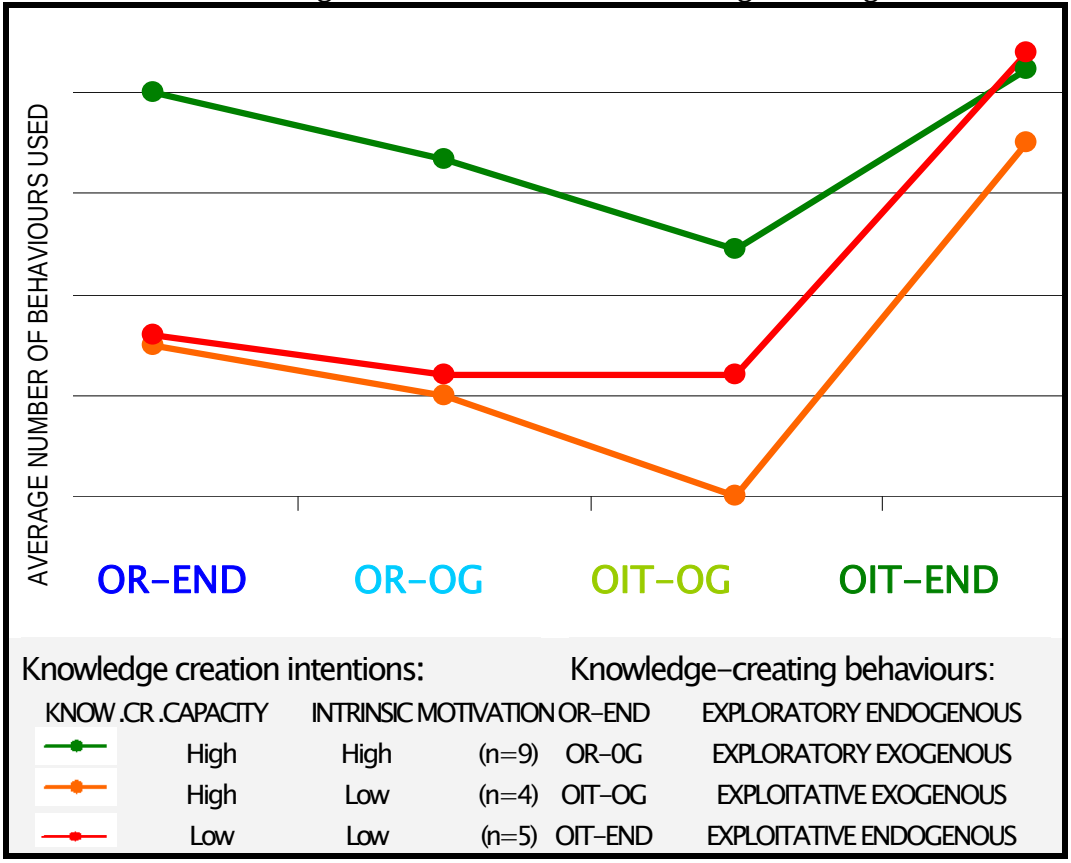
$$18 \div 9 = 2$$

TRANSFORMED TABULAR DISPLAY (USED TO GENERATE CHART):

INTRIN MOTIVATION TO CREATE KNOWLEDGE	OR-END	OR-OG	OIT-OG	OIT-END
High	2	1.666667	1.222222	2.1111111
Low	0.777778	0.555556	0.333333	2

FIGURE 5.14

The effect of knowledge creation intentions on knowledge-creating behaviours



ORIGINAL TABULAR DISPLAY:

KNOWLEDGE CREATION INTENTIONS	OR-END	OR-OG	OIT-OG	OIT-END	n
Hi PRE-Hi IM	18	15	11	19	9
Hi PRE –Lo IM	3	2	0	7	4
Lo PRE –Lo IM	4	3	3	11	5

The figures in the transformed display were calculated by dividing each value in the original display by the corresponding value of n (where n represents the number of individuals within that particular group). For example

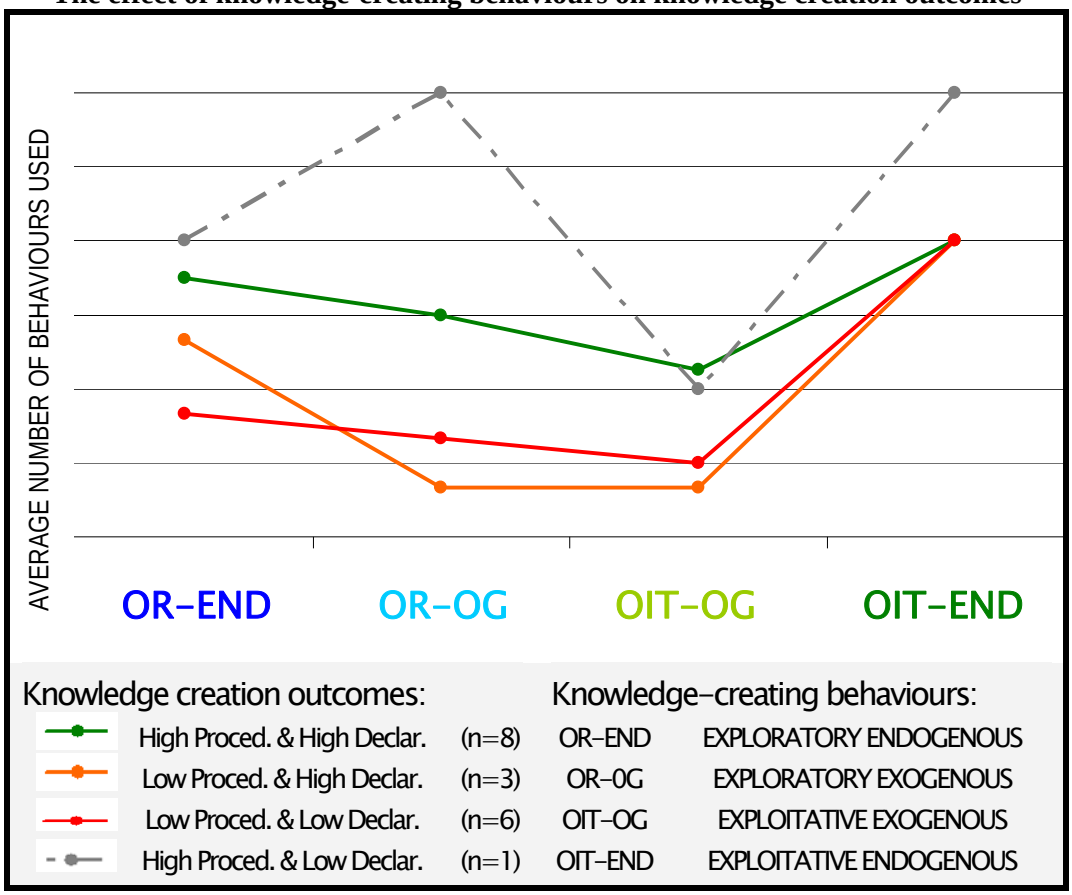
$$18 \div 9 = 2$$

TRANSFORMED TABULAR DISPLAY (USED TO GENERATE CHART):

KNOWLEDGE CREATION INTENTIONS	OR-END	OR-OG	OIT-OG	OIT-END
Hi PRE-Hi IM	2	1.666667	1.222222	2.1111111
Hi PRE –Lo IM	0.75	0.5	0	1.75
Lo PRE –Lo IM	0.8	0.6	0.6	2.2

FIGURE 5.16

The effect of knowledge-creating behaviours on knowledge creation outcomes



ORIGINAL TABULAR DISPLAY:

DECLAR/PROC K.C. OUTCOMES	OR-END	OR-OG	OIT-OG	OIT-END	n
Hi -Hi	14	12	9	16	8
Hi-Lo	2	3	1	3	1
Lo-Hi	4	1	1	6	3
Lo-Lo	5	4	3	12	6

The figures in the transformed display were calculated by dividing each value in the original display by the corresponding value of n (where n represents the number of individuals within that particular group). For example

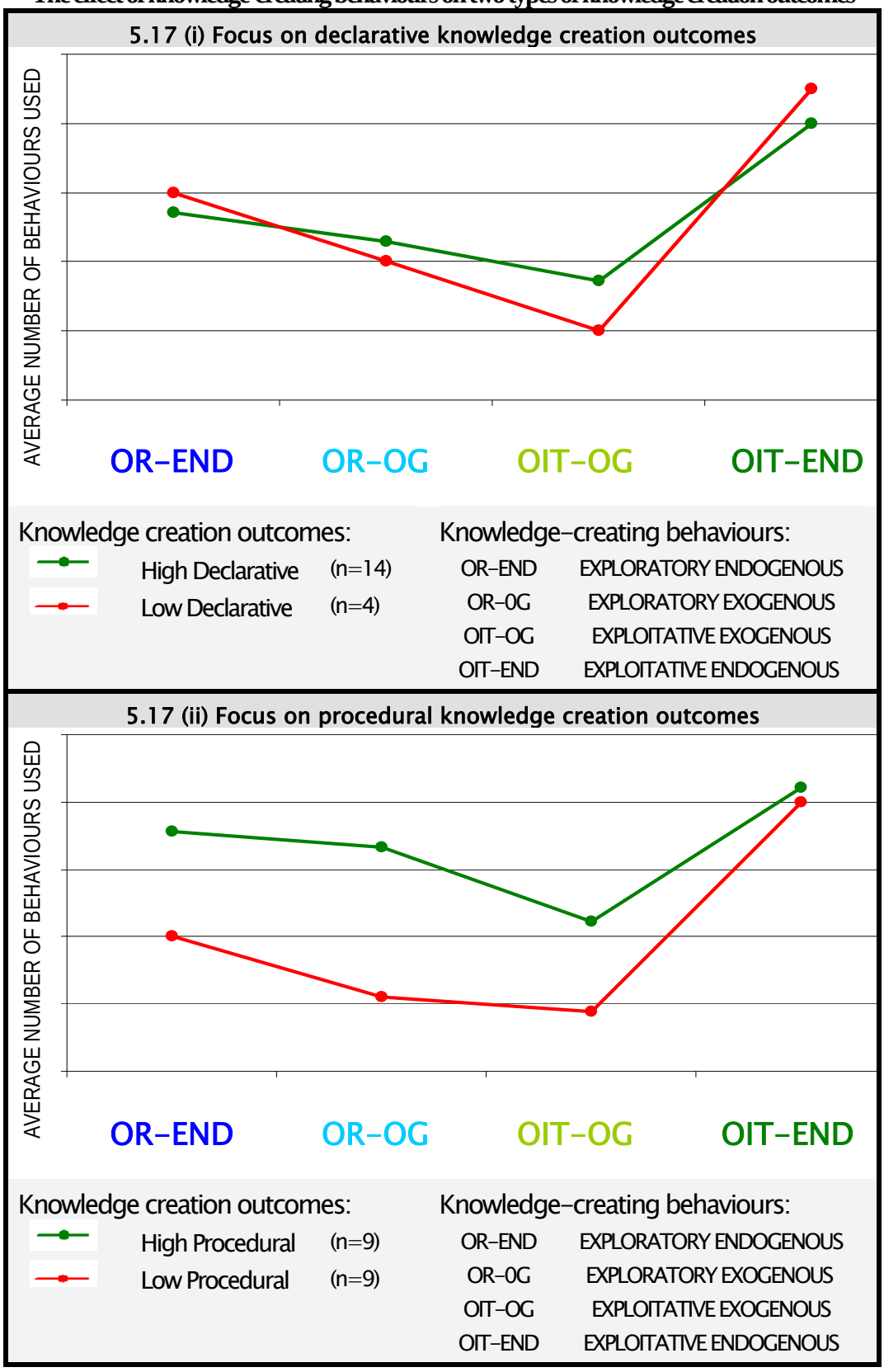
$$14 \div 8 = 1.75$$

TRANSFORMED TABULAR DISPLAY (used to generate chart):

DECLAR/PROC K.C. OUTCOMES	OR-END	OR-OG	OIT-OG	OIT-END	n
Hi -Hi	1.75	1.5	1.125	2	8
Hi-Lo	2	3	1	3	1
Lo-Hi	1.333333	0.333333	0.333333	2	3
Lo-Lo	0.833333	0.666667	0.5	2	6

FIGURE 5.17

The effect of knowledge-creating behaviours on two types of knowledge creation outcomes



ORIGINAL TABULAR DISPLAY:

Know. Cr. Outcomes	OR-END	OR-OG	OIT-OG	OIT-END	TOTAL	n
Hi procedural outcomes	16	15	10	19	60	9
Lo procedural outcomes	9	5	4	18	35	9
Hi declarative outcomes	19	16	12	28	75	14
Lo declarative outcomes	6	4	2	9	21	4

The figures in the transformed display were calculated by dividing each value in the original display by the corresponding value of n (where n represents the number of individuals within that particular group). For example

$$16 \div 9 = 1.77777778$$

TRANSFORMED TABULAR DISPLAY (USED TO GENERATE CHART):

Know. Cr. Outcomes	OR-END	OR-OG	OIT-OG	OIT-END	n
Hi procedural outcomes	1.77777778	1.666667	1.111111	2.111111	9
Lo procedural outcomes	1	0.555556	0.444444	2	9
Hi declarative outcomes	1.35714286	1.142857	0.857143	2	14
Lo declarative outcomes	1.5	1	0.5	2.25	4

7.5 Appendix E Narrative of participant observation in Second Life

Note: any words written in capital letters are explained in the glossary

First impressions

I first read about (the sale of "virtual goods" for "real money" in) Second Life in 2005. At the time, it seemed like an inspired and novel business model: how had Linden Labs convinced their users that virtual goods had 'real' value?[41] I entered Second Life in 2007, with a view to carrying out research therein. At this point, I wanted to study the evolution of user perceptions and attitudes in Second Life. I had no experience of virtual worlds, online games or online communities. But I felt 'comfortable' with technology. I created an account on the Second Life website and downloaded and installed the CLIENT. I then created an avatar called Niamh Babii and completed the orientation to Second Life (where new users learn the basics of Second Life). Nevertheless, I struggled with Second Life and was distinctly uncomfortable in it. It felt 'strange' and I felt 'embarrassed' that I knew so little about it. How could I take myself seriously as a researcher in Second Life when I couldn't operate an ANIMATION OVERRIDE? I failed to get a grip on Second Life: I did not identify with my avatar, form any significant relationships, or acquire any great level of proficiency in the environment. For many months, I stayed away from Second Life, hiding in literature and procrastination.

This experience of a "false start" in Second Life is common. Several study participants had similar experiences. Indeed, most of the changes introduced to Second Life during this study were motivated by user attrition rates and purposefully designed to simplify the new user experience. These observations underline the need for 'comfort' in Second Life.

[41] I subsequently discovered that according to value theory, goods and services "have no intrinsic economic value in themselves, but only the value that a potential consumer or producer imputes to the good or service in question" (Gregg, 2005, p.89); and that "the notion of buying nothing but a visual representation is really no more strange than paying an extra dollar or two for a certain logo printed on a T-shirt" (Lastowka and Hunter, 2004, p. 10)

Investing in an identity: naming my avatar

In March, 2008, I returned to Second Life and created my second avatar, Logos Sohl. I had never particularly liked my first avatar's name (Niamh Babii). So I put far more thought into the selection of my second avatar's name. This was a new kind of 'commitment' to my avatar. I wanted to 'invest' something of myself (in the Latin sense of *investīre*, or to clothe) in my avatar's name. I wanted a name that would be meaningful and would 'suit' me.

I had to select a surname from a drop-down list[42]. I scanned the list and decided to select the name 'Sohl': I thought it might be possible to do a word play on the concept of 'soul'. A web search yielded the word *logos.* The word has many meanings but in a Jungian context, it is used to refer to "the masculine principle of rationality" and is distinguished from its female counterpart, *eros*. The avatar's name – Logos Sohl – would in some way juxtapose the concept of a 'soul' with this idea of a distinctly male notion of "objective interest". The name, then, would be a kind of inside joke[43]. In November, 2009 I began to participate more fully in Second Life and for the next seven months, I spent a considerable amount of time in Second Life[44] as Logos Sohl. Further details of my participation in Second Life can be found in Section 4.4.5.2.

> I feel very lost initially. Chagrin. What am I up to and who do I think I am? Later I wonder why I haven't done this sooner. It's not that hard.
>
> - Ship's log, 18th November 2009

Knowledge-creating behaviours: know-how

[42] This list changes over time so that seasoned Second Life users can tell how old an avatar is according to its surname

[43] By sublimely happy coincidence, the researcher later discovered that Neil Stephenson used the word 'logos' in "Snow Crash", the book which first introduced the concept of a metaverse. In the book, Stephenson writes that "Early linguists believed in a fictional language, the tongue of Eden… the language of the Logos, the moment when God created the world by speaking the word. In the tongue of Eden, naming a thing was the same as creating it… [it] was like a flawless glass, a light of total understanding streamed through it." (p.260)

[44] At one point the researcher used her original avatar as an 'alt' – a second avatar – in order to join more than 25 groups. The researcher went to some effort to re-create Niamh Babii in the image of Logos Sohl and described her as Logos' alt in her profile. Though the avatars were identical, the relationships between the researcher and these two identical avatars were entirely and inexplicably different: Niamh Babii simply "wasn't me".

I was primarily interested from the outset in becoming familiar with the environment, interacting with the educational community in Second Life and in carrying out my research. One of the earliest behaviours I used was to attend INWORLD CLASSES on BUILDING and SCRIPTING. Like many of the case participants coming to virtual worlds for the first time, I felt that it was necessary to have an understanding of content creation in a world which is, after all, entirely created by its residents. There are several well-known groups in Second Life offering scheduled building classes which can be found using the inworld SEARCH ENGINE. These classes were typically text-only classes designed to cover specific topics. The instructor would use an inworld communication tool to 'feed' the contents of pre-written NOTECARDS into LOCAL CHAT whilst cycling through an inworld slide presentation. The notecards would be distributed to students at the end of the class to store in their INVENTORIES. As the classes became more advanced, the need to instruct the students with regard to basic interface issues diminished. Class sizes also dwindled, but they did become more interactive, more practical or hands-on in nature. Over and over, instructors would urge students to practice. Echoing sentiments that were expressed by study participants, they argued that practice was really the only way to learn how to use the scripting and building tools in Second Life.

Apart from teaching the principles of building and scripting in a virtual world, these classes taught me some key lessons with regard to navigating the interface itself. These related to things like CAMERA CONTROL (which is vitally important); the use of ANIMATION OVERRIDES (AOs) (which allow residents to customise the movements and gestures of their avatars); the use of HEADS UP DISPLAYS (customised interactive displays built by residents); and interface customization (disabling camera constraints and enabling the advanced menu, for example). I also visited well known inworld self-directed building and scripting locations in Second Life such as the Ivory Tower of PRIMS and the College of Scripting and Music. I also acquired softer skills such as how to find LAND to rent and how to properly manage burgeoning inventories.

Constructing an online identity: avatar appearance and the personification of self

At the outset, I did not place much emphasis on the importance of my avatar's appearance. Logos Sohl initially wore a default skin and simple 'freebie' clothes that were of poor quality. Logos Sohl very much looked like a 'newb' and Niamh O Riordan did not have a problem with that. Indeed, I was initially unaware of what distinguished a 'newbie' from an 'oldbie' in Second Life.

Over time, I became more aware that avatar appearance is an important issue for Second Life users. There is a certain 'status' associated with having a mature inworld appearance. This is partly related to the fact that substantial inworld technical skills are needed to develop a mature appearance (this is illustrated in the text that accompanies Figure E.1). In addition, Second Life users argued that in the real life, people do not have the power to alter social status indicators such as age, race, gender and appearance. But in the virtual world, people *choose* how to look and how to dress. Therefore, it is acceptable to make judgements about people based upon their inworld appearance. This observation echoes extant research which suggests that real life status equalization takes place in the virtual world (cf. Weisband *et al.*, 1995). However, it is also significant as it suggests that new forms of status inequality also exist in the virtual world.

For several months, I was happy to maintain a "newbie look" as some sort of act of defiance at inworld social convention and peer pressure. Ultimately, the decision to invest more heavily in Logos Sohl's appearance was made in response to a comment made by one of the study's participants: if one wants to be taken seriously by Second Life's resident population, one must take them seriously.

At that point, I made concerted efforts to develop the appearance of Logos Sohl. Initially, I changed Logos Sohl's skin and hair and began to assemble a virtual wardrobe of professional clothing. I found out that there are online blogs dedicated to inworld fashion. I began to follow "freebie fashion" blogs in particular and would travel to inworld destinations highlighted in these blogs to find good quality 'freebies'. I also began to invest real money in higher quality

items. Whilst I experimented with a number of different 'looks' for Logos Sohl, she gradually became a tangible manifestation of my inworld self. She was not just personalised; she was a 'personified' virtual 'me'. The technical skills needed to effect these changes were not inconsequential: it took months to acquire them. Over time, I noticed that study participants began to observe that I 'looked' as if I was familiar with Second Life. Figure E.1 shows a portrait of Logos Sohl taken in June, 2010. Logos Sohl's appearance has not changed substantially since then. The 'look' of the avatar is 'steampunk'[45].



Skills to develop an avatar
(i) Know where to find and how to discern quality skin, hair and clothing inworld
(ii) Know how to correctly position clothing on the avatar
(iii) Know how to use an AO (animation override) to modify the default animations that control Logos' posture and movements

Skills to take an snapshot
(i) Find a suitable location to set to the shot
(ii) Know how to manipulate the camera to zoom in and angle the point of view
(iii) Know how to prevent the appearance of onscreen interface objects such as local chat text in the frame
(iv) Know how to select the highest graphics quality for the shot, and
(v) Know how to control the lighting by selecting suitable environment conditions (i.e. the sunrise setting)

Figure E.1 Portrait of Logos Sohl (June 2010)

[45] Steampunk is a genre of science fiction writing that includes the works of H.G. Wells, Stirling and Gibson, Peake, Jeter, Laumer, and Clark. Steampunk has also become "a burgeoning subculture that draws on the elaborate aesthetics and romantic worldview of 19th century England to envision how things might have looked had a few key technologies been developed further" (Guizzo, 2008)

Knowledge-creating behaviours: know-what

I also joined inworld educational groups in an effort to find out what was happening in the world of Second Life. These groups would make announcements regarding events and would use group instant messaging to announce events that were about to happen. I gradually became aware of a number of weekly inworld meetings centred on education, inworld tools and technology, and issues of relevance to the more mainstream Second Life population. These meetings tended to involve LOCAL VOICE and local chat. It was through these meetings that I developed an understanding of the social norms of Second Life and that I became familiar with the educational discourses taking place in Second Life. These meetings also necessitated the acquisition of a new set of technical competencies as a user of Second Life.

The mechanics of Second Life: managing lag

Most importantly, it became necessary to understand and control lag. Diagnostic tools were available in the viewer to diagnose the sources of lag (i.e. the server, the client or the network). Depending on the source of lag, several strategies could be used to control it. It was often necessary to turn down the graphics quality in Second Life. Lag was especially problematic where large groups of people were assembled (because this meant that the RENDERING COST of the environment was very high). In these situations, users were often asked to remove BLING and it was sometimes necessary to zoom the camera away from other avatars.

All of these tactics compromised the experience of being in Second Life. In terms of my experience of the virtual world, lag meant that graphics and DRAW DISTANCES were often set to the minimum, the environment itself could fail to REZ or would rez slowly or might not rez at all; lag affected my ability to move an avatar (the avatar might fail to stop walking or flying or could also get 'stuck'), to interact with inworld objects or to view inworld content such slides or videos; lag could prevent or disrupt text based chat. In addition, it meant that two users in

the same location could have radically different perceptions of that space according to how their environment was set up.

The mechanics of Second Life: managing sound

Managing sound quality was also important at these meetings. In some locations, embedded videos (often MACHINIMA) were set to auto-play and so it was necessary to know how to turn STREAMING MEDIA off. VOICE CHAT itself could be enabled or disabled. Audio feedback loops would also occur when individuals left their MICs open and it often happened that meetings would be disrupted in order to identify open mics and request that they be closed (usually when there were a lot of new residents in attendance). The client interface itself had no less than six sliders to control various sounds including voice, music and environment sounds. In addition, one could choose to hear sounds from the avatar's position or the camera position according to which was most appropriate. It was even possible to raise or lower the volume on individual speakers.

The mechanics of communication: verbalizing the non-verbal

A number of text-based techniques were used at these meetings to "verbalise the non-verbal" (cf. Walther 1991) in Second Life. Capital letters were used to indicate shouting. Users also tended to describe actions in text. For example, a user might write that they were nodding in agreement. Experienced users could skilfully and humorously depict very visceral scenes in this manner. There was a strong awareness in Second Life that these tactics had been inherited from, and were commonplace across, other online setting. But all of this was new to me and was often explicitly taught to me by other users. For example, G.PM explained that I could use the '/me' command (inherited from Internet Relay Chat) for action statements (it removes the colon that usually separates usernames from chat).

> Logos Sogl: flashes a wide grin
> G.PM: you shoud use /me to lose the :
> G.PM flashes a wide grin
> Logos Sohl: ty, didnt know that
> G.PM: my pleasure
> Logos Sohl smiles

For me, when my avatar was in the same location as those that I was interacting with, these inherited text-based communication techniques appeared to conflict with the fact that avatars in Second Life are quite capable of expressing body language. I found it 'disturbing' for other users to tell me in chat that they were doing a particular thing (reaching for the cream cheese, for example), when I could clearly see that their avatar was doing no such thing. It 'broke' the sense of being 'in' Second Life for me.

The mechanics of communication: mastering the art of polyphonic discussion

At these meetings, I began to develop the necessary skills to effectively follow a group conversation in Second Life. This is a mentally taxing activity and represents a significant cognitive 'load' for virtual world users. It is necessary to be able to follow voice chat and text chat at the same time. This can be an onerous task, depending on the size, experience and loquaciousness of the group. In fact, it was impossible to take in all of the threads of a discussion at once. I was always aware that I was missing out on elements of the discussion and there was evidence that this was also true for others. For example, people would often excuse themselves to "scroll up" to read recent chat. Typos were also very common in these sessions due to the speed at which comments were made (it was common for people to correct these or to apologise for making them). Yet it seemed that experienced Second Life users were able to process 'multiplexed' or 'polyphonic' discussions. I observed that

> this notion of communication in Second Life… [is like] listening to polyphonic music… listening to polyphonic and homophonic music [require] different skills… [When I listen to polyphonic music] I'm tuning in to the different streams with my mind, picking out individual instruments and listening to them. That's not something that many people can do; it's something that I have learned [from] listening to music over the years… Second Life communicators are more capable of handling a polyphonic discussion (~ MEMO WS550334.WMA)

At the same time, I became familiar with a number of commonly used techniques to facilitate effective communication at group meetings. If a comment were made in response to someone else in the group, the comment would be addressed to them (using the '@' symbol followed by their name). It was important that

comments be clearly and concisely expressed and it was also important that individuals did not comment too frequently: this would "clutter up" the chat and drown out other voices. Certain shortcuts were also used for common expressions such as "wb" for "welcome back" (after someone would have 'crashed' and had to're-log'), 'ty' for "thank you", 'yw' for "you're welcome".

The mechanics of immersion: a contingent outcome

Over the course of the study, I came to realise that immersion in Second Life is a gradual process and is by no means guaranteed. This sentiment was routinely echoed by others in Second Life. In fact, one of the study's participants indicated that there will always be those for whom avatars are nothing more than 'dolls'.

At the outset, I noted that I often felt as if I was listening to the radio rather than attending inworld sessions. This contradicted much of what had had been published about virtual worlds as well as what study participants said in relation to the sensory and social immersion that is possible in virtual worlds like Second Life: I felt as if I was sitting in front of Second Life rather than 'in' Second Life. In hindsight, I was focused primarily on voice chat and had not yet developed the awareness of, or skill necessary to, appreciate the corresponding local chat.

As time passed, I no longer felt as if I was listening to a radio and my attention was more firmly focused on what was happening *in* Second Life. I found it increasingly difficult to disengage from Second Life and to look away from the screen. In fact, I increasingly felt as if I was 'in' Second Life. I found, for example, that returning to particular locations inworld would call to mind specific memories: "I [*not* Logos] was here for that event", "this is where we [*not* our avatars] had our interview", for example. Snapshots of locations also quickly triggered specific memories of events. This would appear to support Philip Rosedale's argument that users have the capacity to create episodic, autobiographical memories in Second Life: I was there, I did that.

The mechanics of immersion: tension between social and sensory immersion

However, I also came to realise that at group sessions in particular, my attention was primarily absorbed with voice chat and local chat. During one particular session toward the end of my time in Second Life, I realised that I had left my avatar standing on the periphery of the group for forty minutes: for forty minutes, I had been so engaged in the session itself (which was carried out in voice and text) that I hadn't looked beyond the chat window on my screen to realise that I hadn't yet seated my avatar. This example illustrates the manner in which different communication modalities in Second Life can affect immersion and presence in a virtual world. In this instance, I had been fully immersed with meeting participants and in following the threads of the discussion that were happening in voice and in local chat, but was not at all immersed in the environment itself and had not been aware of my avatar's presence in that environment.

Building social capital in Second Life

Through these meetings, I would regularly meet and communicate with the same people. In addition to monitoring local voice chat, local text chat, and group instant messages, I was now beginning to maintain private instant message (IM) conversations at the same time. This meant that I was increasingly interacting with others in Second Life whose avatars were not in the same location as my own. In other words, as I began to develop connections in Second Life, my own inworld social network began to literally 'expand' in Second Life. This most certainly had a negative impact on the attention afforded to the particular location my avatar was in: it enhanced social immersion to the detriment of sensory and spatial immersion.

These friendships became a useful source of information: one individual in particular directed me to a number of interesting educational and non-educational events and locations: interesting BUILDS, new art installations, mixed reality educational conferences.

I noted a number of observations at the time about these meetings. For example, in a given setting, the chances that I would be familiar with the individuals there appeared to be loosely proportional to the number of times I had been there before[46]. Thus, I became aware that unlike the real world, I was interacting in Second Life with a significant number of individuals who would be seen (in Social Network Analysis) to occupy "structurally equivalent roles" to me. For example, I had far more interaction with researchers in Second Life than I did in the real world at the time.

The extent to which communication in Second Life is by word of mouth also became clearer: the same names and the same projects were mentioned repeatedly, indeed I found myself passing these names on[47]. Over time, I was increasingly taken with the notion that though these communities inhabited advanced technological media, they actually functioned in many ways as oral or non-literate communities might in this regard. For example, as I became more familiar with these groups (and became aware of the personal connections and friendships within them), it emerged that individuals had a tendency to promote work carried out by friends of theirs without necessarily mentioning that they were personally acquainted with these individuals.

From passive communication to active collaboration

Over time, I began to broaden my inworld horizons: moving from passive to active participation in the educational community. I volunteered to help organise Second Life's largest education conference, the Virtual Worlds Best Practices in Education (VWBPE) and I also presenting my initial analyses with Second Life educators at the conference. I began to explore Second Life in earnest and in so doing, formed some close friendships. An awareness of a certain 'hacker' ethos amongst content creators (for instance the commonly made assertion that content creators would begin by "scratching an itch") began to develop; as did an

[46] Snapshots were taken to anecdotally verify this trend

[47] This would seem to suggest that small world phenomena are pronounced in virtual world communities

awareness of the cyberpunk, steampunk and fantasy subcultures that exist within Second Life. I began to explore the oft-mentioned literature and film which had inspired these communities and the technologies supporting virtual worlds. This was reflected in gradual changes to Logos Sohl's appearance (discussed above).

Multi-platform communication in Second Life

As my interaction in Second Life become more active, the extent to which the Second Life community utilises online communication technologies also became more clear: in addition to monitoring the well known SLED list, I subscribed to numerous blogs and RSS feeds, created a blog and a twitter account in the name of Logos Sohl, and joined a social networking site for avatars which was independent of Second Life itself. In addition, I explored a number of alternative Second Life clients and several other virtual worlds, including Blue Mars, Reaction Grid and World of Warcraft[48].

Ongoing evolution of the virtual world

Second Life itself is evolving and changing all the time. In the words of L.FAC, "a lot of it is still in beta". Therefore, this section concludes with a brief account of the changes taking place in Second Life during the time that I was active in Second Life. Linden Lab released Viewer Two for Second Life. The primary purpose of this new viewer was to facilitate new users in Second Life. The viewer was therefore designed with the concept of a web based interface in mind. The viewer was important because it enabled "shared media" in Second Life for the first time. That is to say, Second Life users could now bring web content directly into Second Life – this had not been previously possible. Thus, there was considerable discussion about the implications of the new viewer and shared media in particular amongst technical communities in Second Life and amongst Second Life educators who eagerly sought out educational use cases for the new viewer. In the months that followed, new information resources began to emerge

[48] From the perspective of this study, World of Warcraft is not a virtual world. However, several individuauls compared Second Life to World of Warcraft and so it was deemed relevant and indeed the time spent in World of Warcraft did contribute greatly to the researcher's understanding of Second Life in terms of or from the perspective of MMORGPs.

online in relation to the new viewer and shared media. Linden Lab had promised but had not yet enabled polygon mesh support in Second Life. This feature would allow users to import content created in third party software for the first time. During the data collection phase of the study, Linden Lab also made a number of operational changes. Linden Lab decided to discontinue (i) its Second Life Enterprise development platform, (ii) the Second Life Teen Grid (for users under the age of 18)[49], and (iii) its efforts to support interoperability with other virtual worlds. These changes resulted in substantial malcontent amongst educators in Second Life who felt that Linden Lab was turning its back on its corporate and educator communities.

An ending

In the end, I had to accept (as one of my study participants had suggested to her) that one can live in a city all one's live and still not know it fully and the same is true for Second Life. In my time, I developed some (quite modest) content creation skills, participated in the Second Life educational community, became somewhat familiar with the technical, artistic and music worlds of Second Life, explored some of Second Life's fantasy communities and perhaps most importantly, made a number of friendships with fascinating people from all over the globe. In the intervening months, I have made occasional visits to Second Life but have largely removed myself from the environment. During these occasional visits, the extent to which Second Life users rely on community members to keep up to date has become especially clear: no longer spending hours every day in Second Life, I had fallen firmly "out of the loop".

[49] The Teen Grid was not discontinued until December 2010