BUILDING INSTITUTIONAL CAPACITY FOR MAINSTREAMING E-LEARNING INNOVATIONS: A NEW METHODOLOGY FOR A WICKED PROBLEM

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RESEARCH OUTPUTS

Publications and presentations arising from this study are:

- White, I. M. (2016). Straddling the chasm. Presentation at the Annual Three Minute Thesis competition, Flinders University, 27 May (award as school runner-up).
- White, I. M. (2016). Straddling the technology adoption chasm in university teaching practice using Multi-Mediator Modelling. Poster presented to the annual ASCILITE conference, Adelaide, 28-30 November.
- White, I. M. (2017). Modelling the complexity of technology adoption in higher education teaching practice. Paper presented to the biennial THETA conference. Auckland, 7-10 May (award for student presentation).
- White, I. M. (2018). Challenges related to technology adoption by staff … or relating the challenges. Presentation via Skype to meeting of ACODE 76, Dunedin, 5 April.
- White, I. M. (2018). Modelling the complexity of mainstreaming technology adoption in higher education teaching practice. Abstract presented to the annual HERDSA conference, Adelaide, 2-5 July (award for student presentation).
- White, I. M., Conner, L. N., & Levin, J. A. (2019). Unraveling the complexities of innovation adoption in higher education teaching practice through interpretive case-based modelling. Peer reviewed conference paper presented to the annual American Educational Research Association (AERA) meeting, Toronto, 5-9 May.
- White, I. M. (2019). Interpretive case-based modelling: Getting beyond the tipping point in unravelling the complexity of innovation adoption in higher education teaching practice. Abstract presented at the biennial THETA conference. Wollongong, 19-22 May.
- White, I. M. (2019). Mainstreaming innovations: How to build institutional capacity. Poster presented at DocFest event, Flinders University, 30 August – 6 September. (See Appendix 1.)
- White, I. M., Conner, L. N., & Levin, J. A. (2020). Interpretive case-based modelling: A new method for exploring stakeholder collaboration through a complexity lens. Forthcoming two-hour peer reviewed conference workshop accepted for presentation at the annual AERA meeting, San Francisco, 17-21 April.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed *Irena White*

Date 1 April 2020

ABSTRACT

This PhD study investigates how universities can build institutional capacity for mainstreaming e-learning innovations in university teaching practice and maximise the adoption of transformational new methods of teaching and learning. The study focusses on digital technology-enabled learning, known as *e-learning*, innovations that originate in higher education teaching practice and go on to achieve mainstream adoption within the originating university. Previous research, as indicated in this thesis, suggests that teacher-originated e-learning innovations mostly fail to achieve local mainstream adoption, even where there has been considerable long-term investment in information technology infrastructure and support services in that university. Over the past two decades, studies of this problem around the world have mostly used single and multiple case study and large-scale survey research methods to identify causal and critical success factors, while continuing to view innovation adoption as a single linear process described in theories of diffusion of innovations. In this study, the problem of mainstreaming the diffusion of innovations is viewed through a complex, non-linear, dynamic, systems lens to investigate the multiple relationships between critical success factors associated with key roles played in innovation adoption by actors who represent key university institutional stakeholder groups. Interpretive Case-based Modelling, developed as a new bricolage methodology for conducting this study, applies this complex systems perspective by overlapping case studies with multi-agent computer modelling simulations, guided by an interpretive interactionism research design. The cases and models reported in the study result from interviews with 15 individual volunteer participants located in Australian and New Zealand universities. The computer modelling, conducted *in-situ* during each interview, uncovers the impacts of the relationships between institutional stakeholder roles in universities when enabling and inhibiting connections and levels of influence are applied using a model framework. The resulting participant insights, gained from modelling both *real* and *ideal* case-based scenarios during the interviews, revealed a range of diverse opportunities for harnessing stakeholder relationships for building institutional capacity to facilitate change within the specific context of each case. In this way, the study investigated mainstreaming of e-learning innovation adoption in higher education teaching practice from a new complex systems perspective. Findings from the study suggest Interpretive Case-based Modelling has potential applications in other studies of change in complex social systems, with possibilities for further extension to focus groups.

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I am pieces of all the places I have
been, and the people I have loved. I've
been stitched together by song lyrics,
book quotes, adventure, late night
conversations, moonlight,
and the smell of
coffee.
(Hampton, 2018)

This thesis was made possible through the inspiration and generous support of many people in my life, to whom I am deeply grateful.

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Did you ever know that you're my hero
And everything I would like to be?
I can fly higher than an eagle
For you are the wind beneath my wings
(Silbar & Henley, 1988)

GLOSSARY

ABM

Agent-Based Modelling (q.v.).

Agent

Individual elements or actors in the process of mainstreaming innovation adoption; represented by a distinct role associated within a group of key stakeholders in a university (who are the main actors in the process).

Agent-Based Modelling (ABM)

A research methodology and a tool that uses computer simulations for visualising patterns of non-linear dynamic behaviours that occur when individual elements or actors, known as *agents*, interact with one another in a complex system.

Adopters

Demographic category representing adopters of e-learning innovations, developed within their institution, whose main role is in teaching practice (q.v.), also *micro* (q.v.).

AERA

American Educational Research Association (q.v.).

American Educational Research Association (AERA)

A leading international professional association of educational researchers base in the USA, with an associated annual conference, journal and other publications.

Bricolage

Conceptual drawing together of existing research methods from different disciplinary perspectives with the purpose of extending traditional qualitative, quantitative and mixed method applications to examine complex systems.

Capacity building

An iterative process that incorporates building of frameworks, work cultures, policies, processes and systems enabling an organisation or individual to improve performance to achieve successful outcomes (O'Rafferty, Curtis & O'Connor, 2014).

CAS

Complex Adaptive Systems (q.v.).

Case-based complexity-informed methodology

A methodology in which case studies are treated and modelled as complex systems.

Central support

Term from modelling, representing support services provided within an educational institution (q.v.).

Complex Adaptive Systems (CAS)

Applied as term in research to describe both theory and research methods for capturing and providing insights into the emergence of a system based on its conditions for self-organising (Eoyang, 2001)

Diffusion of e-learning innovations

Spread and adoption of new ways of teaching and learning with digital technologies that leads to mainstreaming (O'Rafferty, Curtis & O'Connor, 2014).

Diffusion of Innovation (DoI)

Theory and model proposed by Rogers (2003).

DoI

See Diffusion of Innovation.

e-learning (alternatives e-Learning and eLearning)

Preferred term used throughout this thesis to describe the process of teaching and learning and learning with digital technologies, commonly also described as online learning.

Epistemology

Theory of knowledge (especially its methods, validity and scope) and the distinction between justified belief and opinion.

Innovators

Demographic category representing developers of e-learning innovations whose main role is in teaching practice (q.v.), also *micro* (q.v.).

Innovation adoption

Processes contained within e-learning innovation adoption (O'Rafferty, Curtis & O'Connor, 2014, p. 70).

Interpretive Case-based Modelling

New methodology proposed in this thesis.

Interpretive Interactionism

The research design and methodology developed by Denzin (2001) applied throughout this study.

Interpretive research design framework

Six phase research method developed by Denzin (2001).

Leadership

Term from modelling, equivalent to management (q.v.).

Learning Management System (LMS)

Software platform and services used to deliver and manage online learning.

LMS

Learning Management System (q.v.).

Macro

Subsystem of actors within universities investigated by this study proposed by Robertson (2008). Equivalent in this study to management (q.v.). See also *meso*, *micro*.

Management

Stakeholder category identified by Sharpe, Benfield and Francis (2006) as playing an active role in both enabling and inhibiting e-learning innovation within universities. Equivalent in this study to *macro* (q.v.).

Massive Open Online Course (MOOC)

Online courses open to the public, usually with little or no cost, aimed at high volumes of participants.

Mainstreaming

When adoption of an innovation achieves sustainable integration into practice (O'Rafferty, Curtis & O'Connor, 2014) also described as achieving critical mass within any given population.

Meso

Subsystem of actors within universities investigated by this study proposed by Robertson (2008). Equivalent in this study to Support services (q.v.). See also *macro*, *micro*.

Micro

Subsystem of actors within universities investigated by this study proposed by Robertson (2008). Broken into the two subcategories of *innovators* (q.v.) and *adopters* (q.v.). Equivalent in this study to roles associated directly with teaching practice (q.v.). See also *macro*, *meso*.

MOOC

Massive Open Online Course (q.v.).

Ontology

Collections of categories and concepts in a domain or subject area depicting properties and relationships.

Support services

Stakeholder category with a variety of central supporting roles within educational institutions, such as, information technology services, libraries and professional learning. Equivalent in this study to *meso* (q.v.).

Teaching practice

Rice (2004) depicts this as the “frontline/coalface” of higher education. Equivalent in this study to the *micro* stakeholder level (q.v.).

Technology adoption

Processes contained within e-learning innovation adoption (O'Rafferty, Curtis & O'Connor, 2014).

Technology-Enhanced Learning (TEL)

Term for e-learning commonly used in higher education (q.v.).

TEL

Technology-Enhanced Learning (q.v.).

Wicked problem

Term for a complex problem, as proposed by Rittel and Webber (1973).

CHAPTER 1. INTRODUCTION

We must find ways to stimulate and scale change across institutions - as well as to sustain those changes - if we are to create models that can serve the expanding needs of our learners. (Ward, 2013, p. 22)

During the past decade, a new conversation has begun in universities around the world about sustaining changes in higher education teaching practice enabled by e-learning innovations (Gunn, 2011). The need for sustaining these changes follows four decades of experimentation with *e-learning*, the term used throughout this study to describe both teaching and learning with digital technologies. Most recently, "studies in the UK, Australia and New Zealand have shown that the benefits of e-learning have not been reaching mainstream learning and teaching in campus universities" (Russell, 2009, p. 3) and has occurred in an organisational climate in which campus-based academics and professional staff have come under increasing pressure from university management to maximise past investments in e-learning (Stepanyan, Littlejohn & Margaryan, 2013). Such investments include "large amounts of funds in training staff to use new teaching platforms such as Learning Management Systems" (Gregory et al., 2015, p. 10).

Top-down management directives have driven university-wide implementations of these Learning Management Systems (LMSs) and have encouraged experiments using Massive Open Online Courses (MOOCs) largely aimed at expanding online courses into rapidly growing global education markets. By contrast, most e-learning innovations initiated by teaching academics that lead to transformational teaching and learning practices have continued to be driven by just a few enthusiastic "lone rangers" (Bates & Sangrà, 2011), who mostly lack ongoing funding, job security and institutional support. These "frontline" academics were depicted by Rice (2004) as teaching at the "frontline/coalface" of higher education: an online environment in which "tutors have to be able to operate seamlessly between both face to face and online activities and mediate between lecturers teaching face to face and/or online and students learning in both situations" (p. 799).

In university courses where e-learning innovations have successfully mediated both face-to-face and online learning/teaching, these innovations have rarely progressed beyond a proof-of-concept stage. There has been little, if any, consideration for how others might adopt these innovations, either within the university faculty, department or school in which they originated or within other faculties, departments or schools (Gunn, 2011; Selwyn, 2011; Smith, 2012; Hanlon, 2015). As a result, Paris and Morino (2014) observed that many opportunities for diffusing and sustaining innovative and effective e-learning initiatives were being lost, leaving these innovations to "wither on the vine" (p. 5). By contrast, McIntyre (2014) noted, daily use of a vast array of technologies in the social and working lives of university managers, professional staff, academics and students continued to proliferate and evolve at an exponential rate. Such ubiquitous use of technologies in everyday life has led to a growing expectation amongst students for greater availability of e-learning in their university courses, resulting in a "disconnect" (Bichsel, 2013, p. 3) between student expectations and what institutions are providing. Building the capacity of institutions to meet these expectations requires bridging the gap between e-learning innovations originating at the teaching “coalface” of higher education (with demonstrated capacity to transform teaching and learning) and take up by potential adopters of these innovations.

To address this gap, the research reported in this thesis develops and applies a new methodology that enables universities to investigate how they can build institutional capacity for mainstreaming e-learning innovations that originate in higher education teaching practice. This new methodology is Interpretive Case-based Modelling. In this study, the application of this methodology is used to reveal relationships between roles played by different groups of institutional university stakeholders in supporting mainstreaming of e-learning innovations that originate in higher education teaching practice. Previous research studies show that e-learning innovations mostly fail to achieve mainstream adoption in universities when these innovations originate in higher education teaching practice (Elgort, 2005; Bichsel, 2013; Stepanyan et al., 2013; Russell, 2017). These studies have largely relied on traditional case study and survey research methods to identify causal factors and viewed innovation adoption as a simple linear process. Such traditional research methods have been shown to be limited in fully addressing challenges in education presented by what Levin and Jacobson (2016) and, most recently, Jacobson, Levin and Kapur (2019) propose are complex problems within complex systems, as they continue to advocate for a new complexity-informed approach to methodology in educational research.

The complexity of the problem of mainstreaming e-learning innovations in the complex system of a university is examined in this study through the development and application of Interpretive Case-based Modelling which allows the visualisation of this dual complexity. Guided by the application of the Interpretive Interactionism research design developed by Denzin (2001), Interpretive Case-based Modelling uses a computer modelling simulation *in-situ* during interviews with study participants to elicit insights into their lived experiences of educational change associated with adoption of e-learning innovations. In this way the problem of mainstreaming e-learning innovations can be viewed and interpreted through a complex systems lens. The method developed for and used in this study combines the Denzin (2001) interpretive research design framework with case studies and agent-based computer modelling to reveal, explore and analyse the relationships between the roles of key university stakeholders in e-learning innovation adoption. The lived experiences of 15 voluntary participants, representing two groups of university stakeholders, were elicited and explored in this study through populating computer model simulations of both *real* and *ideal* scenarios of adoption of e-learning innovations that had originated in 13 universities from Australia and New Zealand.

1.1 A Personal background

Locating, within his or her own personal history, the problematic biographical experience to be studied. (Denzin, 2001, p. 71)

The first phase of the Denzin (2001) Interpretative Interactionism research design applied in this study commenced with an examination of the personal background of the researcher, as a first step in framing research questions guiding a study. In this first stage of my research I reviewed my own reflections from 30 years working with educational technologies. An opportunity for recording this arose following the presentation of my Interpretive Case-based Modelling research methodology at the American Educational Research Association (AERA) conference held in Toronto in 2019 (White, Conner, & Levin, 2019). This AERA presentation attracted an invitation to provide the following background information in a “Q & A” interview that highlighted experiences from my personal and professional life, together with inspirations and challenges that led to this study:

What inspired you to study educational change?

My interest in educational change spans the past 30 years during which I have worked as a developer of e-learning programs and strategies in Australian vocational and higher education. Over these years, I witnessed very little progress, both in Australia and around the world, in the rate of innovation and adoption of digital technologies in teaching practice, beyond the implementation of Learning Management Systems (LMS) and experiments with Massive Open Online Courses (MOOCs). I attended many presentations at education conferences and workshops around the world where enthusiastic educators, who were early adopters of digital technologies, demonstrated the effectiveness of their innovations for teaching and learning. As my professional experience and evidence from the research literature shows, very few of these innovations ever go on to achieve further, let alone mainstream, adoption by other educators. This lag in education is in sharp contrast to the ongoing, prolific and rapid rate of digital technology innovation adoption occurring in our workplaces and homes. This problem led me to develop a method for investigating how universities could build institutional capacity for mainstreaming the adoption of teaching innovations.

What and/or who inspires you in the field? Why?

The first theoretician to inspire my research was the late Professor Everett Rogers, through his seminal Diffusion of Innovations (DoI) theory and research. Since 1962, Rogers’ DoI theory has continued to evolve and influence research, theory development and discussion about the process of mainstreaming innovation adoption. Shortly before he died in 2004, Rogers, together with his colleagues Medina, Rivera and Wiley, explored an extension of his DoI theory by introducing concepts from Complex Adaptive Systems (CAS) theory (Rogers, Medina, Rivera, & Wiley, 2005). In proposing a hybrid theory of DoI and CAS, Rogers and his colleagues broke away from the original portrayal of DoI as a linear process. In their DoI/CAS hybrid proposition the key feature is nonlinearity, characterised by the multilevel relationships between the roles of the members of a system. The need for a shift in focus to nonlinearity and relationships associated with complex systems has, over the past decade, started to emerge as a concern in educational research. One of the leaders promoting this new field of inquiry is Professor Jim Levin from the University of California, San Diego who is my Adjunct Associate PhD Supervisor. In my study, I applied Professor Levin’s Multi Mediator Modeling computer simulation which uses Agent Based Modeling software for investigating the complexity of education systems and how change within these systems occurs, the subject of my study (for more information please go to http://hdl.handle.net/2328/37345). Professor Levin’s work continues to be a main inspiration in my PhD research along with my husband Dr Gerald (Gerry) White’s pioneering application and investigation of the role of collaboration in the system-wide diffusion of educational technologies, which also extended the work of Rogers (White, 2010).

What do you believe to be the biggest challenge for educational change and what would be a first step to address this challenge?

Innovation adoption research in education has, over the past two to three decades, mostly been conducted using case studies which have largely focused on understanding the causes and effects of educational change. Identifying the parts, such as the actors and factors that play a role in educational change, provides a useful first step in researching innovation adoption. However, research about the nature of the relationships between the roles represented by these actors and factors, is necessary for viewing educational change from a complex system perspective - as a whole. Simulating the modeling of all these relationships together has remained a challenge for social researchers as it requires the application of data using skills in computer programming. Another challenge is and continues to be how to explore and interpret the data as it is being modeled in real time.

What are some new areas of inquiry and/or directions you think the field should be headed?

New methodologies, that harness digital technologies, are needed that extend educational research beyond a current focus on causality to modeling and interpreting the complexity of educational change. For my PhD research, I developed an original method for researching institutional capacity building in mainstreaming teaching innovations in higher education that has potential for application in any university undergoing transition and development of new educational practices. The method uses the findings from a literature review of case studies, as a first step in developing a baseline model for a computer simulation to which the lived experiences of participants are applied and explored in real time during an interview. Both *real* and *ideal* scenarios of the relationships between the roles played by institutional stakeholders are modeled and explored throughout the interview. Participant insights that emerge from viewing the impact of the relationships, depicted when running the model, are recorded, compared and then analyzed against previous findings in the research literature. This method has proven to be successful in bringing computer modeling into conversations and conversations into computer modeling and offers a new direction for educational change research. (AERA, 2019 April)

1.2 Aims and scope

The aims and scope of this study embraced the challenge of developing a new methodology for investigating e-learning innovation within universities. Innovation is subject to the social systems in which it exists, and such systems are complex. Any investigation must therefore consider "social complexity by interpreting the target system as a whole which is more than the sum of its parts" (Tubaro & Casilli, 2010, p. 61). The target system in this study was higher education, represented as a *whole* by the organisational structure of universities, while the *parts* represented the actors and factors that played a key role in mainstreaming e-learning innovations in universities. For the purpose of defining the three subsystems of actors within the universities investigated by this study, the terms *macro*, *meso* and *micro* proposed by Robertson (2008) were applied to the following three stakeholder categories, identified by Sharpe, Benfield and Francis (2006) as playing an active role in both enabling and inhibiting e-learning innovation within universities:

- Management (*macro*)
- Support services (*meso*)
- Teaching practice (*micro*).

A further separation was made at the *micro* (teaching practice) level into the demographic categories of *innovators* and *adopters* proposed by Rogers (2003). These two additional categories represented individuals involved in initiating and adopting e-learning innovations at the institutional "frontline/coalface" level of teaching practice in higher education. In this way, the study applied the conceptualisation of e-learning innovations as "situated in the interplay between structure and individual and how this leads to adoption and diffusion" (Hardaker, & Singh, 2011, p. 221).

The study focused on the interrelationships between institutional system levels (*macro*, *meso* and *micro*) and corresponding categories of institutional stakeholders (management, support services, teaching practice innovators and adopters) as actors who played a key role in variously leading, developing, implementing, adopting, promoting, supporting and sustaining the application of contemporary digital technologies in the delivery of innovative and transformative teaching practices. The sustainability, also known as mainstreaming, of adoption of e-learning innovations was recognised by Sharpe et al. (2006) as requiring innovators and adopters of e-learning innovations in universities to be supported "by their Deans, their local strategy for e-learning and central and school-based learning technologists and developers" (p. 149). This study examined the critical success factors and conditions for developing such strategies. The following conditions for achieving e-learning sustainability, as proposed by Gunn (2010, p. 90), provided further criteria for scoping the study, in which:

- Learning design involving information and communications technology has been developed and implemented within a course or courses of study. It has been through a proof-of-concept stage and has been judged, on the basis of evidence produced, to be beneficial to teaching and learning.
- E-learning concepts, designs, systems or resources have proven potential to be adopted, and possibly adapted, for use beyond the original development environment.
- Maintenance, use and further development of the e-learning concept, design, system and resources do not remain dependent on one or a few individuals who created them, to the extent that, if their involvement ceased, future prospects would not be compromised.

Students were not included in the study, as the focus for conducting this research was exclusively on university professional staff and academics and their interactions in mainstreaming e-learning innovation. Also excluded from examination in this study were the features of different technologies, how these technologies were used and evaluated in teaching and learning and the effects of organisational culture on attitudes to new technologies and innovation adoption in educational practice.

1.3 Terminology

Throughout this thesis, a consistent use of terminology for key concepts, terms, abbreviations and acronyms has been attempted to guide the reader. The use of the phrase "mainstreaming e-learning innovations" in the title of this study and throughout this thesis represents the concept of sustainable diffusion of e-learning innovations as encompassing the conditions for sustainability proposed by Gunn (2010) (Section 1.2) and the diffusion processes defined by the Rogers (2003) Diffusion of Innovation (DoI) theory and model (Section 2.2.1). Acronyms and terminologies are defined when they first appear in the body of this thesis, and frequently used terms also appear in the Glossary. Australian English spelling is used in the body of the thesis, while quotations and terms use English as originally published.

McKenzie, Alexander, Harper and Anderson (2005) noted that a wide range of definitions for the terms *sustainable*, *diffusion*, *e-learning* and *innovations* abounded in the research literature. For the purpose of this study, these terms are applied to define *sustainable* as achieving mainstreaming when the adoption of an innovation achieves integration into practice while the process of *diffusion* of *e-learning innovations* encompasses embedding and spreading within the notion of adoption of new ways of teaching and learning with digital technologies that results in mainstreaming, as concluded in Section 2.2.2. The terms *innovation adoption* and *technology adoption* are used throughout the thesis in describing the processes contained within e-learning innovation adoption. *Capacity building* is defined in this study as "an iterative process that incorporates the building of frameworks, work cultures, policies, processes and systems enabling an organisation or individual to improve performance to achieve successful outcomes" (O'Rafferty, Curtis & O'Connor, 2014, p. 70). The term *e-learning* is used throughout this thesis for reasons explained in Section 2.1.1.

1.4 Research questions

The primary research question investigated by this study was: **How can universities build institutional capacity for mainstreaming e-learning innovations?**

The following secondary research questions guided the development of the new methodology in seeking answers to the primary research question and in presenting conclusions from the study:

1. What are the critical success factors in the process of innovation adoption?
2. Who are the key actors as institutional stakeholders in innovation adoption?
3. What roles are played by the key actors in innovation adoption?
4. How do the roles of key actors interact in an institutional setting?
5. What are the impacts of *real* and *ideal* interactions between institutional roles in innovation adoption?
6. What implications arise from the impact of institutional role interactions in innovation adoption?

The discussion of findings from the study analysed the primary research question as a "wicked problem" (Rittel & Webber, 1973). Applying the challenges and notions presented by Rittel and

Webber (1973) in which "the formulation of a wicked problem is the problem" (p. 161), this analysis was guided by the following questions:

1. How is the problem in each university unique?
2. How can the problem be defined?
3. How is the problem multi-faceted?
4. How are multi-stakeholders motivated?
5. How are organisational boundaries in universities straddled?
6. How is the problem connected to other problems in universities?
7. How do solutions have system ramifications?
8. How do better/worse solutions compare with right/wrong solutions?
9. How does time needed for evaluation impact on solving the problem?
10. How is the problem never completely solved?

1.5 Chapters in this thesis

The chapters in this thesis follow the steps in the phases of the interpretive research design framework proposed by Denzin (2001) that guided this study as follows (Denzin, 2001, p.70) with thesis chapter titles shown in brackets:

- Framing the research question (Literature Review).
- Deconstructing and analysing critically prior conceptions of the phenomenon (Methodology).
- Capturing the phenomenon, including locating and situating it in the natural world and obtaining multiple instances of it (Methods).
- Bracketing the phenomenon or reducing it to its essential elements and cutting it loose from the natural world so that its essential structures and features may be uncovered (Findings).
- Constructing the phenomenon or putting the phenomenon back together in terms of its essential parts, pieces, and structures (Discussion).
- Contextualizing the phenomenon or relocating the phenomenon back in the natural social world (Conclusion).

These phases of the interpretive research design framework are also incorporated in the Interpretative Case-based Modelling methodology developed for this study. Application of the phases, in designing this original research methodology and structuring the following chapters, seeks to provide a coherent, rigorous and revealing narrative of this PhD research journey.

CHAPTER 2. LITERATURE REVIEW

Framing the research question. (Denzin, 2001)

The research literature reviewed for this study examined the phenomenon of mainstreaming e-learning innovations in higher education teaching practice with a view to framing the research questions for guiding this study. This examination was conducted from the perspectives of history, theories, models and frameworks, together with an analysis of previous studies. The review of literature in this chapter concludes by identifying limitations, gaps and challenges found in previous studies, summarising themes for further research and producing the primary and secondary research questions for this study (previously listed in Section 1.4).

The process for conducting the literature review reflects the framework suggested by Schirmer (2018) in providing "a coherent synthesis and critical analysis of the state of knowledge on the topic, identification of gaps and inconsistencies in the body of research, and recognition of the next logical steps in the line of research inquiry" (p. 94). The synthesis and analysis conducted in this review also applied phases recommended by Denzin (2001) for "deconstructing prior conceptions of a phenomenon" (p. 73) and in the "framing of the research question" (Denzin, 2001, p. 71). The results of this review informed the development of the primary and secondary research questions as well as the methodology that guided this study. The main themes from this literature review are revisited, together with findings from this study, in the discussion and conclusion chapters.

The sections in this chapter examine and present a review of:

- Evolution of educational technology innovation and adoption.
- Innovation adoption theories, models and frameworks.
- Studies of e-learning innovation adoption in higher education.
- Limitations, gaps and challenges presented in previous studies.
- Summary of themes for further research.

Sources investigated in this literature review were drawn from original peer-reviewed journal articles, books, publicly available reports, conference presentations and online posts published between 2000 and 2018. This time span represented the most relevant and recent research in the field of e-learning innovation adoption available while conducting this study. Initial online searches of Google Scholar, using the phrases and keywords *sustainable diffusion of innovation*, *e-learning innovation adoption*, *higher education*, *educational technology* and *e-learning*, were followed by manual searches of bibliographies from published studies. These further searches revealed 22 studies, published between 2006 and 2017 from around the world, which provided a range of institutional views of mainstreaming e-learning innovation adoption in higher education teaching practice. These studies are listed in Table 2 (Section 2.3).

Published studies and other literature that focussed mostly on student expectations and experiences were eliminated from this search, as the primary focus for investigation by this study was on higher education institutional roles. The attributes of an innovation and the effect of organisational cultural, as potential factors in innovation adoption, were also considered to be outside the scope of this study and thus were excluded from this review (see Section 1.2).

2.1 Evolution of educational technology innovation and adoption

Laying bare prior conceptions of the phenomenon, including how it has been defined, observed and analysed. (Denzin, 2001, p. 73)

The evolution of educational technologies was described by Kidd (2010) as a “lost history” (p. 50) which presented challenges in drawing together a history of the evolution of e-learning innovation. This section pieces together this history by tracing changes in terminology, syntax, definitions and timelines in the evolution of e-learning in higher education from the 1960s until 2018. Three different timelines from this period were examined for this review, with each reflecting a different perspective: (1) priorities, (2) relevance/significance and (3) trends/challenges. The first sums up early priorities for e-learning adoption that emerge in higher education between the 1980s and 2010 (Conole, 2017). The second lists when technologies and theories become relevant and significant in higher education between 1993 and 2018 (Weller, 2018a). The third tracks trends in technology developments and higher education challenges that appear between 2012 and 2018 (Adams Becker et al., 2018). A comparison of the three timelines is provided in Appendix 2.

Section 2.1.1 of this chapter compares e-learning practice over time in higher education. Section 2.1.2 follows with a synopsis of national drivers for change in Australia, the US and the UK that have been influential in the evolution of educational technology in higher education institutions. Section 2.1.3 concludes by contrasting successes and failures in further adoption of e-learning innovations, evident in universities over two decades.

2.1.1 Comparing e-learning practice over time

In reviewing the evolution of educational technology adoption, Kidd (2010) concluded that "comparing e-learning practice over time is problematic and fraught with a host of methodological concerns" (p. 47). This was a view supported by Weller (2018a) who added that "the edtech field is remarkably poor at recording its own history or reflecting critically on its development" (p. 34). As this review of research literature shows, there are many challenges in attempting to piece together a coherent history of the evolution of educational technology. This is exacerbated by inconsistent terminology and reporting variations in timelines which are documented from widely different perspectives. Viewed together, these challenges indicate that educational technology is clearly a field with many challenges that remain and is still very much evolving (McAleese et al., 2014; Bates, 2018; Adams Becker et al., 2018).

From the literature, there appeared to be little evidence of consistency in terminology, syntax and definitions in describing the concept and field of study originally known as *educational technology,* a term that first appeared during the 1960s (Ibrahim, 2015). One of the earliest definitions of educational technology was attributed by Ibrahim (2015) to Donald P. Ely in a monograph, edited by Ely (1963), to the Technological Development Project of the National Education Association of the United States. Ely (1963) attributed this early, and possibly first, definition of the term *educational technology* to a conference presentation in 1962 by Charles J. Hoban Jnr who was listed as a consultant in the Ely (1963) monograph. The Hoban (1962) definition hinted at the potential of “technology in education” (p. 5) for advancing theories, research and educational practice. Ely (1963) noted that in the following conceptualisation of educational technology, provided by Hoban, "the use of the word ‘machine’ in an educational context may be interpreted as the technological ‘hardware’ used in the classroom, e.g., projectors, recorders, programmed learning devices and television equipment" (p. 24). Hoban (1962) developed his proposal as follows:

> When we consider the part machines play in education, we are forced into a consideration of man-machines system. When we consider man-machine systems, we are forced into a consideration of technology. By a process of progressive forcing, we advance to the broader concept of educational technology or technology in education, as a central subject to which we must relate theories, research, educational practice. (Hoban, 1962, p. 5)

Later in the 1960s, Seymour Papert was researching the use of computers in education at the Massachusetts Institute of Technology (MIT) and developing his theory of “constructionism”, versus the common educational practice at the time which he described as “instructionism”, published in Papert (1993). His experimentation led to a simple computer programming language that school children could use, called *Logo* (Stager, 2016). The potential educational uses of programmable machines using *Logo* was captured, several decades later, in the titles of Papert’s best known books: *Mindstorms: Children, computers, and powerful ideas* (Papert, 1980), which was heralded as the book that started the computer revolution in schools, and its sequel, *The children's machine: Rethinking school in the age of the computer* (Papert, 1993). The two books drew global attention to the creative potential of teaching and learning with educational technologies. In 1985 Papert, Marvin Minsky and Nicholas Negroponte founded the MIT Media Lab which has continued to conduct research focused on human-computer interaction. In a tribute to over 50 years of ongoing theoretical and practical contributions to educational technology, Papert was aptly described in the title of an obituary as “the father of educational computing” (Stager, 2016).

During the six decades since those early pioneering days of experimentation with educational technologies, the educational research literature has wavered in its emphasis between references to using technologies, as “machines”, *in* teaching and learning, and teaching and learning *with* technologies. In illustrating the latter, Januszewski and Molenda (2007) described teaching and learning *with* educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (p. 1). A decade later there appeared to be a return to a focus on using technologies as "machines" *in* teaching and learning, with the suggestion by Hargadon (2017) that "'educational technology' (often abbreviated as 'ed tech') is assumed to refer principally to the use of modern electronic computing and other high-tech, mostly Internet-enabled, devices and services in education" (p. 2). From the perspective of university management, there currently appears to be a similar shift, away from an emphasis on the teaching practice as noted by Januszewski and Molenda (2007), towards the enabling functions of technologies noted by Hargadon (2017). This apparent shift back to funding and promoting the use of digital devices rather than encouraging and supporting the emergence of new pedagogies appears to coincide with increasing concerns by university management about maximising investments already made over the past two decades in technology infrastructure and enterprise-wide services, such as, LMS and digital communication platforms used in live video conferencing, lecture capture and MOOCs. An examination of higher education research literature, published over the past two decades, appeared to confirm a shift from an earlier focus on the characteristics of educational technologies as administrative, content, delivery and assessment tools in education to viewing new digital products, services and devices as potential enablers for transforming pedagogical practices. Examples of current practices in new modes of teaching and learning can be found in *blended* and *flexible* learning which combine online with face-to-face teaching to extend the notion of *e-learning* which has emerged as an overarching term to describe both educational practices and how they are implemented.

By the late 1990s, the term *e-learning* had started to take over from *educational technology* as a commonly used term in published literature. The results of a *Google Books Ngram* search https://books.google.com/ngrams, captured in Figure 1, show that by 2008 there had been a rapid rise in the use of *e-learning* (red line) as a term in published books compared with *educational technology* (blue line) and *elearning* (green line) which appeared as a more recent spelling of e-learning. The *Ngram Viewer* allowed an analysis of popular word usage in literature over time. The trends captured in Figure 1 covered the period from 1960, when the use of the term *educational technology* first emerged, to 2008 which was the limit for *Ngram* searches available at the time this search was conducted. Figure 1 shows that the unhyphenated term *elearning* first appears around 2000, a decade after the first appearance of the more commonly used hyphenated version, *e-learning*, which has remained in constant use in published literature since the 1990s. It is for this reason that the hyphenated term *e-learning* has been selected for use throughout this study.

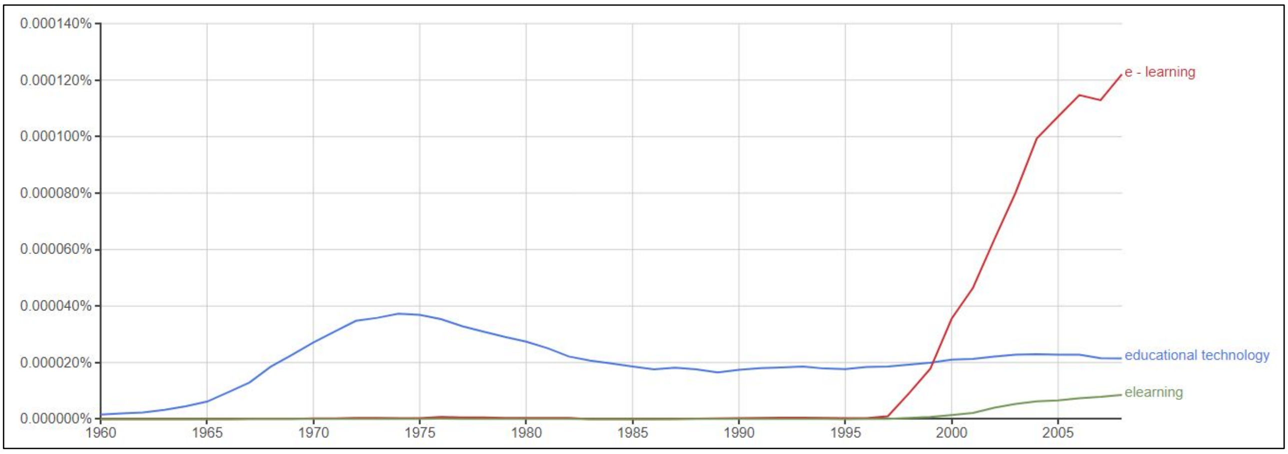


Figure 1. Google Books Ngram comparing terms “e-learning” (red), “educational technology” (blue), and “elearning” (green). Created 3 September 2018.

The term *e-learning* was claimed to have been coined in 1998 by American futurist Jay Cross (Cross, 2004). This new term was intended to signal a shift away from thinking about computers and other digital devices as tools, to a focus on new forms of internet-enabled learning. Prior to 1999, the year when the term first came into wider use, *Computer Based Training* (CBT) had been commonly used in corporate training where the take up of learning technologies pre-dated the spread of e-learning in higher education. During the late 1990s, other new terms, such as, *telepedagogy* and *telelearning* had started to appear in higher education literature, in response to the impact of visual media use in education (McLoughlin & Krakowski, 2001), but these terms were soon superseded during the 2000s with acronyms, such as, *CAL* (Computer Assisted Learning) commonly used in the UK, *CAI* (Computer Assisted Instruction) more common in the US, *ICT* (Information Communication Technologies) as a broad term in teaching and learning, *ILT* (Information Learning Technologies), IT&T (Information Technologies and Telecommunications) and *TEL* (Technology-Enhanced Learning) - terms also shortened to *learning technologies* and *information technologies*. Other terms that appeared in the literature around this time included *computer-supported learning*, *web-based learning, online learning* and *learning networks*. This multiplicity of terms continued to appear in research literature across all sectors of education in the English-speaking world, together with the use of various forms of syntax for e-learning that included *elearning*, *E-learning, e-Learning* and *eLearning.* This would appear to confirm that e-learning is still very much an evolving global concept in education, even 60 years after the first use of its “parent” term *educational technology* first appeared in publications.

While the term *email,* rather than the original hyphenated version *e-mail,* now appears in common English language usage, *e-learning,* rather than the unhyphenated version of the term, was used as a key term in conducting the literature search for this study and in the writing of this thesis. Over the coming decade it may be that, like *email*, the hyphen in e-learning will also disappear and the term *elearning* itself may become redundant as educational technologies become absorbed into new forms of teaching, learning and critical inquiry and the adoption of e-learning matures and morphs into common educational practice.

The evolution of these terms appears to follow the evolution of the World Wide Web (commonly abbreviated to The Web, WWW or simply web) which has enabled the development of educational technologies and their applications since the 1990s. The web followed the development of the Internet which started as an U.S. Defense Advanced Research Projects Agency (DARPA) federal government supported initiative in 1973 (Cerf, 2019). In 1989, the web was developed at CERN, the European Organization for Nuclear Research, established 30 years earlier in 1952 by 12 European governments. The web was the result of a collaboration between two CERN engineers, Tim Berners-Lee and Robert Cailliau, which envisaged and led to the wide scale development and use of “touch-sensitive screens, graphic user interfaces, applets that propagated themselves over the network, [and] instant messaging” (Cailliau, 2008, para. 1). The environment at CERN for this collaboration was described by Cailliau (2008) as having "the right mix of academic freedom, entrepreneurial drive, and down-to-earthness that is the breeding ground for success” (para. 5). These environmental forces for innovation were captured in the title “fertile ground” (Cailliau, 2008) used in Cailliau’s reflection on his 30-year career at CERN.

Over the past three decades, the web has progressed from read-write services of Web 1.0 into the social-media environment of Web 2.0, towards the proposition of a semantic Web, commonly referred to as Web 3.0 and, most recently, the emergence of Web 4.0 as demonstrated in applications of Artificial Intelligence (AI) services in educational assessment (Conole, 2017). This evolution of the Web also reflects a constantly changing focus within higher education on early priorities for e-learning innovation and adoption (Conole, 2017) as illustrated in Figure 2.

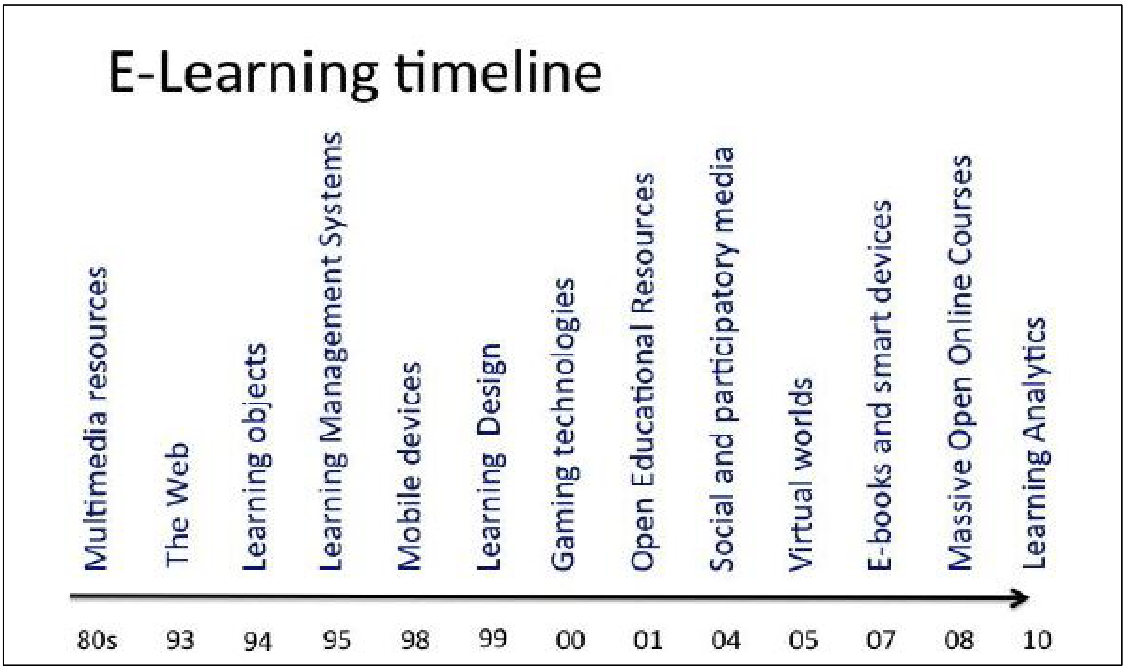


Figure 2. E-learning timeline 1980s to 2010 (Conole, 2017). Permission to reproduce received from author May 14, 2019.

The timeline in Figure 2 tracks the early emergence of Web services through a sequence, from transmission to social to semantic functions in education. During the 1990s, Web 1.0 enabled the creation and transmission of learning objects (items of reusable and shareable digital content) and the introduction of LMS platforms and services, followed during the 2000s by Web 2.0 which ushered in the advent of social participatory media and experiments with MOOCs and, since 2010, Web 3.0 and most recently Web 4.0 which have been harnessed in applying learning analytics in higher education assessment (Conole, 2017). As Salmon (2017) noted, conceptualising these changes in education has led to claims about how this transition from transmission to social to semantic application is disrupting educational practice. Digital technologies, such as those listed in the timeline in Figure 2, have come to be known as disruptive innovations, a concept proposed in 1997 by American business consultant and academic Clayton M. Christensen (Christensen, Horn & Johnson, 2008).

While the concept of disruptive innovation was first used to explain the impact of digital technologies on traditional business practices, it has since spread to discussions about the impact of digital technologies in education. Christensen and Eyring (2012) applied the concept of disruptive innovations in their historical analysis of the evolution of digital technologies and its impact on universities, noting that universities have a long history of imitation which has both hindered innovation and the adoption of digital technologies in educational practice. The exception to this trend appears to be the wide-spread adoption of the content delivery, assessment and administrative functions of LMS platforms which has been driven through top-down implementation strategies by university management (Bichsel, 2013) and motivated by university business objectives to reduce costs and demonstrate institutional accountability (Conole, 2017).

In a blog post comment, Weller (2018b) challenged the notion of disruptive innovations as a potential threat to the historical longevity of universities, which he associated with the impact of new technologies. He argued that technologies that correlate most closely to the core university functions of "content, delivery and recognition" (Weller, 2018b, para. 8) are most likely to be adopted in higher education. Weller (2018b) also viewed criticisms of university slowness and resistance to change as a strength rather than a weakness and proposed that this slow rate of change was illustrated in the careful adoption of LMSs in higher education. The LMS first appears as an e-learning priority in the Conole (2017) timeline (Figure 2) in 1995, yet its relevance and significance as a widely adopted educational technology in higher education is not evident until 2004, almost ten years later, according to the timeline proposed by Weller (2018a). Weller (2018a) concluded his analysis of the evolution of educational technologies in higher education by suggesting that in universities "educational transformation is a slow burn" (p. 38) which required patience. The same need for patience appears to apply in the ongoing lag in ePortfolio adoption rates in universities. Weller (2018a) noted that "even when there is a clear connection to educational practice, adoption can be slow, requiring many other components to fall into place" (p.

46). However, Weller (2018a) did not suggest what these components were or how they might be connected. The historical perspectives presented by Conole (2017) and Weller (2018a) appeared, as Kidd (2010) suggested, to say “little about the processes and agency occurring under the various categories" (p. 47) used to classify developing educational technologies. As noted previously, the emphasis in some classifications in timelines is on education while in others this emphasis is on the technologies.

The final timeline reviewed in this chapter is from the Adams Becker et al. (2018) Horizon Report series. This annual series of reports represents an ongoing collaborative research study, with origins dating back to 2002. The reports utilise primary and secondary research data in monitoring both emerging trends in educational technologies and the challenges these trends present for current and future educational practice. The Adams Becker et al. (2018) report timeline, shown in Figure 3, traces trends in educational technologies and significant challenges for higher education that emerge between 2012 and 2018.

In the top of Figure 3 the challenge presented by competition for new models of education, which occurred from 2012 to 2016, has been replaced, during both 2017 and 2018, by the need to improve digital literacy, rethinking the role of educators, and advancing digital equity. During 2018, developments in technologies are shown in the last column in the lower half of Figure 3 as occurring in analytics technologies, adaptive learning technologies, makerspaces, artificial intelligence, mixed reality and robotics.

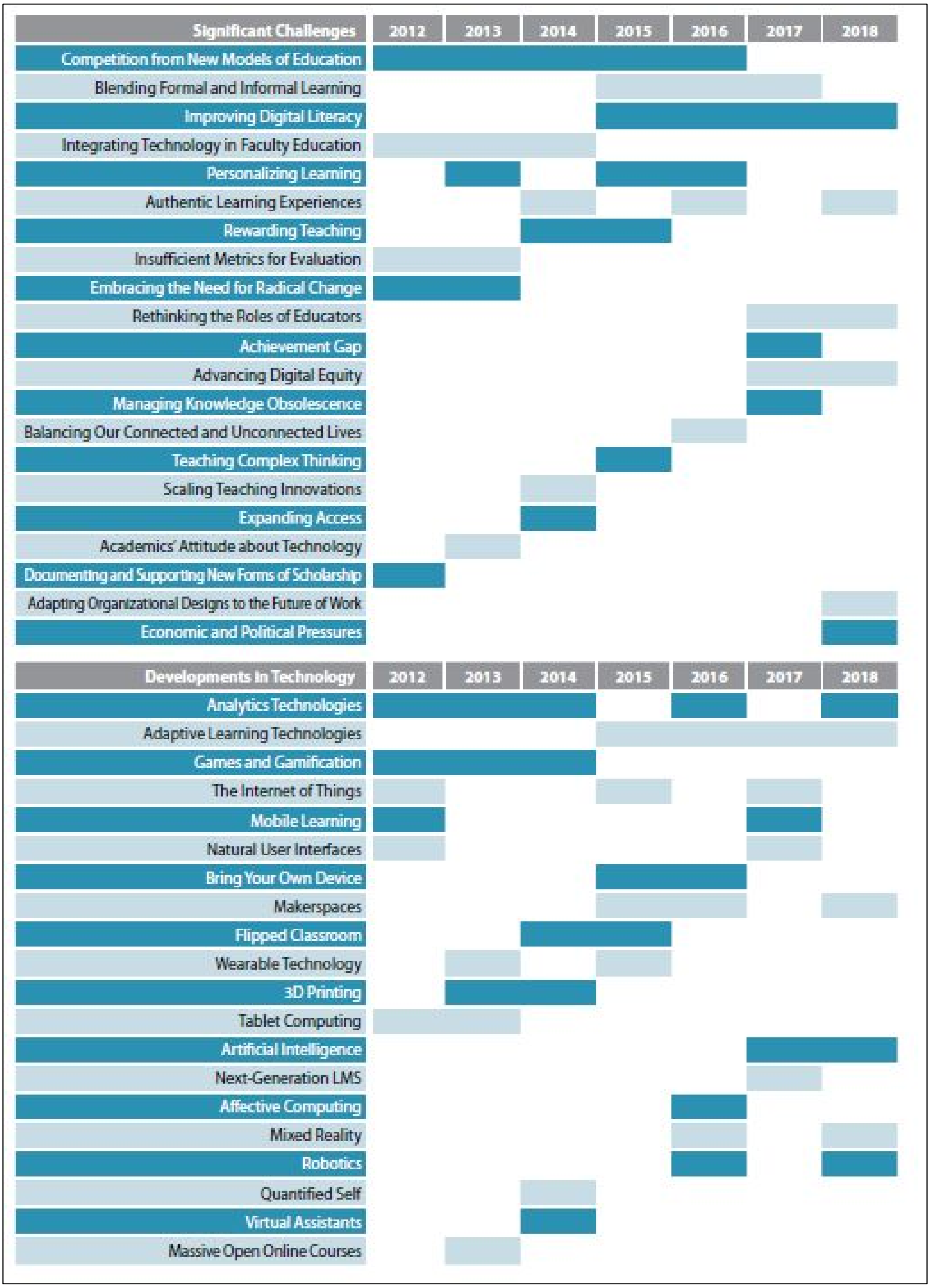


Figure 3. Trends in developing educational technologies and significant challenges for higher education (Adams Becker et al., 2018, p. 5). Image by Adams Becker et al. is licensed under CC BY https://creativecommons.org/licenses/by/4.0.

Appendix 2 provides a comparison of all three timelines (Conole, 2017; Weller, 2018a; Adams Becker et al., 2018). In comparing these three timelines, the lag in technology adoption in higher education noted by Weller (2018a) remains evident. For example, gaming technologies appear in 2000 (Figure 2), but the first appearance of games and gamification as an emerging trend in higher education is 12 years later in 2012 (Figure 3). By 2014, “scaling teaching innovations” (Adams Becker et al., 2018, p. 5) appears in Figure 3 for the first time as a significant challenge in higher education, followed three years later, in 2017, by “rethinking the role of educators” (Adams Becker et al., 2018, p. 5). An overall comparison between the three timelines appears to support the meme, attributed to science-fiction writer William Gibson, which states "the future is already here - it is just unevenly distributed" (cited in Survey: Peering round the corner, 2001, Oct 13).

2.1.2 Drivers for change in higher education

National government policies in Australia supporting e-learning in public education first appeared in 1986. In higher education this was achieved through the Australian Vice Chancellors’ Committee (AVCC) with its representation on the Australian Information & Communications Technology in Education Committee (AICTEC) and the members of the Ministerial Council on Education, Employment, Training & Youth Affairs (MCEETYA) (White, 2004). Leading higher education peak member organisations, particularly in Australia, were amongst the first in the world to play an active role in promoting and supporting the adoption of educational technologies. These organisations today include the Committee of Australian University Librarians (CAUL), active since 1965; the Council of Australian University Directors of Information Technology (CAUDIT), active since 1966; the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE), active since 1985; and the Australasian Council on Open, Distance and e-learning (ACODE), active since 1993. In other English speaking countries, higher education e-learning policy continues to be driven by peak member based organisations, such as, the New Media Consortium/EDUCAUSE in the US, which has been operating since 1993, and JISC (originally known as the Joint Information Systems Committee) which was founded in the same year in the UK. These organisations continue to provide forums, research journals, digital resources, professional learning opportunities and reports that influence the educational technology agenda for change in universities.

The impact of these drivers has resulted in a gradual maturing of e-learning adoption in universities. Salmon (2005) noted that as adoption of e-learning in universities has evolved and increased, there has been a “growing recognition of the need for evidence-based research especially associated with achieving positive and successful change processes” (p. 207). A growing focus on change processes coupled with the need for evidence-based research, was viewed by Bichsel (2013) as reflecting a maturing of e-learning applications in higher education and a shift from earlier concerns in universities, centred purely on justifying investments in new technologies (Massy & Zemsky, 1995). At the same time, in Australia there appears to have been a gradual waning in strategic leadership and funding support for e-learning innovation. In a forward in Ellis and Goodyear (2019), Carol Nicholl, Executive Dean in the Faculty of Education at Queensland University of Technology, reflected on the demise of national policy drivers and what has replaced this in universities as follows:

> For many years Australian universities had benefited from significant government funding and policy interest to improve and innovate in teaching and learning. Indeed, Australia had been recognised as an international leader in teaching and learning policy and practice in higher education for many decades. In 2018, however, the policy carrots are long gone, replaced by sticks of various sizes and potency, and government rhetoric (rather than coherent policy) around budget constraints, accountability, performance measures and graduate outcomes. (Ellis & Goodyear, 2019, p. vii)

Leading government agencies that drove university capacity building for e-learning innovation included Education.au Limited, Australia's national education and training technology agency, which operated from 1996 to 2009, and the Office for Learning and Teaching (OLT), formerly the Australian Learning and Teaching Council (ALTC), and Carrick Institute for Learning and Teaching in Higher Education, which operated between 2004 and 2016. Both Education.au Limited and OLT were gradually dismantled from 2011. Universities benefitted particularly from Education.au Limited's Education Network Australia (EdNA) online forums, which continued to be actively used at Flinders University up until 2012, and educational metadata innovations which were developed and promoted through Education.au Limited (White, 2010). Funding of e-learning research collaboration between universities and its dissemination was successfully managed through the OLT and its predecessor ALTC (Gannaway, Hinton, Berry & Moore, 2011) leading to cited research outputs about higher education e-learning from McKenzie, Alexander, Harper and Anderson (2005) to Selwyn et al. (2016a, 2016b).

Funding concerns, raised in the research literature, suggest that financial and global marketing pressures have influenced a shift in the strategic concerns of universities back towards sustaining the money and effort already invested in e-learning (Stepanyan et al., 2013) away from disseminating new practices. Simultaneously, there has been an increasing recognition by universities for the "need to ensure that innovative ideas and practices translate into a positive sustained impact on the quality of online teaching and learning" (Schneider, Applebee & Perry, 2008, p. 898). Current strategic concerns in universities are also being driven by predictions that "education delivery in lecture theatres will decline by at least 20 per cent by 2026, while computer lab use is expected to decline by 50 per cent in the same time period" (Chlopicki, 2017, para. 10). The current COVID-19 pandemic appears to be greatly accelerating this timeline even as this thesis is being finalised.

Studies conducted by Bichsel (2013) revealed that "institutions in general are most mature in their synergy of e-learning systems" (p. 4). These LMSs are provided and centrally supported within universities through both open source and commercial services, such as *Moodle*, *Blackboard* and *Canvas*, which now operate in most universities around the world. The potential disadvantage of applying top-down control in mandating the use of an LMS across all university courses is that this control can lead to a stifling of creativity and innovation in higher education teaching practice (Nichols, 2008; Groom & Lamb, 2014) necessary for challenging traditional models of higher education. In a provocation aimed at challenging traditional teaching practices in higher education, Aldridge (2013) described these traditional practices as the "continued reliance on the old 'factory model of higher education', with its textbook-driven, teacher-centered, talk and test methodologies" (p. 54). The need for harnessing drivers for change in moving universities beyond this factory model remains a challenge for higher education and one that may yet be met as a result of the COVID-19 pandemic.

2.1.3 Contrasts between successes and failures

Over the past two decades, success of large-scale adoption of LMS services in universities contrasts sharply with an ongoing high rate of failure in furthering the adoption of e-learning innovations that originate in higher education teaching practice (Stepanyan et al., 2013). The proliferation of top-down mandating of university-wide LMS implementations during the early 2000s saw a rise in LMS usage in universities that located it “at a more advanced adoption stage compared to the teaching and learning innovation" (Elgort, 2005, p.184). Stepanyan et al. (2013) made similar observations in their UK based scoping study of teaching and learning innovations, stating emphatically that in cases of innovations driven bottom-up rather than top-down “many e-learning initiatives fail” (p. 91). They added that “these [bottom-up] projects often exhaust the resources and degrade in their impact and, therefore, are destined to be unsustainable” (Stepanyan et al., 2013, p. 91). By contrast, Jansen, Cammock and Conner (2011) warned that “over-emphasising bottom-up emergence can lead to chaos" (p. 68). Concerns about overcoming these bottom-up versus top-down tensions in innovation adoption have led to the proposition of theories, models and frameworks that are discussed in the next section.

2.2 Innovation adoption theories, models and frameworks

Critically interpreting previous definitions, observations, and analyses of the phenomenon.
(Denzin, 2001, p. 73)

The theories, models and frameworks presented in this section offer a range of complimentary perspectives for furthering the adoption of innovations in higher education institutional settings. These perspectives informed the choice of research questions for this study and the development of a conceptual framework for the interpretive case-based modelling method used in conducting interviews for the study.

The review of theories, models and frameworks presented in this section follows a recommendation by Burton-Jones, McLean and Monod (2011) which stated: “being open to multiple theoretical approaches could only help researchers, [by] providing them with more conceptual tools with which to understand and describe the way that actors themselves understand and describe their social settings” (p. 19). This review starts with the dominant DoI theory and model, published over five editions between 1962 and 2003 (Rogers, 2003) and widely cited in educational technology innovation and adoption research. Theories, models and frameworks that emerged from this DoI seminal theory (Straub, 2009; Buchan, 2014) are also reviewed.

Some theories and models were not included in this review because of their greater focus on implementation of information systems, rather than adoption of e-learning innovations that originated in teaching practice. These exclusions include: Theory of Reasoned Action (TRA), Theory of Planned Behaviour, Technology Acceptance Model (TAM) and extended TAM, Unified Theory of Acceptance and Use of Technology (UTAUT), Motivational Model, a model combining TAM and the Theory of Planned Behaviour, and Social Cognitive Theory (Tarhini, Arachchilage, Masa'deh & Abbasi (2015). The e-learning Maturity Model (eMM), which has been applied in Australian universities as an e-learning quality framework and assessment tool (Marshall, 2013), has not been included in this review for similar reasons.

The theories, models and frameworks reviewed for this study were selected in response to a need identified by Singh and Hardaker (2014) for seeking "a more integrated theoretical framework that provides a means to investigate both the influence of exogenous factors, and the influence of individual strategies" (p. 117) in e-learning adoption which was the objective of this review. In setting out to address a similar quest, Burton-Jones et al. (2011) noted that "whatever one's research interest or epistemological orientation, all researchers want to improve their ability to understand, explain, or predict empirical phenomena" (p. 37), recommending that a "more sophisticated understanding of theoretical approaches can assist this process":

> It can help researchers who wish to build new theories, by helping them understand the types of concepts and relationships available to them; it can help researchers who wish to extend theories, by enabling them to see additional types of concepts and relationships that may complement those in the existing theory; and finally, it can help researchers in their reviewing roles, by enabling them to see ways in which authors can clarify the concepts and relationships in a theory and improve their justification. (Burton-Jones et al., 2011, p. 37)

The review of theories, models and frameworks in this section attempts to apply these Burton-Jones et al. (2011) recommendations by comparing concepts and relationships found in the following: DoI theory and model, Critical Mass, Bass Model, combined DoI and Complex Adaptive Systems (CAS) theory, Leadership, Academic & Student Ownership and Readiness (LASO) model, Activity Theory (AT), Actor-Network Theory (ANT), Transformative Framework for Learning Innovation, and Coherence Framework. Each of these theories and models reveals different yet complimentary perspectives of the conditions necessary for the diffusion of innovation.

2.2.1 Diffusion of Innovations theory and model

Since its first publication in 1962, Everett Rogers' DoI theory (Rogers, 2003) has continued to evolve and influence research, theory development and discussion about the process of mainstreaming innovation adoption (Jeyaraj, Rottman & Lacity, 2006; Straub, 2009). DoI was considered a seminal theory by Buchan (2014), while Straub (2009) regarded DoI as "probably the most influential theory in the research" (p. 632). Throughout subsequent editions of his book (editions three to five) published respectively in 1983, 1995 and 2003, Rogers (2003) consistently applied his original definition of the diffusion of innovations, as a "process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5) with the emphasis on "communicated". In Rogers, Medina, Rivera and Wiley (2005), published after Rogers' death in 2004, this original definition of DoI was amended to describe diffusion of innovations as a "process by which an innovation spreads via certain communication channels among members of a social system" (p. 3). The subtle shift between the original emphasis from *communicate* to *spread,* along with the omission of time as a factor in the later definition, suggests a move away from a broadcast transmission (one to many) model of DoI to a view of communication in DoI as occurring in a networked environment, unrestricted by time.

Key variables explored during Rogers' development of his DoI theory were (Rogers, 2003):

- Characteristics of the attributes of an innovation in terms of its ease of adoption.
- Propensity of individuals to adopt the innovation.
- Communication channels used in achieving the spread of innovation adoption.
- How rates of adoption occurred over time in a social system.

Each of these variables is discussed in the following sections.

Attributes of an innovation

According to Rogers (2003), an innovation represented "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 12). The attributes of an innovation were listed by Rogers (2003) as: perceived relative advantage, compatibility, complexity, trialability and observability. As well as influencing ease of adoption, Rogers' DoI theory proposed that the perceived attributes of an innovation also influenced its speed of adoption (Rogers, 2003). An increased speed of adoption was associated with an innovation having the "most relative advantage (measured as most economically rewarding and least risky)" (Rogers, 2003, p. 121).

The Organisation for Economic Co-operation and Development (OECD) provided a broader definition of innovation. In the OECD/Eurostat (2005) definition, both new and improved technological processes and methods used within organisations, were encompassed in proposing that "an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (p. 46). The broader OECD definition recognised that innovations could also build on existing knowledge and practice, a compatibility attribute also identified by Dix (2006).

An extensive literature review conducted by Arkorful and Abaidoo (2015) listed the relative advantages of e-learning innovations in higher education as: flexible usage in time and place; ease of access to information; more interactivity between students and teachers; cost effectiveness in reducing travel and the need for buildings; consideration of individual learners' differences;

compensation for scarcities of academic and other support staff and self-pacing for learners. Disadvantages listed by Arkorful and Abaidoo (2015) included the need for academics to: possess strong motivation, time management and delivery skills; overcome their preference for face-to-face delivery; increase regulation of activities such as cheating and plagiarism; accept a limited role as directors of the educational process; and deal with potential congestion or heavy use of some websites.

From these various definitions and perspectives, e-learning appears to demonstrate the attributes of an innovation by providing new and improved solutions with benefits for transforming teaching, learning and academic productivity. Studies presented in Section 2.3 of this chapter further demonstrate that e-learning displays all the attributes of perceived relative advantages, compatibility, complexity, trialability and observability that Rogers (2003) associated with an innovation. As noted at the start of this chapter, e-learning is a practice in higher education that is constantly evolving and therefore will continue to be perceived as an innovation by those in universities who initiate and support new educational practices with digital technologies and by those who adopt and have yet to adopt these new practices. Thus, in this study the term *e-learning* is at times absorbed into the term *innovation(s*) throughout this thesis and the use of digital technologies is implied.

Population segments in the adoption of innovations

The Rogers (2003) DoI model categorises the individuals in the adoption process within a social system into five population segments (see Figure 4). Each of the five segments represents the propensity of individuals to initiate and adopt an innovation over time, shown as a percentage within each segment. These psychographic segments and their respective percentage representation within any given population are labelled by Rogers (2003) in his DoI theory as:

- Innovators (2.5%)
- Early adopters (13.5%)
- Early majority (34%)
- Late majority (34%)
- Laggards (16%).

In Figure 4 the relative size of these DoI demographic segments as they appear over time within any given population are depicted within a normal distribution, also known as a bell curve.

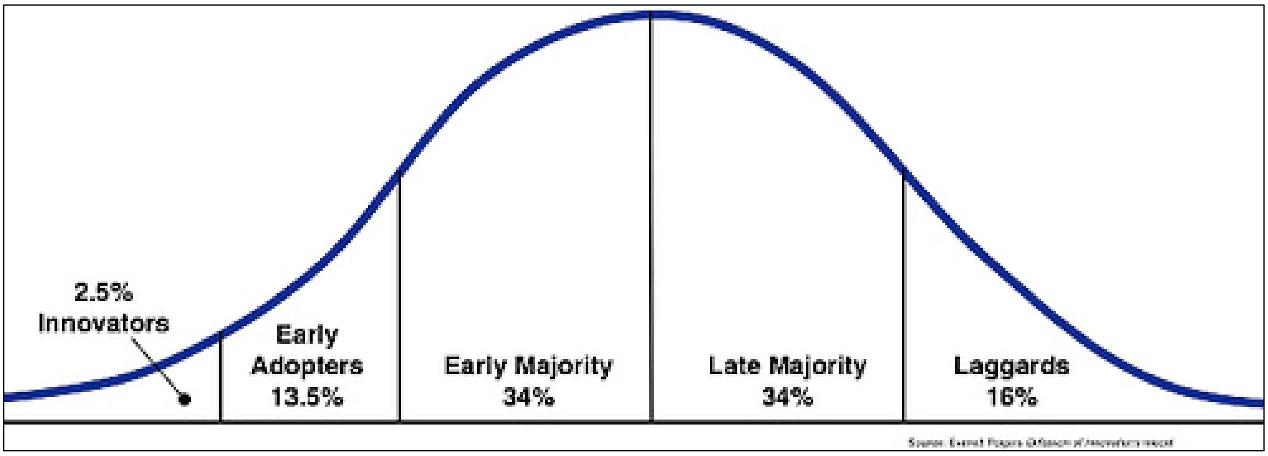


Figure 4. Diffusion of Innovations model (Rogers, 2003). Image by Wesley Fryer https://www.flickr.com/photos/wfryer/1342355056/ is licensed under CC BY https://creativecommons.org/licenses/by-sa/2.0/

Viewing Figure 4*,* from left to right, innovation adoption can be interpreted as a linear and sequential process that occurs across five discrete stages within a relatively stable system (Singh & Hardaker, 2014). In transposing the DoI model into a university setting, Bates and Sangrà (2011) depicted the innovator as a "lone ranger" (p. 138) claiming this role "fits well with the autonomy of the faculty member in higher education" (Bates & Sangrà, p. 138). The role of lone rangers in the adoption of e-learning innovations was viewed by Bates and Sangrà (2011) as "essential for getting innovation started, for demonstrating the potential of technology for teaching, and for ensuring that technology is used when there is no systematic support from the institution" (p.138). As indicated by the 2.5% of innovators in the DoI model shown in Figure 4, Everett Rogers concluded that "only a small percentage of an organization's members are innovators, which implies that generating innovative ideas needs to cross over the barrier of the innovator's marginal status" (as cited in Goldstein, Hazy, & Lichtenstein, 2010, p. 89). A common interpretation in the research literature depicts this transition as a bottom-up process. Uys (2007) suggested that the Rogers (2003) DoI model also applied in cases of innovations that were driven top-down in organisations by senior management. In the adaptation of Figure 4 into a higher education setting by Pacansky-Brock (2015) shown in Figure 5, the Rogers (2003) population segments were translated into roles that labelled innovators as technology enthusiasts, early adopters as visionaries, early majority as pragmatists, late majority as conservatives and laggards as sceptics.

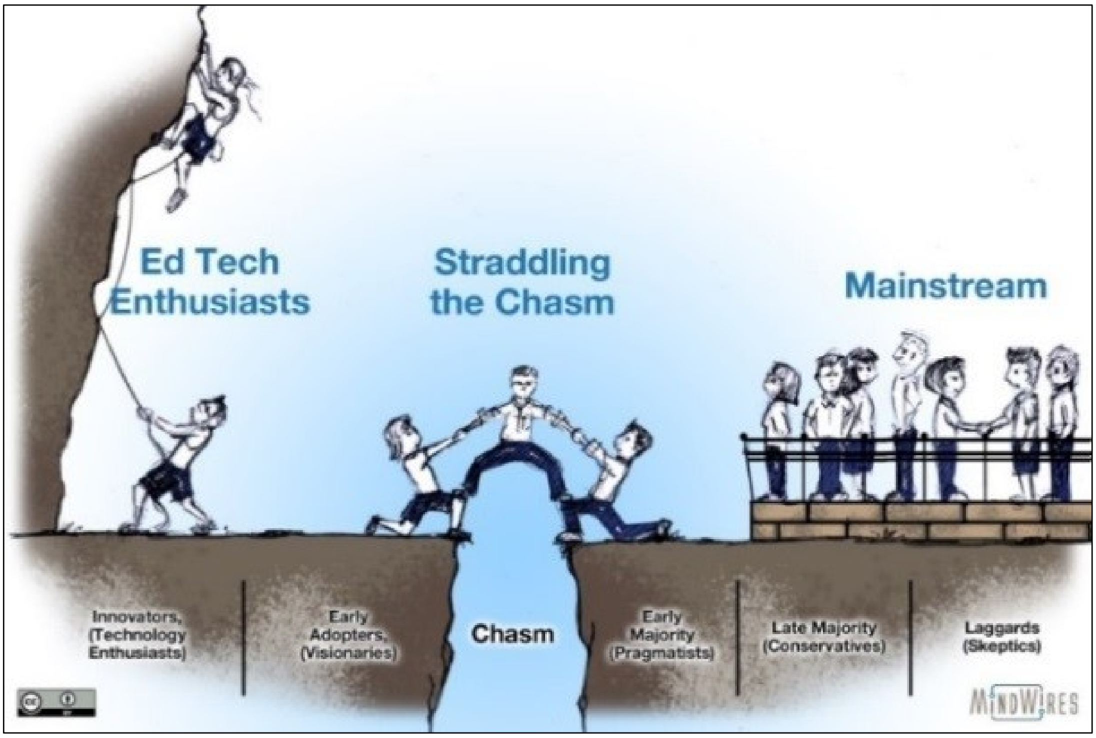


Figure 5. Mainstreaming technology adoption in higher education (Pacansky-Brock, 2015). Image by MindWires http://mindwires.com/ is licensed under CC BY https://creativecommons.org/licenses/by/4.0/

The demographic segments of the Rogers (2003) model thus have continued to provide a useful lexicon (Robertson, 2015) for describing population behaviour over time and in studying innovation adoption roles.

Communication channels in the spread of innovation adoption

Yin, Heald, Vogel, Fleischauer and Vladeck (1976) viewed diffusion studies as being concerned with communication processes that occurred within social networks but were interpreted from "the standpoint of the individual adopter" (p. 11), reflecting a sender-message-receiver transmission model of communication popular in research literature during the 1970s. In progressing DoI theory, Rogers and Kincaid (1981) moved away from this individualised transmission model by drawing together innovators and adopters in formulating a network convergence model of communication. In doing so, Rogers and Kincaid (1981) rejected the previously held view in diffusion and persuasion studies that communication channels were linear and one-way. In citing a detailed network analysis of a case study conducted by Rogers and Kincaid (1981), Rogers (2003) introduced the fifth and final edition of his book about the diffusion of innovations by reiterating:

> Most past diffusion studies have been based upon a linear model of communication, defined as the process by which messages are transferred from a source to a receiver. Such a one-way view of human communication describes certain types of communication; many kinds of diffusion do indeed consist of one individual, such as a change agent, informing a potential adopter about a new idea. But other types of diffusion are more accurately described by a convergence model, in which communication is defined as a process in which the participants create and share information with one another to reach a mutual understanding. (Rogers, 2003, p. xviii)

From a network analysis of a detailed community development case study in South Korea, Rogers and Kincaid (1981) drew the following lessons to characterise effective networks within a convergence model of communication as defined by:

- Sense of personal efficacy through participation.
- Being well-organised and adequately led, assisted by information and resources.
- Search for improved solutions to mutual problems.
- Problem-solving leading to self-development.
- Restructuring traditional communication channels from within through charismatic leadership.
- Capacity to develop and manage communication networks.
- Reaching mutual understanding through collective action.
- Greater reliance on interpersonal communication.

These characterisations provide recurring themes throughout much of the diffusion of innovation research literature.

Rate of innovation adoption over time

While Rogers (2003) claimed that “diffusion research began in 1943” (p. 100), French lawyer and judge Gabriel Tarde was attributed by White (2010) as the first, around 1900 to note “that the rate of adoption of an innovation usually followed an S-shaped curve” (p. 68). This S-shaped or sigmoid curve was further elaborated by Rogers (2003) in depicting the growth rate in adoption of an innovation over time as starting slowly, then increasing more rapidly, before dissipating once an innovation saturated a social system, unless a new curve formed before the initial one tapered off (Uys, 2007; Callan & Bowman, 2010). This view of diffusion of innovations, according to Straub (2009) “takes a macro perspective on the spread of an innovation across time" (Straub, 2009, p. 626) in which innovation adoption is viewed as single smooth process. Uys (2007), however, found in studies conducted in a New Zealand and two South African universities that this view failed to take account of uncontrollable events, staffing changes, and problems with experimentation, resulting in a “ragged contour of the diffusion S-Curve” (p. 248). The problem of irregularity noted by Uys (2007) had been previously recognised by Rogers et al. (2005) who suggested the need for a “new toolbox” (p. 14) to map the irregularities in diffusion and the multiplicity of factors that shaped the process. Callan and Bowman (2010) suggested that in doing so “the ‘trick’ is to identify those factors that affect the ability to sustain e-learning innovations and to ensure that there is an ever-developing upward curve of innovation” (p. 11) which they argued required both top-down (management-driven) and bottom-up (practitioner/teacher-driven) effort within organisations. Robinson (2009) noted that "in later work even Rogers broke away from the linear orientation of his original project” (p. 4), referring to Rogers et al. (2005) which recommended a hybrid DoI and CAS model for explaining the diffusion of innovations as occurring across multiple, simultaneous perspectives and different points in time (reviewed in Section 2.2.5).

2.2.2 Criticisms and further conceptualisations in DoI literature

While numerous studies have cited the Rogers (2003) DoI theory and DoI model in investigating e-learning adoption there have been those who have challenged its limitations. Rogers (2003) product-centric view of DoI was rejected by Singh and Hardaker (2014) as too narrow when applied to the role of e-learning, which they regarded as demonstrating the characteristics "more of a social system than a discrete entity or product" (p. 117). Straub (2009) cautioned that because DoI was "primarily descriptive rather than prescriptive, it does not tell how to facilitate adoption but rather why adoption occurs" (p. 632) and thus made it difficult to frame a study within descriptions of characteristics alone. Another criticism of DoI was that it did not consider individual attitudes towards wider acceptance or rejection of an innovation (Tarhini et al., 2015). Jacobsen (1998) suggested that the challenge was not to blame or attempt to fix faculty attitudes, but rather to design educational systems that reflected faculty social systems, communication channels and patterns of diffusion. To achieve this revised challenge, Jacobsen (1998) recommended "a different support infrastructure" (p. 7) that met the different needs of early and mainstream adopters. Singh and Hardaker (2014) also advised considering "the effect of organisational roles and organisational position" (p. 117). The need for different kinds of organisational support for the diffusion of innovations does not appear to have been previously addressed in any detail in the literature. By contrast, the research literature does contain a wide range of conceptualisations about what the diffusion of an innovation defines.

Since the early 2000s, definitions that appear in the research literature have tended to associate the term *innovation* with new technologies (Smith, 2012) and the process of *diffusion* of innovations with an act of "technology transfer" (Robinson, 2009, p. 2). The term *technology transfer* appears to be preferred in business and technology literature. Within an educational context, DoI appears to apply to a wide range of notions that include *scaling up*, *mainstreaming*, *sustainability*, *pervasive adoption* and *embedding* associated with adoption of new practices in teaching and learning with digital technologies. To clarify a common confusion between the terms *diffusion* and *dissemination* in educational literature, Gannaway et al. (2011) differentiated the two terms by describing diffusion as the passive spread of innovations, as distinct from dissemination which they described as an active, targeted process of implementation that involved "a continuous two-way process from the outset" (Gannaway et al., 2011, p. 22). Hughes, Greenhow and Schifter (2004) distinguished between *diffusion* and *integration* by suggesting "diffusion is an act of spreading and its culmination is complete mixing [while] integration is an act of combining and its culmination is a combination that works well" (p. 3). By contrast, Larson and Dearing (2008) made no distinction between "dissemination, knowledge use, scale up, technology transfer, or diffusion" (p. 511). Collyer and Campbell (2015) introduced the concept of *pervasive adoption* in applying a change management theory perspective to adoption of educational technologies in their Australian university case study. The concept of pervasive adoption, as illustrated by Collyer and Campbell (2015) in Figure 6, is depicted as occurring when the adoption of an innovation crosses over what has come to be known as Moore’s Chasm (Elgort, 2005) in achieving *critical mass, a concept* which is discussed in more detail in Section 2.2.3 of this chapter. Moore’s Chasm is depicted between early adopters and early majority in the adapted Rogers (1962) DoI model shown in Figure 6.

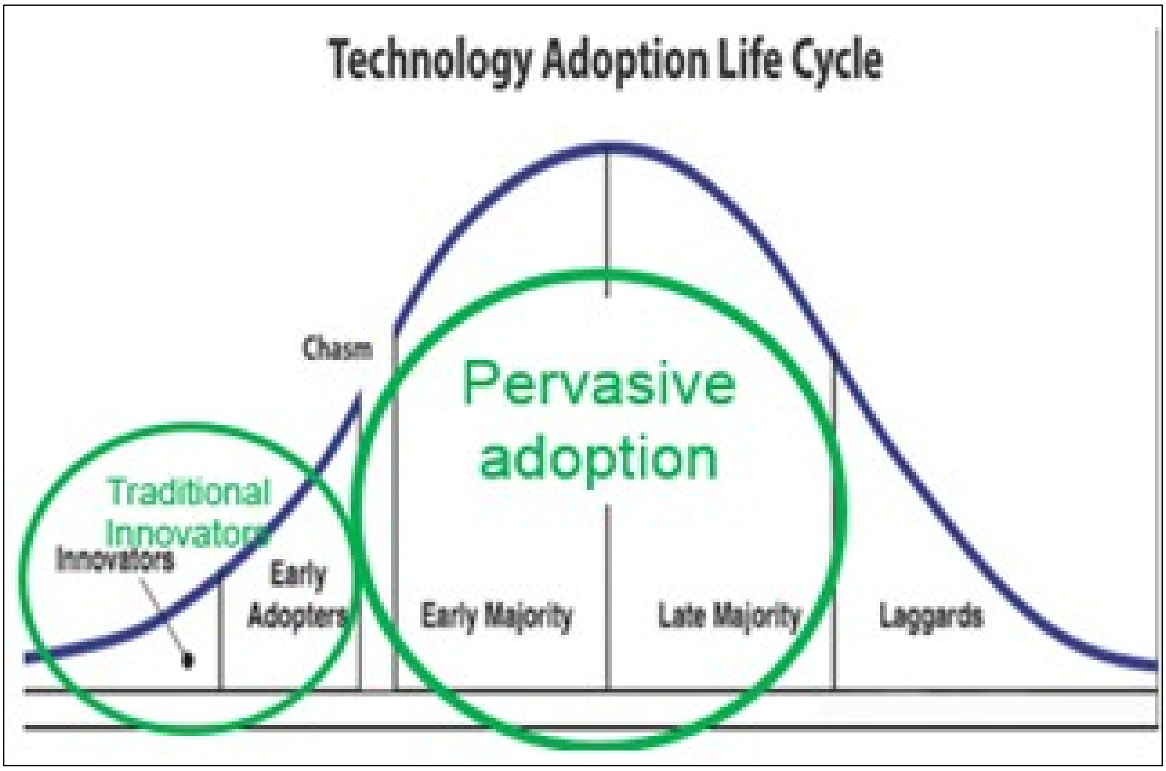


Figure 6. Pervasive technology adoption life cycle as adapted from Rogers (1962) by Collyer and Campbell (2015). Reproduced with permission from co-author Simon Collyer, received 23 October 2018.

Another term in the literature for pervasive or sustained adoption of innovation is *mainstreaming* (Russell, 2009; Holt et al., 2013; Nascimbeni & Spina, 2015; Pacansky-Brock (2015). In Figure 6, Collyer and Campbell (2015) depicted mainstreaming as pervasive adoption that occurred once an innovation was adopted by both the early and late majority, while Pacansky-Brock (2015) depicted mainstreaming as only occurring once there was adoption of an innovation by both the late majority (conservatives) and laggards (sceptics) as shown in Figure 5. In this study, mainstreaming is viewed as occurring once there has been adoption of an innovation by the late majority, recognising that there may always be sceptics and laggards in any given population.

Rossiter (2006), in defining mainstreaming as a "state of embeddedness" (p. 135) drew on notions of both integration and sustainability associated with policy, practice, values, benefits and interventions that occurred across an entire population, to characterise embedded DoI as:

- Widespread adoption or use of the innovation within the organisation, laterally and vertically.
- Integration of the innovation through policy, process and practice.
- Legitimisation of the innovation at all levels of the organisation (individual, work group and institutional).
- Sustainability of the innovation with respect to core values, characteristics and benefits, as evidenced in minimisation or absence of external and internal interventions.

Trentin (2007), in seeking to define adoption in terms of e-learning sustainability, suggested that by having the "characteristics to integrate itself effectively and efficiently in the institutional reference context … sustainability may be considered the measurement of success of an innovation process" (p. 38). In responding to numerous interpretations of the term *sustainability*, Gunn (2010) proposed three characteristics for measuring the outcome of sustainable integration of e-learning innovations (as listed in Section 1.2). Stepanyan et al. (2013) in their extensive literature review of e-learning sustainability as both an outcome and a process, viewed the "integration of a range of competing factors [as] influencing sustainable e-learning" (p. 96). Throughout these many conceptualisations, *diffusion of innovation* appears to remain the most frequently used term in sociological literature (Robinson, 2009) that encompasses the variously related concepts which continue to inspire research, discussion and further reflection in the literature. For the purposes of this study, the diffusion of an e-learning innovation has been conceptualised as adoption (encompassing embedding and spreading) of new ways of teaching and learning with digital technologies that results in mainstreaming, defined as achieving critical mass within any given population.

2.2.3 Critical mass

According to Rabin, Brownson, Haire-Joshu, Kreuter and Weaver (2008), one of the key factors in achieving the self-sustaining point in the DoI process, known as *critical mass*, occurs when "an evidence-based intervention can deliver its intended benefits over an extended period of time after external support is terminated" (p. 3). In reflecting on his own vast body of research that spanned 50 years, Rogers (2004) noted the important addition to his original DoI theory of the notion of *critical mass*, which he defined as "the point at which enough individuals have adopted an innovation that further diffusion becomes self-sustaining" (Rogers, 2004, p. 19). The first suggestion of the concept of a barrier to sustainability, as chasm between the early adopter and early majority segments in the Rogers (2003) DoI model, depicted in Figures 5 and 6, was attributed to Geoffrey Moore (Elgort, 2005). Moore (1999) first described this chasm in a sales and marketing guide without any formal attribution to the original Rogers (1962) DoI model. This lack of attribution by Moore (1999) to Rogers (1962) or to any of his successive editions, for example, Rogers (1983) and Rogers (1995), may reflect the familiarity that readers with a sales and marketing background, towards the end of the 1990s, may have had with this population segment distribution model. The barrier, between the early adopter and early majority population segments identified by Moore (1999), has come to be known in the literature as "Moore's Chasm" (Elgort, 2005, p. 184) and represents the point in the Rogers (2003) DoI model beyond which the adoption of an innovation either fails to progress or succeeds in crossing over to achieve mainstream adoption and sustainability as portrayed by Pacansky-Brock (2015) in Figure 5.

The point of *critical mass*, as located on the far side of Moore's Chasm, is associated with reaching a tipping point represented by approximately 16% of any given population that successfully adopts an innovation (Markus, 1987). This tipping point coincides with the first appearance of the early majority of adopters on the other side of Moore's Chasm, "after which further diffusion becomes self-sustaining" (Rogers, 2003, p. 369) or, as Markus (1987) describes, with reference to Rogers and Kincaid (1981), "the way we do things around here" (p. 506). Markus (1987), in proposing her Critical Mass Theory of Interactive Media, introduced the concept of "reciprocal interdependence, in which earlier users are influenced by later users as well as vice a versa" (p. 491), a process that was later reflected in the two-way dissemination process described by Gannaway et al. (2011). The role of interactions between population segments in innovation adoption emerged as a recurring theme throughout the innovation diffusion literature (Jeyaraj et al., 2006; Straub, 2009; White, 2010; Gannaway et al., 2011; Singh & Hardaker, 2014; Collyer & Campbell, 2015; Pomerantz, 2018) and was central to framing this study of diffusion of e-learning innovations as a process in achieving mainstream adoption, and thereby critical mass and sustainability, in higher education teaching practice.

In the e-learning literature, achieving sustainability of innovation adoption was characterised by meeting educational needs and demonstrating continuous adaptation to change while not exhausting resources or reducing effectiveness (Stepanyan et al., 2013). To achieve this, Nichols (2008) applied the term *sustainable embedding* of e-learning as an "activity that is proactive (it permits forward-thinking and further planning to take place), scalable (e-learning can be rapidly deployed across new programmes or else new approaches can be readily adopted) and self-perpetuating (in that e-learning has become an established part of operations)" (p. 600). This description suggests that a broad combination of factors is also necessary for defining the achievement of critical mass as a marker of mainstream adoption and sustainability in the diffusion of e-learning innovations.

2.2.4 Bass model

The extension of the Rogers (2003) DoI theory and innovation adoption model is evident in the Bass (1969) model. In 1969 Frank Bass adapted Everett Rogers' original DoI theory in developing a predictive model for use in marketing to forecast the interaction between users and potential users of innovations (White, 2010). Known originally as the Bass Forecasting Model but abbreviated to the Bass Model, it continues to be applied in predicting the outcomes of advertising and online viral marketing that uses "well-connected individuals to spread new ideas through their own social networks" (Robinson, 2009, p. 3). In diffusion studies, Bass models mathematically calculate and visualise a series of aggregated feedback loops that trace connections between individuals, guided by the principle that "as an innovation spreads from early adopters to majority audiences, face-to-face communication therefore becomes more essential to the decision to adopt" (Robinson, 2009, p. 3). In Figure 7 the feedback loops depict communication between potential adopters of an innovation (on the left) and adopters (on the right). These feedback loops are based on mathematical interpretations of internal (word of mouth) and external (advertising) effects in the process of innovation adoption.

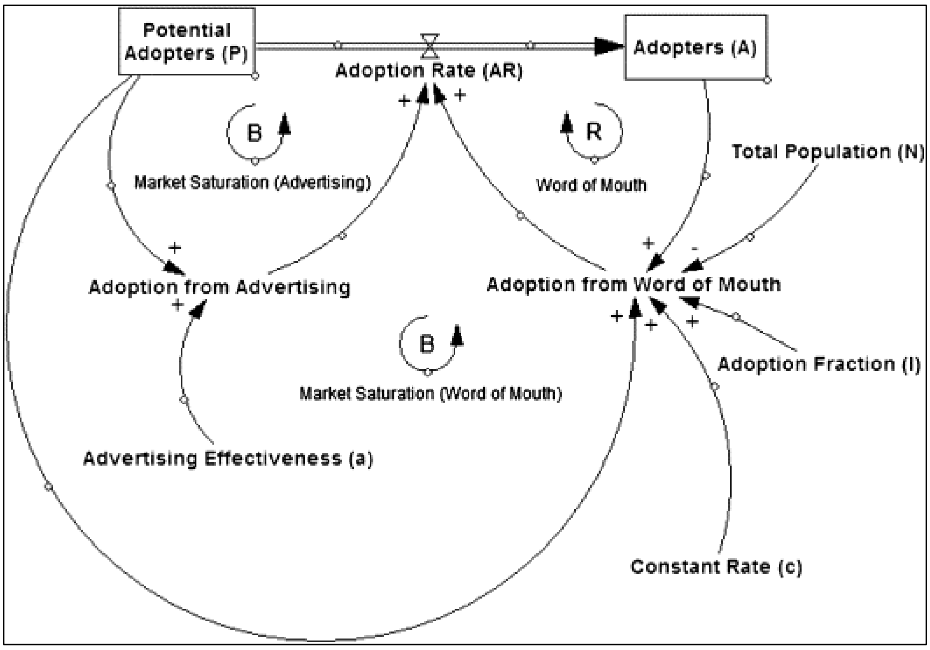


Figure 7. Bass system dynamics diffusion model, adapted from Sterman (2000), (Meyer & Winebrake, 2009, p. 80). Reproduced with permission received from co-author Patrick Meyer on 11 November 2018.

While supportive of the predictive power of Bass models, such as the one shown in Figure 7, White (2010) and Kiesling, Günther, Stummer and Wakolbinger (2012) were also critical of their limited descriptive and explanatory power as models for depicting the diffusion of innovations. White (2010) focused his criticism of the Bass model to limitations in its "descriptive power of large scale take up of innovation" (White, 2010, p. 7) while Kiesling et al. (2012) viewed Bass models as not behaviourally based and therefore unable to "reproduce the complexity of real-world diffusion patterns [and] reflect underlying diffusion mechanisms" (p. 6). Although extending Roger's DoI theory, the Bass predictive model appears limited in describing the process of mainstreaming adoption in innovation diffusion and the connective mechanisms between the parts that represent the factors and actors in this process. Like the DoI model of Rogers (2003), the Bass model is viewed by Kiesling et al. (2012) as providing a limited linear and aggregate interpretation of influences in innovation adoption. The Interpretive Case-based Modelling conceptual framework presented in Figure 15 in Section 3.5 sought to address limitations in the Bass model and in the additional models, theories and frameworks which were reviewed.

2.2.5 DoI and CAS theory

Shortly before his death in 2004, Everett Rogers, together with his colleagues Medina, Rivera and Wiley, recognised that his diffusion of innovations theory, on its own, was limited in explaining the complex connective mechanisms between the parts that make up the process of adoption of innovations. Rogers et al. (2005) saw a possible solution to this limitation in combining an understanding of the process of the diffusion of innovations with the characteristics of institutions as complex adaptive systems. Siemens, Dawson and Eshleman (2018) described the characteristics of a complex adaptive system as based on “a set of diverse actors who dynamically interact with one another awash in a sea of feedbacks” (Siemens et al., 2018, p. 36). Unlike the series of aggregated feedback loops depicted in the Bass predictive model, a Complex Adaptive Systems (CAS) model visualises the dynamic and “often independent and unpredictable” (Siemens et al., 2018, p. 28) nature of interactions between the parts, as active agents that represent factors and actors in the process of innovation diffusion. The unpredictability found in complex systems is the result of the impact of these individual agents on one another rather than the direct result of causes and effects found in reductionist studies of systems (Bore & Wright, 2009), such as those conducted using the predictive Bass model. Niazi (2011) noted:

> In contrast to reductionism which is rooted in simplifications and thus gives a misleading confidence that understanding the parts will somehow “ensure” that we will be able to understand the whole, the complex systems approach focuses instead on a specific meaning of the phrase “the whole is more than the parts”. Here, literature notes that the key factor in understanding CAS is to understand the “interactions” of the parts which cannot be quantified easily. (Niazi, 2011, p. 25)

According to Bore and Wright (2009), the active *agents* in CAS “are located near the boundary of anarchy, far from certainty and agreement” (p. 246). Coupled with unpredictability and interconnectedness this suggests, according to Bore and Wright (2009) why “the concept of a complex adaptive system offers a good description of a school or college” (p. 246) in which “surprise, creativity and emergent behaviour are not the problems they are in reductionist systems” (Bore & Wright, 2009, p. 246). In applying CAS behaviours to a university setting, Stacey (1999) is quoted as suggesting that “no individual agent (e.g., teacher or administrator), or group of agents (e.g., teaching team or department) determines the patterns of behavior that the system as a whole displays or how these patterns evolve, and neither does anything outside the system" (as cited in

Lazaridou, 2015, p. 2). To reveal how these patterns of interaction evolve in the diffusion of innovations, Rogers et al. (2005) recommended using CAS as "an entirely new toolbox with which to model the diffusion process, essentially giving researchers a new way to look 'inside the box', with a variety of population sizes at the scale of interest" (Rogers et al., 2005, p. 14). In CAS studies, this toolbox is provided by computer simulation modelling techniques which can capture and provide insights into the "emergence of a system based on its conditions for self-organizing" (Eoyang, 2001, p. 117). This self-organizing capability applies equally to viewing human actors and institutions as complex adaptive systems (Hall, 2016). Combining DoI with CAS, through modelling the interactions between actors, as advanced in this thesis, offers a method for revealing and gaining insights about the relational mechanisms that make up the complexity of institutional innovation diffusion. Russell (2017) cautioned that CAS models can never be perfect as "there will always be dynamic imbalances that drive the processes of change and growth" (p. 471) making quantification and prediction difficult.

2.2.6 LASO model

The LASO (Leadership, Academic & Student Ownership and Readiness) model, developed between 1995 and 2000 by Uys (2007), extended the Rogers (1995) bottom-up view of DoI that started with the innovators, by introducing several enterprise layers to describe the need for a systems view of technological transformation in higher education. Like Niazi (2011), Uys (2007) drew on systems theory in calling for an integrated approach that studied the process of innovation adoption as it occurred across a whole system, not just from the bottom up. Uys (2007) recommended that for true technological transformation, "an enterprise and all its subsystems need to be considered" (p. 241). In a university these subsystems include both senior and middle management layers as top-down drivers of strategic frameworks, vision, leadership and reward structures, which augment bottom-up drivers achieved through work groups, pilots, training, teams and student interests. The top-down/bottom-up differentiation between the layers, as shown in Figure 8, reflects the integrated view of diffusion of innovations, as defined by Hughes et al. (2004), in which the LASO model was described as demonstrating "the necessity for integrated and orchestrated top-down, bottom-up and inside-out strategies" (p. 4).

Importantly, as Figure 8 shows, the LASO model, "advocates true partnership between academic and support staff" (Uys, 2007, p. 250) based on an interrelationship between leadership, from above, and academic and student ownership and readiness from below, which adds an additional dimension to the linear technological transformation progression in the Rogers (2003) DoI model.

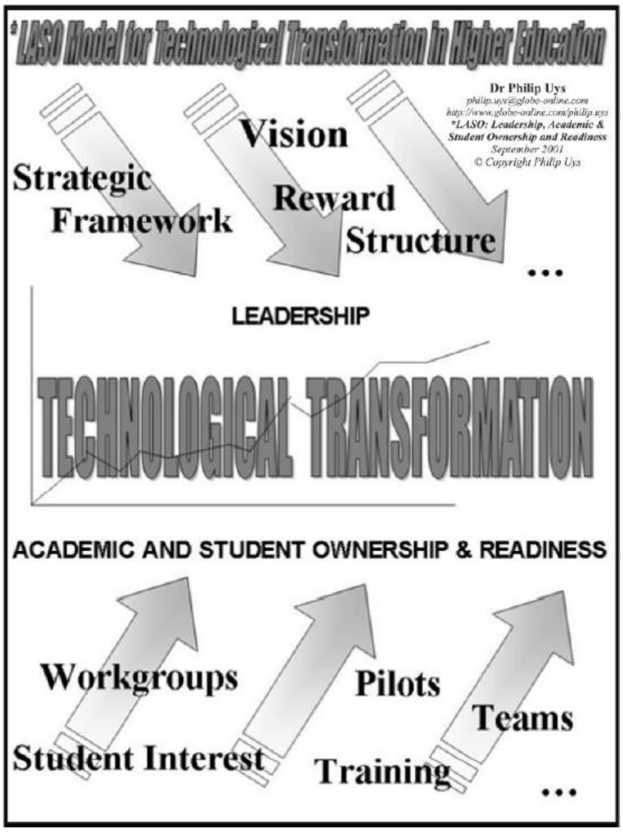


Figure 8. LASO model for technological transformation in higher education (Uys, 2007, p. 243). Reproduced with permission from the author Philip Uys received 5 December 2018.

2.2.7 Activity theory

In a similar way to the Uys (2007) LASO model, Activity Theory (AT) views levels of activity in a system as interrelated. The evolution of AT is attributed by Bakhurst (2009) as having originated during the 1970s in the work of followers of “Vygotsky’s model of mediation” (p. 199) and culminating in a view of AT as “an empirical method for modeling activity systems” (Bakhurst, 2009, p. 197). In a comparative study of the implementation of two new university course management systems conducted by Benson, Lawler and Whitworth (2008), the application of AT revealed "interfaces between e-learning at the macro-organisational level (strategy, policy, ‘campus-wide’ solutions) and the micro- (everyday working practice, iterative change, individual adaptation)” (p. 1). The Benson et al. (2008) study concluded that these macro- and micro-organisational roles, defined by “pronounced divisions of labor” (p. 12) within a university, combined with tools, rules and external contexts to behave as mediators in the process of innovation diffusion.

Robertson (2008) similarly applied an AT view of institutional activity systems to describe the diffusion of e-learning innovations in higher education as occurring across not two (macro and micro) but three levels: macro (organisational), meso (technical) and micro (pedagogical). These three levels were respectively described by Robertson (2008) as “the organisational activity system – largely represented by management [macro] … the technological activity system – largely represented by information technology specialists [meso] … the pedagogic activity system – represented by those with primary responsibility for teaching and learning [micro]" (p. 821). In proposing possible tensions and contradictions between each of the three systems – organisational (*macro*), technological (*meso*) and pedagogical (*micro*) – Robertson (2015) suggested that "given the premise that sustainable e-learning is most likely to emerge where there is congruence between each system, these tensions and contradictions have the potential to reduce the likelihood of success" (p. 168) in achieving sustainable diffusion of innovations. Kiesling et al. (2012) recommended that "further empirical research is needed to clarify what micro-, meso-, and macro-level mechanisms of social influence act in different … stages of the diffusion process" (p. 43). Their recommendations supported the need for further investigation into the nature of the interrelationships that occurred as a result of institutional role interactions between the actors in each level: (*macro*) managers, (*meso*) technology specialists and (*micro*) educators as both innovators and adopters of innovations in higher education teaching practice.

Hasan and Crawford (2006) applied the principles of AT in conducting their comparative analysis of a range of computer-based analysis tools to inform decision-making in socio-technical systems. The term socio-technical system was attributed by Clarke and Wigan (2018) to "Trist and Emery [Emery, 1959] at the Tavistock Institute in the 1950s, to describe systems that involve complex interactions firstly among people and technology, and secondly between society's complex infrastructures and human behaviour" (p. 677). Almost 70 years later, Clarke and Wigan (2018) observed that such systems continued to exhibit tensions between organisational objectives and human values. Hasan and Crawford (2006) supported a clear role for applying AT in exploiting modelling software for collecting tacit knowledge about these tensions and thus providing a holistic understanding, from a "birdseye view" (p. 7) of congruent (enabling) and contradictory (inhibiting) interactions that occurred in the interplay between variables within a socio-technical system.

2.2.8 Actor-network theory (ANT)

Carroll (2014) continued the analogy of a "birdseye" view of the diffusion of innovations (DoI) process by proposing Actor-Network Theory (ANT) as offering a roadmap for revealing the pathways of two-way interactions that occurred between actors who were the DoI stakeholders in technology transformation within a socio-technical system. Carroll (2014) applied an eight step ANT roadmap to an organisational case study of a paper-based to automated system transformation. The function of the roadmap in the study provided "an approach to understand how both social action shapes technology and how technological innovations shape social action" (Carroll, 2014, p. 144).

The following steps in the roadmap, originally developed by Neil McBride and adopted by Carroll (2014), were proposed by Carroll (2014) as an ANT research method for undertaking studies of technology adoption in public organisations:

1. Identify the stakeholders – in relation to policies and practice.
2. Investigate the stakeholders – by their characteristics.
3. Identify stakeholder interactions – by tracing interactions and levels of influence.
4. Construct an actor-network model – to determine complexity, cohesion, strength, and influence.
5. Examine irreversibility – the degree of difficulty in making a change.
6. Source inhibitors and enablers – through who enables and inhibits actions.
7. Trace actions – in aligning the actor-network.
8. Report on the actor-network – how actions shape the overall nature of the network.

Each of the steps reflected Bruno Latour's call to "follow the actors" (as cited in Carroll, 2014, p. 131) which distinguished this theory by focussing on actor relationships and interactions. In this way, ANT is unlike more traditional demographic approaches to researching DoI in organisations, such as depicted in Rogers (2003) five population segment model comprised of innovators, early adopters, early majority, later majority and laggards. In ANT the focus is on modelling the network of relational dynamics between the actors in population segments and thus representing actor-network interactions.

Carroll (2014) highlighted an overlap between DoI theory and ANT as occurring when a tipping point was reached in the innovation adoption process through a "final decision to implement or continue using an innovation to a point to which it is impossible to return" (p. 131), a concept also found in the notion of critical mass. The process for connecting interactions between actors, using the (Carroll, 2014) eight step ANT roadmap, offers both a way of thinking about networks and a method for revealing who the actors are in innovation adoption and how they interact through enabling and inhibiting interactions and associated levels of influence. In step five of the ANT roadmap the need to examine the degree of difficulty in implementing change is suggested but there is no elaboration on how or why tensions may exist between actors or how to depict time frames needed for achieving change, other than suggesting that "the amount of time required depends on certain characteristics of the person or social system" (Carroll, 2014, p. 130).

2.2.9 Transformative framework for learning innovation

In the four-quadrant Transformative Framework for Learning Innovation proposed by Salmon (2015), shown in Figure 9, factors involved in the process of e-learning innovation adoption are depicted as occurring along east/west and north/south axes to demonstrate tensions between current and new capabilities involved in transformational change through e-learning in higher education teaching practice. As well as indicating the direction of these tensions, the Salmon

(2015) framework allows estimates of the levels of risk and time frames associated with implementing the DoI process in universities.

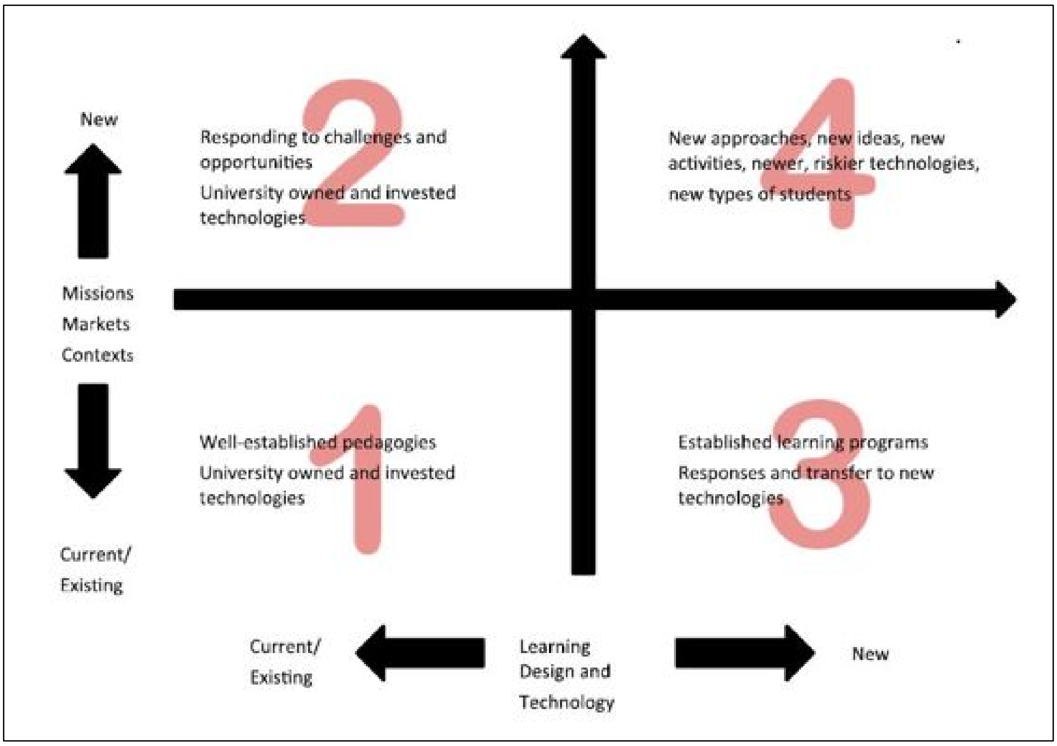


Figure 9. Transformative Framework for Learning Innovation (Salmon, 2015, p. 224). Reproduced with permission received from author, 24 September 2019.

In Figure 9, the capabilities in the framework can be viewed as reflecting activities found in higher education at *macro* (policy and collaboration), *meso* (library and media services) and *micro* (teaching materials) levels. For example, it is possible to associate "responding to challenges and opportunities" (in Quadrant 2) to the *macro* level; "responses and transfer to new technologies" (in Quadrant 3) to the *meso* level; and "well-established pedagogies" (in Quadrant 1) to the *micro* level. The framework was applied by Salmon (2015) in suggesting a range of strategies, levels of risk and time frames associated with each quadrant in achieving transformational change: in Quadrant 1 a strategy for improving learning design was coupled with professional development and staff support which was viewed as low risk and requiring one to two years to implement; Quadrant 2 required further professional development that was slightly more risky with an unspecified time frame beyond one year; in Quadrant 3 greater use of everyday technologies was recommended to move beyond a dependence on university owned systems which was also viewed as involving some risk over a one to two year time frame; achieving full transformation, was described in Quadrant 4, and was considered unlikely to succeed without greater investment and commitment to experimentation, therefore involving a high risk although offering potential high value for universities that succeeded, but requiring a longer time frame of two to four years. These strategies reflected the elaboration of an earlier framework (Salmon, 2005) that noted “staff development and new systems and processes will be necessary for scaling-up offerings” (p. 213).

The Salmon (2015) framework extended an earlier e-learning and pedagogical innovation strategic framework (Salmon, 2005) that rejected the frequently cited DoI model of Rogers (2003) as too linear and simple, claiming that "the linear process views appeared too simple to be useful as a framework for considering the complexity involved in e-learning in HEIs (Higher Education Institutions)" (Salmon, 2005, p. 211). This criticism by Salmon (2005) appeared around the same time as the later work of Rogers et al. (2005), which addressed this same limitation in proposing a hybrid theory that added an interpretation of CAS to the Rogers (2003) DoI theory. Other than noting the need for astute planning, the Salmon (2005) framework did not go on to describe the processes she recommended for overcoming the limitation in the Rogers (2003) model, beyond noting the previously mentioned need for "staff development and new systems and processes" (Salmon, 2005, p. 213). Salmon (2005) appeared to embrace the notion of complexity, being simultaneously proposed by Rogers et al. (2005), with both suggesting the need for systematic change within universities, informed through understanding the dynamic complexities of processes involved in e-learning diffusion.

2.2.10 Coherence framework

In proposing the need for leadership as a pivotal and unifying influence in driving educational change, Quinn and Fullan (2018) drew on the analogy of the four chambers of a heart to describe their Coherence Framework for organisational cultural change in education systems. While an examination of cultural change, as a factor in innovation adoption, was outside the scope of this study (see Section 1.2), the analogy of the chambers of the heart suggested a number of useful metaphors for modelling the interconnected behaviour of innovation adoption roles across organisational (*macro*), technological (*meso*) and pedagogical (*micro*) levels in universities as socio-technical systems. The metaphors that emerge from this analogy reflect both an Activity Theory perspective, in viewing different yet connected roles in a system as mediators, and Actor-Network Theory, in examining enabling and inhibiting interactions and associated levels of influence of actors who perform organisational, technological and pedagogical roles. The components in the quadrants in the Coherence Framework (Quinn & Fullan, 2018, p. 226) describe processes for:

- Focusing direction.
- Cultivating collaborative cultures.
- Securing accountability.
- Deepening learning.

To imagine the function of these four components in the framework, Quinn and Fullan (2018) advised the following:

> Think of the four components as the four chambers of the heart. They operate independently, but all four are essential to sustain life. Each of the four components is interconnected to and serves the other three. Actions in one have a profound impact on the others. It is not a constraining set of components but rather a catalyst for action. Damage one of the four chambers, and the heart (organization) fails. (Quinn & Fullan, 2018, p. 227)

The Coherence Framework was presented as fulfilling a challenge proposed by Fullan (2015) in which he questioned the limitations of “top-down versus bottom-up thinking” (p. 26), as described in the Benson et al. (2008) Activity Theory depiction of a flat technology transformation interface between macro- and micro-organisational roles. By contrast, Quinn and Fullan (2018) viewed the Coherence Framework as non-linear, agile and better suited to solving the multi-dimensional problems of complexity found in cases of educational change, noting that in education systems “people come and go, policies change, the context shifts, and the environment is dynamic" (p. 226). In discussing these common challenges, found particularly today in higher education institutions, Fullan and Quinn (2016) concluded that "educational change is technically simple and socially complex" (p. 67). The framework proposed by Fullan and Quinn (2016) attempted to resolve the tension between technical and social forces by locating the role of leadership as pivotal within education systems, depicting leadership as radiating from the centre into each of the four quadrants of the framework. Other than showing the role of leadership as exerting an equal influence on each of the four quadrants, Quinn and Fullan (2018) did not indicate how each of the independent processes found in educational change, as listed within each of the quadrants, interacted with and influenced each another. For example, "capacity building", listed as a process in the *Cultivating collaborative cultures* quadrant, and "shifting practices through capacity building", in the adjacent *Deepening learning* quadrant, appeared separately as impacted by leadership in driving educational change. Any possible relationships between these two processes, or relationships with other processes listed in other quadrants of the framework, were left unexplored. This may be because, as Quinn and Fullan (2018) acknowledged, understanding “whole system change is still at the early stages” (p. 236), a challenge addressed by this study.

2.2.11 Summary of theories, models and frameworks

The theory of DoI (Rogers, 2003) together with the widely recognised model of DoI (Figure 4) continue to dominate in studies that investigate the diffusion of innovations in education. Extensions of DoI and alternative theories, models and frameworks have attempted to address the limitations of the Rogers (2003) DoI theory and model. Table 1 lists leading theories, models and frameworks that have been reviewed in this section and presents these together with a summary of key concepts that apply to this study.

Table 1. Summary of theories, models and frameworks and associated key concepts

Theories, models and frameworks		Key concepts applicable to this study
Theories	Diffusion of Innovations (DoI) (Rogers, 1962-2003)	Only the second (population segments) of the following four key variables is directly applicable to this study: (1) attributes of an innovation; (2) population segments: innovators, early adopters, early majority, late majority, laggards; (3) communication channels; and (4) rate of innovation adoption over time.
	Diffusion of Innovation (DoI) and Complex Adaptive Systems (CAS) (Rogers, Medina, Rivera & Wiley, 2005)	An extension of DoI that proposes applying the characteristics of CAS in modelling relational mechanisms between DoI variables. CAS is characterised by the dynamic interactions between actors in a system which is a focus of this study.
	Activity Theory (AT) (Robertson, 2008)	AT views levels of activity in a system as interrelated. Levels in a higher education system are described as organisational (*macro*), technological (*meso*) and pedagogical (*micro*)
	Actor-Network Theory (ANT) (Carroll, 2014)	An overlap between DoI theory and ANT occurs through the shared notion of a tipping point (critical mass). ANT method contains eight steps: (1) identify stakeholders (2) investigate stakeholder characteristics (3) identify stakeholder interactions (4) construct actor-network model (5) examine degree of difficulty in making a change (6) source inhibitors and enablers (7) trace/align actions (8) report on how actions shape the overall nature of the network.
Models	Bass Model (Meyer & Winebrake, 2009)	An extension of DoI that shows a series of aggregated feedback loops that trace connections between individuals as shown in the example provided by Meyer and Winebrake (2009).
	LASO Model (Uys, 1995)	An extension of DoI that demonstrates an integrated systems approach in education comprising of both top-down and bottom-up forces.
Frameworks	Transformative Framework for Learning Innovation (TFLI) (Salmon, 2015)	Rejects Rogers (2003) DoI model as too linear and simple but reflects the Rogers et al., (2005) DoI CAS theory proposition in the design of the multi-directional TFLI framework that depicts relationships occurring in an education system across four quadrants influenced by two sets of axes that show directions from current to new capabilities involved in transformational change.
	Coherence Framework (Quinn & Fullan, 2018)	Reflects both an AT perspective, in viewing different yet connected roles in a system as mediators, and ANT, in examining enabling and inhibiting interactions and associated levels of influence of actors who perform organisational, technological and pedagogical roles in education.

Studies, examined in the next section of this literature review, apply these theories, models and frameworks in attempting to reveal underlying relationships that operate in sustaining the process of technology adoption as part of educational change.

2.3 E-learning innovation adoption in higher education teaching

Critically examining the underlying theoretical model of human action implied and used in prior studies of the phenomenon. (Denzin, 2001, p. 73)

This section presents an analysis and synthesis of findings from extant studies and reviews, conducted from 2006 to 2017. This analysis provided the secondary data sources for undertaking this study. The sources for analysis were selected with a focus on identifying the roles of institutional actors, as key stakeholders in implementing e-learning innovations within universities, and critical success factors associated with achieving mainstream adoption of e-learning innovations. The process for selection of sources adopted the approach taken by Kannan, Atwater and Stephens (2007) for conducting a synthetic review of literature, which they described as "studying the role and purpose of a system and its parts to understand why they behave as they do" (p. 26). In this study, the roles and purposes of the parts of a university system were drawn out of an examination of different levels of institutional actors with distinct roles in e-learning innovation adoption. These levels were then coupled with a thematic separation of critical success factors that impacted on innovation adoption. The actor groups and success factors were then brought together in a baseline model shown in Figure 17 (Section 4.7.2) which links actors and factors in locating key institutional roles in e-learning innovation adoption across a university landscape.

Search terms and phrases used to select sources for review included *sustainable diffusion of e-learning innovations*, *technology adoption*, *case studies*, *higher education* and *universities*. Thirteen studies published between 2005 and 2015 (see Appendix 3) were found as a result of an initial online search with these terms as key words (Elgort, 2005; Alexander, 2006; Sharpe, Benfield & Francis, 2006; Birch & Burnett, 2009; Gunn, 2010; Hardaker & Singh, 2011; Gunn & Herrick, 2012; Csete & Evans, 2013; Salmon & Angood, 2013; Smigiel, 2013; Singh & Hardaker, 2014; Henderson, 2015; King & Boyatt; 2015).

A key objective throughout the initial search of the literature was to locate case studies of bottom-up adoption of innovations that had originated in higher education teaching practice, also referred to by (Nascimbeni, 2013) as “grassroots” innovations. These proved to be more difficult to locate than case studies of top-down management-driven e-learning innovation adoption involving the implementation of an LMS which were more abundant. Elgort (2005) located management implementation of the LMS in universities “at a more advanced adoption stage compared to the teaching and learning innovation" (p.184). LMS implementations appeared a key consideration in innovation adoption in universities through its central technology support role and therefore findings from studies of both top-down and bottom-up adoption were selected for review. The initial thirteen studies were further examined for references to case study data.

Results from the further examination of the literature yielded a total of 22 research studies which included eight studies from the initial list in Appendix 3 which are highlighted in Table 2 with an asterisk (*). The studies in Table 2 were published between 2006 and 2017, representing a decade of adoption of e-learning innovations in universities. The 22 studies in Table 2 are listed in alphabetical order (by author) together with the number of references found in each study assessed as relevant for an analysis of actors and factors in e-learning innovation adoption. The number of references per publication ranged from four (Anderson, 2012; Bates & Sangra, 2011) to the highest numbers found in the two largest studies of bottom-up e-learning adoption (Gunn & Herrick, 2012), with 81, and a study conducted in two parts by Selwyn et al. (2016a, 2016b), with 142.

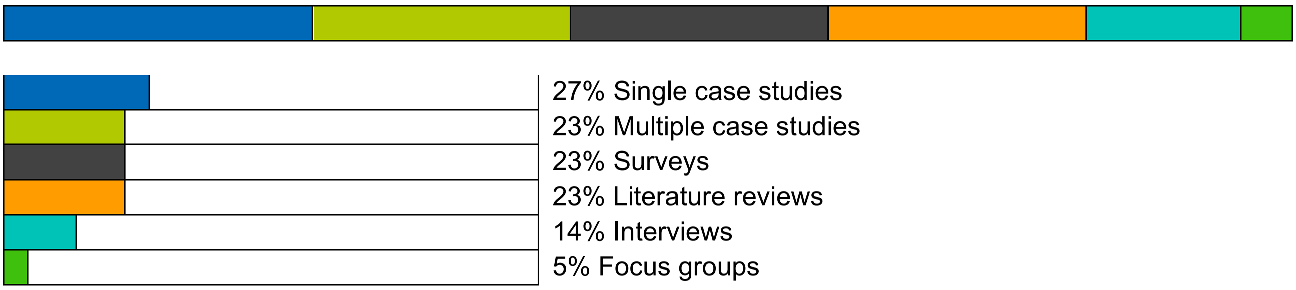
Table 2. Published studies from 2006 to 2017 used as secondary data sources

Author	Date	Title	References
Alexander *	2006	Dissemination of innovations: A case study.	20
Anderson	2012	Barriers and enablers to teachers' adoption of online teaching at an Australian University.	4
Bates and Sangra	2011	Managing technology in higher education: Strategies for transforming teaching and learning.	4
Collyer and Campbell	2015	Enabling pervasive change: A higher education case study.	8
Csete and Evans *	2013	Strategies for impact: Enabling e-learning project initiatives.	16
Czerniewicz and Brown	2009	Intermediaries and infrastructure as agents: The mediation of e-learning policy and use by institutional culture.	6
Davis and Fill	2007	Embedding blended learning in a university's teaching culture: Experiences and reflections.	14
Dennison	2014	Critical success factors of technological innovation	13
Elgort *	2005	E-learning adoption: Bridging the chasm.	7
Gregory et al.	2015	Barriers and enablers to the use of virtual worlds in higher education: An exploration of educator perceptions, attitudes and experiences.	15
Gunn *	2010	Sustainability factors for eLearning initiatives	10
Gunn and Herrick *	2012	Sustaining eLearning innovations: An ACODE research study report.	81
King and Boyatt *	2015	Exploring factors that influence adoption of e-learning within higher education.	19
Laurillard, Oliver, Wasson and Ulrich	2009	Implementing technology-enhanced learning.	6
Nascimbeni	2013	Grassroots micro-innovations as drivers for systemic change in ICT-supported learning: The VISIR experience.	8
Pomerantz and Brooks	2017	ECAR study of faculty and information technology.	28
Robertson	2015	Sustainable e-learning: A guide to practice and analysis.	21
Salmon and Angood *	2013	Sleeping with the enemy.	38
Selwyn et al.	2016a 2016b	What works and Why? Understanding successful technology enabled learning within institutional contexts. Appendices Part A and B.	142
Singh and Hardaker *	2014	Barriers and enablers to adoption and diffusion of eLearning: A systematic review of the literature – a need for an integrative approach.	16
Smigiel	2013	Making changes.	6
Snyder, Marginson and Lewis	2007	An alignment of the planets: Mapping the intersections between pedagogy, technology and management in Australian universities.	8

The 490 references in Table 2 were coded in conducting an analysis of secondary data sources for this study. The analysis and synthesis of actors and factors from these studies used thematic coding conducted with *Quirkos* software (Turner, 2014) which is described in Section 4.9 and the results are reported in Section 5.1.

Frequencies resulting from the analysis of types of studies are shown as percentages in the tables that follow, produced by the Quirkos software. Table 3 shows that half of the 22 studies analysed used case study as the preferred research method for investigating the adoption of e-learning innovations in universities, with these studies split almost evenly between single (27%) and multiple cases (23%). The next most common method reported was surveys (23%) which were sometimes combined with case studies. Literature reviews (23%) that cited both case studies and surveys were also included for analysis. A small selection of interview (14%) and focus group-based studies (5%) were also included for comparison with case-based research studies.

Table 3. Types of study methods



Yin (2014) defined case studies as illuminating “a decision or set of decisions: why they were taken, how they were implemented, and with what result” (p.15). Case studies were also found to be useful for explaining “presumed causal links in real-world interventions that are too complex for survey or experimental methods” (Yin, 2014, p.19). This review confirms that case studies appear to have remained the preferred research method for investigating the complex problem of mainstreaming e-learning innovations for over one decade up to 2017.

Table 4 shows the distribution of top-down versus bottom-up driven e-learning adoption studies reported in the research literature selected for review in this study. As stated in the introduction to this section, the aim of the literature review was to locate case studies of bottom-up adoption of grassroots e-learning innovations, and these proved more difficult to find (23%) compared with studies that described cases in which both bottom-up and top-down adoption occurred (41%). This may be attributable to the need for many bottom-up e-learning innovations to comply with a centrally controlled LMS in the university where an innovation originates. The 23% of top-down studies were all concerned with investigating LMS implementation in universities.

Table 4. Origin of innovations in studies

Percentage	Origin
23%	Top down
36%	Bottom up
41%	Bottom up and top down

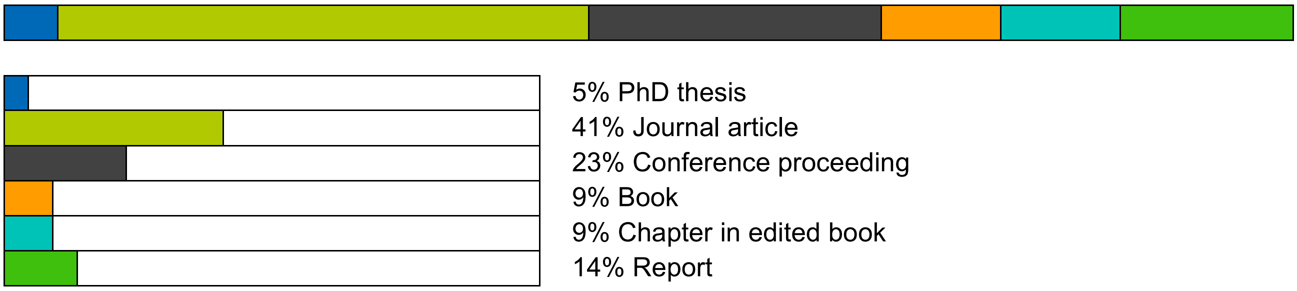
In Table 5, references to implementation of an LMS dominated 50% of the coverage of e-learning innovations. Reference to a range of other e-learning innovations provided the remaining 50% of coverage. Where specific innovations and their applications were investigated within this range, they represented the following in order of coverage: online teaching (18%); online assessment, (mobile) m-learning, student response systems and simulations (14%); eportfolios, collaboration environments, multimedia and social networking (10%). The remaining 5% covered virtual worlds, authoring applications, scenario-based learning, visualisation software, lecture capture, blended learning, digital annotation, flipped classrooms, online forums, free web-based content, search tools, alert systems, publisher electronic resources, e-books and e-textbooks, and laptops as learning tools. The complete range of e-learning innovations is depicted in Table 5 which also provides an indicator of the top four e-learning innovations by percentage, indicated by the numbered parentheses.

Table 5. Types of e-learning innovations in studies

Percentage	Type
18%	Online teaching **(2)**
14%	Online assessment **(3)**
5%	Virtual worlds
9%	Eportfolio **(4)**
5%	Authoring application
5%	Scenario based learning
14%	M-learning **(3)**
4%	Visualisation software
9%	Collaboration environment **(4)**
14%	Student response system **(3)**
5%	Lecture capture
5%	Blended learning
50%	Range of e-learning initiatives **(1)**
5%	Digital annotation
5%	Flipped classroom
5%	Online forums
9%	Multimedia **(4)**
14%	Simulations **(3)**
9%	Social networking **(4)**
5%	Free web-based content
50%	Learning Management System **(1)**
5%	Search tools
5%	Alert systems
5%	Publisher electronic resources
5%	E-books and e-textbooks
5%	Laptops as learning tools

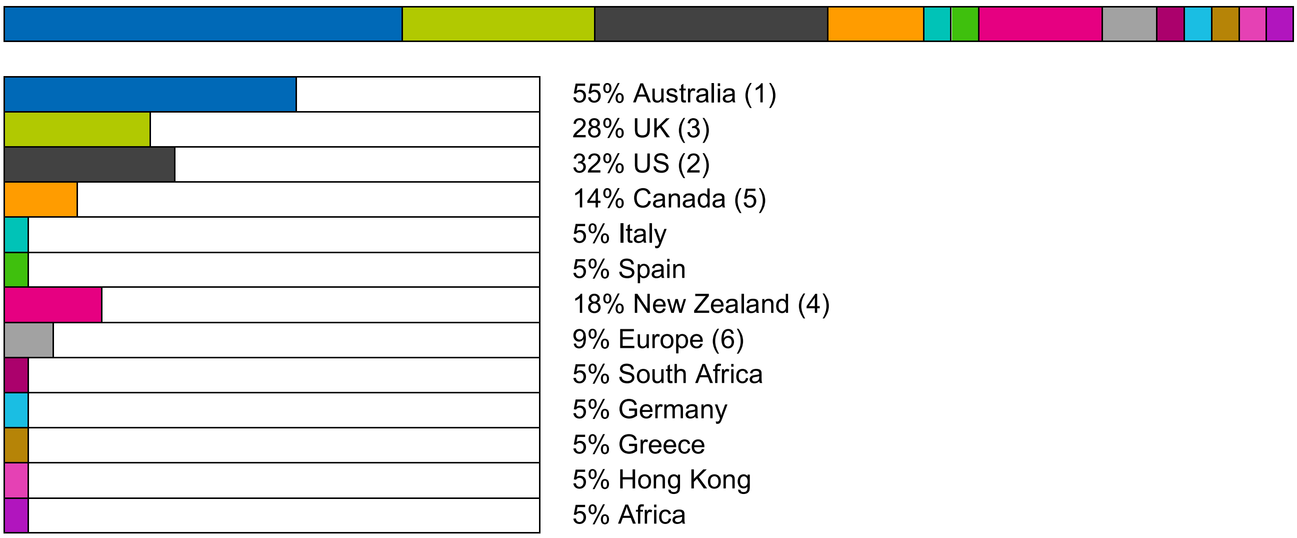
Depicted in Table 6 are the types of publications reviewed for conducting an analysis of actors and factors in this study. These ranged from journal articles (41%) followed by conference proceedings (23%), reports (14%), books (9%), book chapters (9%) and a PhD thesis (5%). The dominance of exploratory presentations and articles in journals and conference proceedings suggests that e-learning in higher education is still an evolving field.

Table 6. Types of publication



Geographic origins for studies represented in the publications, listed in Table 7, show a wide spread of global locations. While Australian studies were not targeted specifically during the initial literature search, in the secondary data search, as shown in Table 7, they were heavily represented (55%), followed by the United States (32%), the United Kingdom (28%), New Zealand (18%), Canada (14%) and Europe (9%). Also represented (at 5%) were studies from Italy, Spain, Africa and South Africa, Germany, Greece and Hong Kong.

Table 7. Location of studies



The dominance of Australia in this wide-ranging list of study locations would appear to confirm the claim made in Ellis and Goodyear (2019) that Australian universities have played a leading role in undertaking studies of adoption of e-learning innovations over the past decade.

2.4 Limitations, gaps and challenges presented in previous studies

Presenting the preconceptions and biases that surround existing understandings of the phenomenon. (Denzin, 2001, p. 73)

This section of the literature review reveals limitations, gaps and challenges in representing how adoption of e-learning innovations occurs in higher education teaching practice. Previously presented models and frameworks are re-examined and numerous gaps in portraying relationships between factors and actors are revealed. The challenges of addressing complexity as a wicked problem (Rittel & Webber, 1973) are raised and explored. The voices of researchers, engaged in studies of e-learning innovations, are added to illustrate shared concerns about a lack of available data and processes for informing university practices. Propositions for further research in overcoming gaps, challenges and limitations are then presented which lead to the formulation of the research questions that guide this study.

2.4.1 Limitations of data from previous studies

Case studies have, over the past two decades, remained the dominant method of inquiry for investigating the problem of mainstreaming the adoption of e-learning innovations in higher education. While numerous case studies of e-learning innovation adoption were available in the higher education research literature (see Table 2), findings from these case studies failed to connect and contextualise the key interactions that occurred between institutional actors across universities. These studies were limited in providing insights about interactions between actors within university systems and even less on the extent of impacts and influences arising from such interactions when they occurred. Many of the researchers cited in this literature review raised particular concerns about a lack of data about what needed to happen in universities in order to address the problem of mainstreaming e-learning innovations that originated in higher education teaching practice.

While Tubaro and Casilli (2010) noted that case studies using “qualitative methods provide rich and detailed descriptions of social phenomena … and can account for the meanings actors themselves give to their behaviors [sic] and attitudes” (p. 60) they concluded that case studies were also limited in “uncovering the underlying structure of a phenomenon and potentially deriving universal conclusions” (Tubaro & Casilli, 2010, p. 60). Anderson (2012) noted that in previous studies "enabling factors are seldom mentioned or examined" (p. 35). This appears to contradict the following conclusion by Gunn (2010):

> While there are numerous studies that identify success factors and barriers for achieving sustainable elearning innovations across higher education institutions, very little data is available about what actually needs to happen for successful implementation beyond the development stage of a new elearning initiative. (Gunn, 2010, p. 97)

Gunn (2010) claimed that in universities “the 'problem' of sustainability has been visible on the horizon for many years” (p.91) yet “no processes have been put into place to address it” (Gunn, 2010, p. 95). From their Australian and New Zealand university case studies, Gunn and Herrick (2012) noted that “there is little evidence of enacted intention, or internal processes to support development and dissemination, or even of deep understanding of the work and support needed to move an innovative product into a sustainable entity” (p. 2). They concluded that “there are no common methodologies or uniform sets of data to present a coherent picture” (Gunn & Herrick, 2012, p. 16) for how to sustain innovations in higher education teaching practice.

Singh and Hardaker (2014), in their systematic review of enablers and barriers to adoption and diffusion of e-learning in higher education, rejected the focus by Rogers (2003) on individual innovators and adopters, as being too narrow. They stated that “Rogers’ model focuses on the individual and there is limited assessment of the role which structural and environmental issues are likely to play in predisposing a person to adopt” (Singh & Hardaker, 2014, p. 117). The aspects of institutional structures that were missing, according to Singh and Hardaker (2014), included “library systems, virtual learning environments, administrative support systems and other technical systems such as enrolment, registration, assessment and students, with respect to the adoption of eLearning” (p. 105).

More recently, Bennett, Lockyer and Agostinho (2018) repeated similar concerns that led them to conclude “there is a great deal we do not yet understand about how to effect lasting organisational change through changing practices within higher education institutions" (p. 1022). To date, there appear to be no studies that have attempted to model what actually happens and what needs to happen in higher education institutions when e-learning innovations originate in and are adopted at the teaching-practice level. This contrasts with large number of studies of student use of technologies in learning. MacCallum, Jeffrey and Kinshuk (2014) noted that research has not focused so much on the teachers’ adoption of digital technologies as it has on student adoption and "there is a research gap in the adoption of digital technologies by teachers" (p. 154).

2.4.2 Gaps in finding relational linkages

In Section 2.2, each of the theories, models and frameworks depicts a different view of how relationships occur between institutional actors and factors in e-learning innovation adoption. In the Rogers (1993) DoI model, actors are represented by population segments (innovators, early adopters, early majority, late majority, and laggards) while factors are listed as attributes of an innovation, communication channels and adoption rates over time within a social system. The distribution represented by the curve in the Rogers (2003) DoI model *(*Figure 4*)* depicts the relative size and sequence of emergence of each population segment over time. The insertion of Moore’s Chasm in this model, between the early adopters and early majority segments, indicates where most innovations fail to reach mainstream adoption.

Elgort (2005) and Salmon (2015) challenged the Rogers (1993) DoI model as being too linear. Elgort (2005) claimed that Moore's Chasm "is not located within a linear adoption process but between the two interrelated but distinct components of e-learning: adoption of the e-learning technology innovation and adoption of the e-learning pedagogy innovation" (p. 184). Salmon (2015) argued that the linearity of the Rogers (1993) DoI model also failed to consider the complexity of relationships in higher education institutions, and in the Salmon (2015) framework presented an alternative relational view to that of Rogers. The Salmon (2015) framework (Figure 9) consists of two sets of axes and four quadrants which represent different levels of engagement between factors in e-learning innovation - such as, learning design, investments and prototyping - and institutional actors who represent professional development, staff support and partner members. The challenges presented by connecting the relationships between such factors and actors in higher education institutions are discussed from several perspectives in Section 2.4.3.

The Bass model (Section 2.2.4) attempted to predict how the diffusion of e-learning innovations occurred by applying curved feedback loops (illustrated in Figure 7) to depict relationships between factors and adopters and potential adopters, as the actors in the adoption process. This modelling appeared to overcome the limitation of linearity in the Rogers (1993) DoI model but, as Kiesling et al. (2012) noted, it was not behaviourally based and therefore was unable to represent complexity in real-world relationships. This complexity provides a recurring theme that is discussed further in Section 2.4.3.

Other models attempted to show the direction of relationships. The LASO model (Section 2.2.6) portrayed top-down and bottom-up influences as arrows emanating from two sets of multiple factors aimed towards the centre of the model (see Figure 8) while in the Quinn and Fullan (2018) four quadrant framework the radiating influence of leadership was described as emanating from the centre in all directions.

While each of these models and frameworks sought to provide different relational views that accounted for the roles of some actors and factors e-learning innovation adoption, they failed to connect all of the relationships necessary in mainstreaming e-learning innovations within an education system, in order to show what would work best. The criticism by Gunn (2011) of the limitations of the Buchan (2010) guidelines for "strategic and sustainable management of e-learning projects" (p. 73) could also be applied to each of the discussed models and frameworks for failing to describe the "decision-making process or who would need to be involved" (Gunn, 2011, p. 515). To explain this failure, Gunn (2011) suggested that in universities there has been a focus on individual adaptability rather than on how systems work. Similarly, Singh and Hardaker (2014) noted that "Rogers' model focuses on the individual and there is limited assessment of the role which structural and environmental issues are likely to play in predisposing a person to adopt" (p. 117). Stepanyan et al. (2013) concluded that "despite the significance of sustainable e-learning in the literature, no generic framework or model for sustainable e-learning was identified” (p. 95). Stepanyan et al. (2013) suggested that “this gap in the literature may be explained by the fact that there are few studies that synthesise the knowledge in the area” (p. 95).

Over the past decade, there have been many opportunities to learn from both large and small successes in e-learning innovation adoption from around the world. Yet, there have been few attempts to study and develop system or process-based models aimed at guiding the ongoing adoption of an e-learning innovation, as proposed by the Rogers et al. (2005) DoI/CAS theoretical extension discussed in Section 2.2.5. Numerous reasons for this gap in the research have been proposed, including that “innovations require very different types of processes to those commonly found in universities” (Gunn, 2011, p. 517). As noted by Giersch and McMartin (2014), there appears to be little evidence within universities of decision-making and project management processes, commonly found in entrepreneurial business environments. This lack of processes is confirmed in the findings from studies reviewed in Section 2.3, although these studies do provide some clues about where the relationships in these processes might be found in a higher education setting. For example, Salmon and Angood (2013) linked project management with evidence (p. 922); Gunn and Herrick (2012) linked testing with developing strategies for "development, dissemination, support" (p. 1); while teaching and learning support was associated by Csete and Evans (2013) and Selwyn et al. (2016b) with project management, which was further associated by Csete and Evans (2013) with evaluation. The development of a university e-learning strategy in the UK provided one other example of where connections had been made in developing a process for informing the adoption of e-learning innovations. In the UK example provided by Sharpe, Benfield and Francis (2006), funding was associated with enabling the writing of strategies and the “planning for e-learning to be integrated into existing university systems" (p. 146). By contrast, other than noting the need for “astute planning”, the Salmon (2005) framework did not go on to recommend specific processes for achieving a plan, beyond noting that “staff development and new systems and processes will be necessary for scaling-up offerings” (Salmon, 2005, p. 213).

Daly (2018) noted that in research about change in education systems "what appears to be generally missing is acknowledgment of the power of the relational linkages among individuals" (p. 154) and proposed that exposing these linkages in educational change was what was needed. Daly (2018) based this proposition on the following argument:

> In 21st-century education it seems that we are striving to move from models of hierarchal command and control to flatter more networked types of organizing. This suggests a series of transitions from independence to interdependence; centralized leadership to distributed leadership and shared responsibility; specialists to cross-trained generalists; dogma to dialogue; change being guided not by rigid policy and procedure but facilitated through simple, shared, and flexible parameters that honor professionalism and the influence of context. Therefore, approaching work of education as a system of relations recognizes that whereas the individual is important, it is the system of interactions in which that individual resides that is also consequential in many ways, with some being evident and explicit and others being hidden in plain sight. (Daly, 2018, p. 158)

Stepanyan et al. (2013) coupled the need to reveal the interactions that occurred within systems with understanding tensions that could arise between the multiple stakeholders and factors in innovation adoption. For example, findings by Stepanyan et al. (2013) suggested that “few studies examine the tensions between the concepts of cost-efficiency, effective pedagogy, and continuous innovative practice” (p. 98). Rossiter (2006) noted similar “tensions between autonomous traditions underpinning teaching and research activities on the one hand, and the business processes associated with scalable solutions and delivering efficiency and accountability to multiple constituents on the other" (p. 259). Stepanyan et al. (2013) recommended that in future studies “improved understanding of these tensions, aligned with better insight into multiple stakeholder perspectives” (p. 98). The gaps in depicting relational linkages can be summed up as failures to (1) relate actors with factors; (2) identify the enabling and inhibiting relationships between them; and (3) account for where different contextual influences apply. These are gaps found in complexity.

2.4.3 Challenges of complexity in higher education

Throughout the research literature, universities are frequently represented as large-scale bureaucracies in which the emergent use of technologies is associated with increasing complexity experienced by teachers when integrating technologies within constantly changing social, academic policy, managerial and teaching practice environments (Conole, White & Oliver, 2007; Laurillard et al., 2009; Nascimbeni, 2013; Stepanyan et al., 2013; Buchan, 2014; Robertson 2015; Bates, 2017; Conole, 2017; Russell, 2017; Marshall, 2018; Ellis & Goodyear, 2019). In the introduction to their book, Davis and Sumara (2006) acknowledged that increasing complexity in education presented "a profound challenge to much of current theory and practice" (p. xii).

In the higher education literature this challenge was examined from the following four perspectives:

- Hierarchy versus panarchy in organisational systems
- Emergent technologies
- Complexity of integrating technology in teaching
- Changing university workplace environments.

These perspectives are outlined in the following sections.

Hierarchy versus panarchy

Max Weber, who developed a theory of bureaucracy at the end of the 19th century, characterised a bureaucracy as an organisational hierarchy made up of ordered structural levels that operated through a rational-legal authority (Carroll, 2014). This characterisation was in direct opposition to the theory of panarchy proposed by Holling, Gunderson and Ludwig (2002) in writing about global changes in the 20th century as based in “linkages between system dynamics and scale - the roots of the term *panarchy*” (p. 21). Buchan (2010) applied the term *panarchy* as a metaphor for complexity in universities to describe "the complex interrelationships of multi-scale institutional projects and the influences of a variety of factors on the potential success of e-learning initiatives" (p. 55). The origins of the term panarchy and the theory that informed it can be traced back to Holling et al. (2002) who referred to institutional systems and the role of interactions in arguing:

> The theory that we develop must of necessity transcend boundaries of scale and discipline. It must be capable of organizing our understanding of economic, ecological, and institutional systems. And it must explain situations where all three types of systems interact. The cross-scale, interdisciplinary, and dynamic nature of the theory has lead [sic] us to coin the term *panarchy* for it. Its essential focus is to rationalize the interplay between change and persistence, between the predictable and unpredictable. Thus, we drew upon the Greek god Pan to capture an image of unpredictable change and upon notions of hierarchies across scales to represent structures that sustain experiments, test results, and allow adaptive evolution. (Holling et al., 2002, p. 5)

Holling et al. (2002) further defined panarchy as an “antithesis to the word hierarchy (literally, sacred rules)” (p. 21). Their theory drew on the multiple characteristics of complex systems and a need for “rational actor models” (Holling et al., 2002, p. 22). Similarly, Singh and Hardaker (2014) drew on both system and individual characteristics in proposing that “future research studies should not model the adoption and diffusion of eLearning based primarily on either an individualist (Micro) or structuralist (Macro) perspective, but by using a more interactive approach to examine the complexity and multiple levels and dimensions of social reality” (p. 105). Davis and Sumara (2006) argued that interactions between the components of complexity in education "are not fixed and clearly defined, but are subject to ongoing co-adaptions" (p. 11) and were themselves dynamic and adaptive. One major component of complexity in e-learning adoption in higher education can be found in the proliferation of emergent technologies available to higher education teaching practice, as discussed in the following section.

Emergent technologies

The range of emergent technologies and applications in higher education varies widely. Conole (2017) listed the following emerging technologies, along with their applications, in higher education:

- Bring your own device
- Learning analytics/measuring learning/adaptive learning
- Augmented and virtual reality
- Makerspaces/classroom repurposing/learning space redesign
- Affective computing
- Robotics
- Blended and informal learning models.

Comparisons of trends presented in successive annual Horizon Reports (see, for example, Johnson et al., 2016) illustrate the ongoing dynamic and adaptive nature of these technologies with new and variations of technologies continuing to become available.

There is a clear distinction between emerging technologies that are being adopted by individuals and the emerging technologies that get adopted across a university system (Stepanyan et al., 2013). From the above list, system-wide adoption of learning analytics, learning spaces and blended learning models in universities are being driven primarily top-down by management. Top-down organisational pressures also continue to drive large-scale implementation of LMS platforms and experiments with the delivery of MOOCs in universities around the world, aimed at expanding university courses into global education markets. By contrast, small-scale experimentation and low rates of bottom-up adoption continue to occur in academic teaching with emerging technologies, such as augmented and virtual reality, robotics and informal learning models.

According to Bates and Sangrà (2011) most faculty initiated (grassroots/bottom-up) e-learning innovations have continued to be driven by just a few enthusiastic innovators and early adopters they described as “lone rangers” within their universities. These individuals were described as mostly interested in driving e-learning innovations on a smaller scale, compared to large-scale management-driven initiatives, but lacked ongoing funding, sufficient time and wider organisational support for spreading and embedding (diffusing) the adoption of these innovations for the benefit of other academic teaching staff (Stepanyan et al., 2013). In courses in which such e-learning innovations were successfully developed, they rarely progressed beyond a proof-of-concept stage with often little, if any, consideration towards how others might adopt these initiatives, either within the originating faculty or beyond into wider university teaching practice (Gunn, 2011; Selwyn, 2011; Smith, 2012; Hanlon, 2015). As a result, many opportunities for diffusing successful e-learning innovations have been lost, with such innovations left to “wither on the vine” (Paris & Morino, 2014, p. 5) in universities that fail to harness these opportunities. This is in direct contrast to the use of digital technologies within the social and working lives of academics and students, where technology use has continued to proliferate and expand at an exponential rate (McIntyre, 2014).

Opportunities for scaling up the use of emerging technologies are being lost in universities throughout the world. Nascimbeni (2013), for example, noted that "on the one side a lot of spontaneous innovation exists in Europe at different levels, on the other the cases of successful large-scale adoption are extremely limited" (Nascimbeni, 2013, p. 3). Similarly, in the UK, Stepanyan et al. (2013) commented on such failures in further adoption of e-learning innovation initiatives by noting that “transient as they are, these projects often exhaust the resources and degrade in their impact—and, therefore, are destined to be unsustainable” (p. 91). The complexity of integrating technologies in teaching was proposed as a further reason in the UK for such lost opportunities (Laurillard et al., 2009).

Complexity in integrating technology with teaching

Russell (2017) reported that teaching in universities was already viewed as a complex task before adding emerging technologies to this, particularly when these technologies significantly altered traditional teaching practice and were mandated as essential in the delivery of teaching. Robertson (2015) proposed that three modes of technology integration were evident in higher education teaching practice which he labelled: technology *enhanced*; technology *integrated;* and technology *based*. These three modes reflect the distinctions made by Snyder (2013): simple, complicated and complex. Robertson (2015) suggested that simple integration occurred when “technology is bolted onto conventional practice with the aim of *enhancing* rather than replacing existing practice" (p. 48). Complicated integration was involved when “digital technologies are *integrated* as an essential part of a conventional face-to-face or distance education program" (Robertson, 2015, p. 48). According to Snyder (2013), once this type of integration was achieved it was easily replicable, although Robertson (2015) noted that it was also more difficult to revert to previous teaching practice if the integrated technology was removed.

Complex integrations involve combining technologies to achieve "the full range of functions required in education" (Bates, 2017, p. 261). Complex integration of technology in teaching practice occurs when “technology is used for the basis of teaching, learning and assessment" (Robertson, 2015, p. 48). This is compounded when various technologies need to be used in combination as part of educational practice. In the 2018 Horizon Report, Adams Becker et al. (2018) noted that "educators are increasingly expected to employ a variety of technology-based tools, such as digital learning resources and courseware, and engage in online discussions and collaborative authoring" (p. 23). This expectation is in sharp contrast to much simpler modes of traditional paper-based face-to-face teaching. Conole (2017) viewed such “competing models of education” (p. 2), in combining traditional teaching and e-learning, as a particularly difficult challenge for educators.

University workplace environments

Laurillard et al. (2009) noted that the integration of technologies in teaching practice presented the greatest challenge for those teachers in universities who remained sceptical about and resistant to the introduction of even simple technologies. Ten years ago, Laurillard et al. (2009) also reported a perceived trend towards reliance on technology in teaching as being viewed by many teachers in universities as a threat to their professional identity. Almost 10 years later, Keehn, Anderson and Boyles (2018) proposed that such scepticism and resistance amongst teachers towards technologies was still apparent in universities. They illustrated this by using the example of the ongoing circulation of this limerick within some higher education institutions:

> The news is now out, clear and clean,
> That by aid of a teaching machine,
> King Oedipus Rex
> Has learned all about sex
> Without ever touching the queen.
> (Keehn et al., 2018, p. 60)

The more serious side to this cheeky limerick reflects a continuing preference by academics for traditional face-to-face lectures and hands-on tutorials as shown in multiple studies (Sheely, 2006; Smigiel, 2013; Deaker, Stein & Spiller, 2016; Keehn et al., 2018). This preference appears to remain a major challenge for universities committed to changing academic practice through the integration of technologies. Universities have attempted to address this perceived resistance largely through professional development workshops (Elgort, 2005; Gunn & Herrick, 2012; Salmon & Angood, 2013; Smigiel, 2013; Dennison, 2014; King & Boyatt, 2015) coupled with the introduction of new policies (Czerniewicz & Brown, 2009; Gunn & Herrick, 2012; Robertson, 2015) that, for example, require all subjects/topics/units in courses to contain online components (Smigiel, 2013). Such policies were found by Laurillard et al. (2009) to generate further scepticism and perceived threats in terms of teacher professional identity:

> Using policy to encourage change is often ineffective because many practitioners see these as disconnected from their own experiences, so that the contrast between the policy "hype" and the challenges that characterise their own use of TEL can increase rather than reduce their scepticism (Price et al., 2005). It has long been recognised that this is no simple case of technophobia (Cuban, 2001) – indeed, this can be seen as a sensible response by teachers to a situation that seems to threaten their sense of professional identity.
> (Laurillard et al., 2009, p. 292)

Conole et al. (2007) stated that policy effects on practice could be unpredictable and erratic and such criticisms of policies were also applied to professional development outcomes, as further noted by Pomerantz and Brooks (2017). Russell (2017) recommended overcoming resistance to change by altering the way decision-making occurred within organisational systems, noting that "attempts to introduce a new technology or a new process without changing any of the complementary subsystems will usually fail" (p. 445). Birch and Burnett (2009) expressed concern that "adopting and integrating educational technology may leave academics with less time to devote to research and other activities that lead to promotion and tenure" (p. 122), which, in turn, could lead to further resistance by academics to technology based innovation adoption in educational delivery. To overcome this resistance, Laurillard et al. (2009) suggested that the constraints inherent in systems needed first to be understood and considered in any attempt to foster serious change. Universities were described as silo-based institutional systems by Salmon and Angood (2013) in which the roles and relationships between university academic and professional staff were continually being impacted by the introduction of new technologies.

Over the past two decades, diffusion of e-learning in universities has occurred in an organisational climate in which faculties are increasingly under pressure from university management to maximise large investments in centralised services that support e-learning (Stepanyan et al., 2013) and to demonstrate the value of these investments and services (Buchan, 2014). This has particularly been the case in UK universities through the impact of "austerity measures" (Stepanyan et al., 2013, p. 91) and, more recently, the yet unknown potential impacts of the Brexit decision.

Both university systems and individual academic and professional roles in universities are being transformed by these pressures. In their UK study, Bolden, Jones, Davis and Gentle (2015) used the visualisation of a "'sinking ship' model of academic leadership" (p. 11) to represent the reality for UK universities faced by funding cuts and other uncertainties. Their model attempted to capture a "sense of conflict and ambiguity experienced by people whose sense of professional identity and purpose does not map neatly onto organisational boundaries" (Bolden et al., 2015, pp. 8-9). Evidence provided by Bolden et al. (2015) suggested a blurring of leadership roles between management, professional staff and academics was emerging in what they described as a "'third space' in which professional staff engaged in leadership activity based on their expertise, particularly in learning and teaching support areas" (Bolden, 2015, p. 10). Bates (2017) held the view that educators should be the ones who controlled and managed "the use of computing for teaching and learning" (p. 308). Creation of hybrid roles, such as learning technologists (Sharpe, Benfield & Francis, 2006; Buchan 2012) and educational technologists (Ellis & Goodyear, 2019), was viewed as representing part of this transition from "specialists to cross-trained generalists" (Daly, 2017, p. 158). Such new ideas about leadership, both shared (Bolden, et al., 2015) and distributed (Daly, 2017), in shaping new workplace environments appear to be attempts to meet the challenges of complex technology integration in teaching practice within a complex education system (Jacobson, 2015; Levin & Jacobson, 2016). This may be summed up as presenting a complex problem in a complex system.

2.4.4 Wicked versus tame problems

Bates and Sangrà (2011) concluded that to achieve university transformation in a digital age required an understanding of "the black art of technology management in higher education" (p. 238). Such a challenge is commonly referred to as generating a *wicked problem*, a term proposed by Rittel and Webber (1973) that continues to be discussed in the research literature (Bore & Wright, 2009; Buchan, 2012; Marshall, 2018). The term *wicked* does not imply evil but rather a problem that is difficult to resolve. The Australian Public Service Commission (2007) report traced the origin of the term as follows:

> The terminology was originally proposed by H. W. J. Rittel and M. M. Webber, both urban planners at the University of California, Berkeley, USA in 1973. In a landmark article, the authors observed that there is a whole realm of social planning problems that cannot be successfully treated with traditional linear, analytical approaches. They called these issues wicked problems and contrasted them with "tame" problems. Tame problems are not necessarily simple—they can be very technically complex—but the problem can be tightly defined and a solution fairly readily identified or worked through. The original focus of the wicked problem literature was on systems design at a more "micro" level, but the concept has gradually been applied to broader social and economic policy problems.
> (Australian Public Service Commission, 2007, p. 3)

The importance of tackling wicked problems has been recognised in addressing environmental issues and government policies since the term was first conceptualised, but it has only more recently been applied in education settings (Marshall, 2018). In government policy setting, wicked problems were characterised in an Australian Public Service Commission report (Australian Public Service Commission, 2007, pp. 3-5) as follows:

- Difficult to define clearly
- Have many interdependencies that are often multi-causal
- Often not stable (policy makers have to focus on a moving target)
- Usually have no clear solution
- Socially complex
- Hardly ever sit conveniently within the responsibility of any one organisation
- Involve changing behaviour
- May be characterised by chronic policy failure.

Such characterisation acknowledged that attempts to address wicked problems in government often led to “unforeseen consequences” (Australian Public Service Commission, 2007, p. 4). In tackling wicked problems, the Australian Public Service Commission (2007) report recommended seeking out "the Holy Grail of effective collaboration" (p. 27), to describe this elusive organisational communication process, and concluded by proposing that solving wicked problems was as “an evolving art” (pp. 35-36) that required the following (pp. 35-36):

- Holistic, not partial or linear thinking
- Innovative and flexible approaches
- Ability to work across agency boundaries
- Increasing understanding and stimulating a debate on the application of the accountability framework
- Effectively engaging stakeholders and citizens in understanding the problem and in identifying possible solutions
- Additional core skills
- Better understanding of behavioural change by policy makers
- Comprehensive focus and/or strategy
- Tolerating uncertainty and accepting the need for a long-term focus.

To this list can be added the recommendation by Van Bueren, Klihn and Koppenjan (2003) for the need to resolve cognitive, strategic and institutional uncertainty. Van Bueren et al. (2003) concluded from an analysis of a wicked problem examined in a Dutch environmental case study that "interdependencies are often very complex and not easily visible" (p. 211). They concluded that exposing these interdependencies required "a clear understanding of actor positions and institutional constraints" (Van Bueren et al., 2003, p. 211). Adams Becker et al. (2018) concluded that “wicked challenges, the most difficult, are categorized as complex to even define, and thus require additional data and insights before solutions will be possible” (p. 22), to which they added “rethinking the roles of educators” (p. 23). Marshall (2018) noted that in university settings “even agreeing that there is a challenge (other than reputational)” (p. 21) may be contested when tackling wicked problems. Marshall (2018) contrasted features of wicked problems with tame problems, noting there were no correct formulas for addressing wicked problems in higher education teaching and learning, exacerbated by difficulties in even drawing out the key elements of the problem. In this regard, analysis of factors and actors conducted in this study represents an initial revealing and untangling of the problem using secondary data and insights from research literature. Marshall (2018) concluded by recommending the use of scenarios as tools for untangling complexity in wicked problems. Thus, social complexity of e-learning innovation adoption in universities, when considered as a wicked problem, needs firstly to be revealed, taken apart and then put back together "as a whole which is more than the sum of its parts" (Tubaro & Casilli, 2010, p. 61).

Before considering methods of addressing wicked problems, it is important to examine traditional methods, used to address tame problems. Figure 10 depicts the traditional linear waterfall view of problem solving (Conklin, 2006).

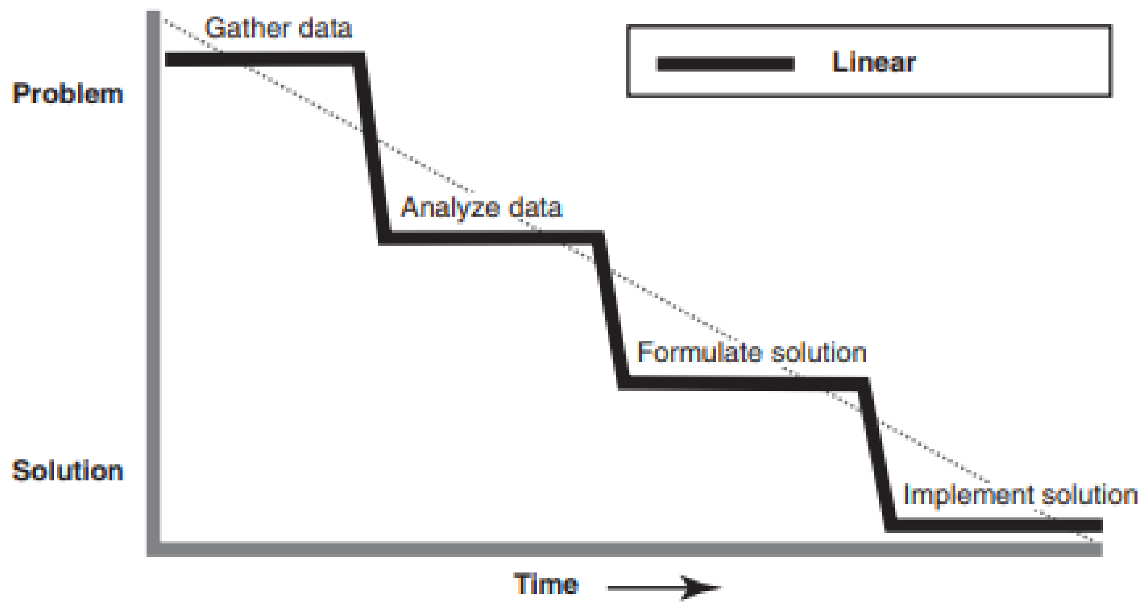


Figure 1.1 Traditional wisdom for solving complex problems: the ‘waterfall’

Figure 10. Waterfall model (Conklin, 2006, p. 9). Permission to reproduce received from John Wiley and Sons, License Number 4705290907131, 10 November 2019.

Figure 10 represents the conception by Marshall (2018) of a tame problem as providing “a ‘correct’ formulation” (p. 21) in a classical model that is used widely for organisational problem solving and planning. Rittel and Webber (1973) proposed the following list of features to describe commonly held views of this idealised modern-classical model of planning:

> Many now have an image of how an idealized planning system would function. It is being seen as an on-going, cybernetic process of governance, incorporating systematic procedures for continuously searching out goals; identifying problems; forecasting uncontrollable contextual changes; inventing alternative strategies, tactics, and time sequenced actions; stimulating alternative and plausible action sets and their consequences; evaluating alternatively forecasted outcomes; statistically monitoring those conditions of the publics and of systems that are judged to be germane; feeding back information to the simulation and decision channels so that errors can be corrected - all in a simultaneously functioning governing process.
> (Rittel & Webber, 1973, p. 159)

Rittel and Webber (1973) associated the features in traditional planning procedures with “the classical systems-approach of the military and the space programs” (p. 162) that comprised the following distinct steps: “‘understand the problems or the mission,’ ‘gather information,’ ‘analyze information,’ ‘synthesize information and wait for the creative leap,’ ‘work out solution,’ or the like” (Rittel & Webber, 1973, p. 162). Rittel and Webber (1973) viewed these steps as both idealised and unattainable and questioned if they were even desirable. They suggested the processes described by these steps were more suited to *tam*e rather than *wicked* problems. Tame versus wicked problems were distinguished as follows:

> For tame-problems one can determine on the spot how good a solution-attempt has been. More accurately, the test of a solution is entirely under the control of the few people who are involved and interested in the problem. With wicked problems, on the other hand, any solution, after being implemented, will generate waves of consequences over an extended - virtually an unbounded - period of time. Moreover, the next day's consequences of the solution may yield utterly undesirable repercussions which outweigh the intended advantages or the advantages accomplished hitherto. In such cases, one would have been better off if the plan had never been carried out. (Rittel & Webber, 1973, p. 163).

There are clearly many challenges presented by attempting to solve wicked problems as if they are tame problems. Marshall (2018) noted that, unlike tame problems, wicked problems “commonly exhibit a range of features that challenge leaders, planners and strategists when seeking rational, orderly and planned solutions to their organisational problems" (Marshall, 2018, p. 20). Figure 11 depicts multiple dimensions of wicked problems that need to be considered in revealing a whole made up of parts which contrasts sharply with the traditional linear waterfall view of problem solving of Figure 10.

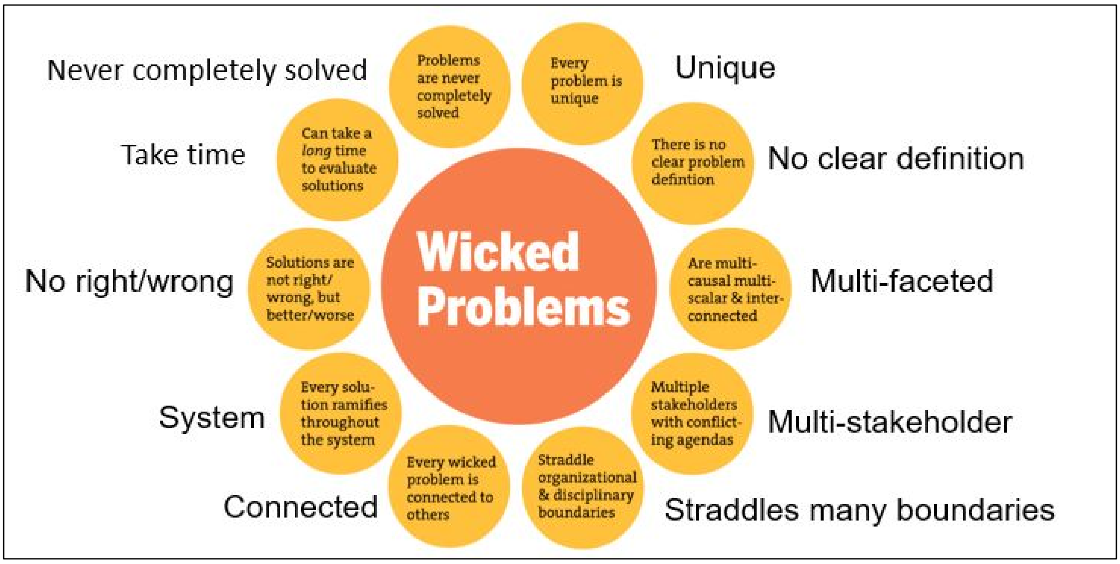


Figure 11. Multiple dimensions of wicked problems, adapted from Rittel and Webber (1973).

Rittel and Webber (1973) originally developed the propositions represented in Figure 11 in their *Dilemmas in a general theory of planning* article, which Bore and Wright (2009) acknowledged as a seminal theory in behavioural change. According to Rittel and Webber (1973), a wicked problem demonstrates the following characteristics (as outlined in Figure 11):

- **Unique**: "Despite seeming similarities among wicked problems, one can never be certain that the particulars of a problem do not override its commonalities" (p. 165).
- **No clear definition**: "The process of solving the problem is identical with the process of understanding its nature" (p. 162).
- **Multi-faceted**: "There are no ends to the causal chains that link interacting open systems" (p. 162).
- **Multi-stakeholder**: "The higher the level of a problem's formulation, the broader and more general it becomes and the more difficult it becomes to do something about it" (p. 165).
- **Straddles many boundaries**: "System boundaries get stretched, and as we become more sophisticated about the complex workings of open societal systems" (p. 159).
- **Connected**: "Every wicked problem can be considered to be a symptom of another problem" (p. 165).
- **System**: "The aim is not to find the truth, but to improve some characteristics of the world where people live" (p. 165).
- **No right/wrong**: "Problems can be described as discrepancies between the state of affairs as it is and the state as it ought to be" (p. 165).
- **Take time**: "There is no immediate and no ultimate test of a solution to a wicked problem" (p. 163).
- **Never completely solved**: "There are no criteria which enable one to prove that all solutions to a wicked problem have been identified and considered" (p. 163).

Rittel and Webber (1973) argued that "the process of solving the problem is identical with the process of understanding its nature" (p. 162) which they elaborated as follows:

> If we can formulate the problem by tracing it to some sorts of sources - such that we can say, "Aha! That's the locus of the difficulty," i.e. those are the root causes of the differences between the "is" and the "ought to be" conditions - then we have thereby also formulated a solution. To find the problem is thus the same thing as finding the solution; the problem can't be defined until the solution has been found. The formulation of a wicked problem is the problem! The process of formulating the problem and of conceiving a solution (or re-solution) are identical, since every specification of the problem is a specification of the direction in which a treatment is considered. (Rittel & Webber, 1973, p. 161)

Thus, formulating the causes underlying the differences between real and ideal conditions in a wicked problem can be viewed as having solved the problem, suggesting that research methodology/method and solution are the same when addressing wicked problems.

2.4.5 Challenges presented by wicked problems

Rittel and Webber (1973) highlighted numerous challenges for planners and researchers presented by wicked problems that included “defining problems (of knowing what distinguishes an observed condition from a desired condition) and of locating problems (finding where in the complex causal networks the trouble really lies)" (p. 159). These become even more challenging when investigating evolving trends, such as e-learning, that impact on organisations by stretching system boundaries, creating a *Third Space* (Bolden, 2015) in which new roles and associated job titles appear. Selwyn et al. (2016a) suggested that innovators in universities embrace a “fail fast and fail often” (p. 28) approach to seeking funding for e-learning innovation, suggesting support for the challenging proposition from Rittel & Webber (1973) that "the ultimate goal of planning should be anarchy, because it should aim at the elimination of government over others" (p. 158), a proposition unlikely to find favour with university hierarchies. Perhaps the most challenging proposition by Rittel and Webber (1973) in researching wicked problems was the need for examining the ramifications of the ripple effects of solutions in systems resulting from “waves of consequences” (p. 163) that are alternatively described as “waves of repercussions” (p. 156).

The methodological dilemma posed by wicked problems is how to capture these ripple effects, as they create ramifications that are unique within each system. In defining the essentially unique nature of a wicked problem, Rittel and Webber (1973) noted that “despite long lists of similarities between a current problem and a previous one, there always might be an additional distinguishing property that is of overriding importance" (p. 164). A further challenge to resolving a problem occurs as "the higher the level of a problem's formulation, the broader and more general it becomes: and the more difficult it becomes to do something about it" (Rittel & Webber, 1973, p. 165), with Rittel & Webber (1973) associating higher levels with increasing roles (and therefore complexity) of multiple stakeholders and of hierarchies.

Forty six years after these propositions were first published, Head (2019) criticised Rittel and Webber (1973) for not developing "a clear and coherent account of how to improve policy analysis and social planning practices" (Head, 2019, p. 181) and for not "offering detailed advice on improved processes for managing complex and wicked issues into the future" (p. 182). Advice from Rittel and Webber (1973) was found by Head (2019) to be limited to suggesting that "inclusive discussion, involving a wide range of stakeholders, would be needed to deal with the most challenging and divisive issues" (p. 182). There is, however, acknowledgement by Head (2019) of the recommendation by Rittel and Webber (1973) for engaging participants in visualising a problem through "an argumentative process in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgment, subjected to critical argument" (Rittel & Webber, 1973, p. 162). This recommendation for visualisation appears to offer a way forward for investigating wicked problems and is reflected in the Conklin (2006) proposal of a dialogue-mapping group-facilitation technique with which "you don't so much 'solve' a wicked problem as you help stakeholders negotiate shared understanding and shared meaning about the problem and its possible solutions" (p. 5). Conklin (2006) viewed this proposed technique, with its focus on coherent action rather than a final solution, as addressing problems characterised by (p. 39):

- Powerful fragmenting forces of wicked problems, social complexity, and technical complexity.
- Confusion, chaos, and blame created by failing to distinguish these forces.
- Lack of tools and techniques for "defragmenting" project dynamics.

These fragmenting forces are depicted in Figure 12 as comprising technical complexity, social complexity and wicked problems. In this study, technical complexity is associated with incorporating the technical challenges of e-learning innovations in traditional higher education teaching practices and social complexity is represented by the higher education systems that operate within universities. Conklin (2006) pictured the tensions caused by such complexities as "centrifugal fragmenting forces pulling a project apart", as shown in Figure 12.

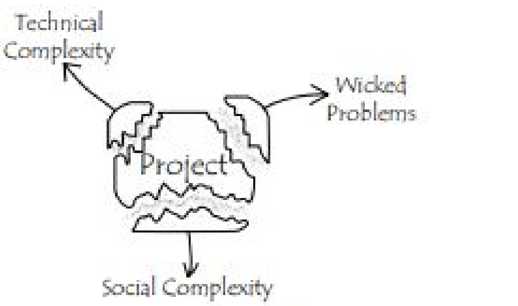


Figure 1.6 'Centrifugal' fragmenting forces pulling a project apart

Figure 12. Fragmenting forces (Conklin, 2006, p. 35). Permission received to reproduce from John Wiley and Sons,

The challenge for researching these fragmenting forces and tensions is reflected in the wicked problem, addressed by this study, which is how to build institutional capacity in universities for mainstreaming e-learning innovations that originate in higher education teaching practice.

2.5 Challenges for further research

> Beginning to ask not why but how it is that these experiences occur. (Denzin, 2001, p. 71)

This literature review started with an examination of the evolution of educational technology innovations, by focussing on variations in terminology and timelines in tracing the history of e-learning innovation adoption in universities. A comparison of theories, models and frameworks followed that illustrated both differing and complementary perspectives. Studies conducted in higher education settings were then investigated to reveal actors and factors involved in e-learning innovation adoption. The literature review also examined limitations, gaps and challenges in findings from previous studies used as secondary data sources for informing this study.

This final section presents further conclusions from the literature review (Section 2.5.1) that lead to the *how* questions that arise from this review (Section 2.5.2), which in turn lead to the formulation (Section 2.5.3) of the primary and secondary research questions this study investigates.

2.5.1 Conclusions from literature review

Nichols (2008) concluded his study of the many challenges of e-learning diffusion by recommending that “further research into the nature of e-learning sustainability and its longevity within a continually changing technological and pedagogical context would be of assistance to those involved with managing e-learning change” (p. 608). Gunn (2014) suggested that what university managers needed for achieving this change were “new organizational models and ways of working” (p. 404) through "promoting consultation and collaborative partnerships between innovators and their institutions; creating new channels and directional flows for communication; providing strong but not restrictive support structures around innovations" (Gunn, 2014, p. 401). The Rogers (2003) DoI model, which features channels of communication as playing a key role, continues to dominate the literature in guiding studies of diffusion of innovations and transformational change in organisations. As this review showed, DoI along with other derivative theories, models and frameworks has failed to depict how interactions occur between organisational actors and factors involved in creating transformational teaching and learning change when harnessing digital technologies within constantly changing contexts.

Models were presented in the literature as depicting outcomes and strategies but not the relational processes involved in innovation adoption. Hameed, Counsell and Swift (2012) noted the “lack of research that offers a complete model to fully explain the IT innovation adoption process” (p. 359).

The quest for such a singular model continues in the research, as evidenced by the range of models presented in Section 2.2 of this literature review. Salmon (2005) conceded there were limitations to these models, suggesting that “more models are needed to demonstrate the transferability and scalability of e-learning” (p. 208). Both Davis and Sumara (2006) and Singh and Hardaker (2014) were reported in Section 2.4.3 as arguing for a focus in models on interactivity between levels, dimensions and components. Agent-Based Modelling (ABM), as a method discussed in Section 4.7, offers such an approach which has potential for further application in studies of innovation diffusion (Kiesling et al., 2012; Gräbner, 2016). ABM also offers an approach that satisfies the recommendation by Macfadyen and Dawson (2012) for future research to "visualize in compelling ways" (p. 161). Macfadyen and Dawson (2012) coupled this recommendation with “the necessity for ensuring that any data analysis is overlaid with informed and contextualized interpretations” (p. 161). Marshall (2010) proposed that such interpretations utilised lived experiences to inform changing policies and practices. Dede (2009), similarly saw the way forward as advancing out of sharing the collective wisdom gained from past experience in addressing wicked problems, a view reaffirmed by Marshall (2018). Johnson et al. (2014) suggested that universities also needed to look beyond their own internal organisational policies and practices for models of processes based on iterative and incremental approaches used outside higher education. They recommended looking for such processes in technology-based industries where sustainable innovation development and adoption had already been successful through such “agile” practices. Rosenberg (2005) recommended that what was needed in education was an evidence-based approach because “advocates of elearning have squandered opportunities to demonstrate real value” (p. 15). This suggests that decisions to adopt an e-learning innovation should be based on evaluation through rigorous research about what works in practice. As research into wicked problems demonstrates, what works in practice in one context does not necessarily work in another, resulting in research questions that are highly resistant to resolution (Australian Public Service Commission, 2007).

There appeared to be some agreement that in future research the activity of adopting e-learning innovations needed to be viewed as a complex (wicked) problem in education, which Jacobson, Levin and Kapur (2018) also described as a complex system (discussed in more detail in Section 3.2). Similarly, Elgort (2005), viewed e-learning adoption as more than simply a technical rational linear activity. Robertson (2015) agreed with this view, particularly when the complex integration of technology in teaching practice was involved. Recommendations for moving beyond a linear and simple view included conducting investigations from the perspectives of both the attributes of individuals (Jeyaraj et al., 2006; Daly, 2018) and institutional/organisational roles and structures (Singh & Hardaker, 2014), which were classified in the research literature variously as *macro/meso/micro* and top-down/bottom-up (Robertson, 2008; Hardaker & Singh, 2011; Kiesling et al., 2012). Gunn and Herrick (2012) noted in their study that “IT departments were not interviewed for their perspective” (p. 7) and concluded by recommending their inclusion in future studies. Gunn and Herrick (2012) also recommended that “universities consider and clarify the roles of key individuals, practitioners and departments in the support, evaluation and adoption of new elearning [sic] products” (p. 2). They suggested the need to investigate questions “around the institutional structures and processes where the innovators work” (Gunn & Herrick, 2012, p. 16). The need for examining the interplay/interrelationships/intersections/interactions between multiple stakeholders and organisational structures provided an overarching theme in recommendations for further research (Salmon, 2005; Casanovas, 2010; Stepanyan et al., 2010; White, 2010; Johnson et al., 2011; Hameed et al., 2012; Smith, 2012; Singh & Hardaker, 2014; Bui, 2015; Daly, 2017). Third space theory and methodology (Bhabha, 2012), as suggested by Jordan and Elsden-Clifton (2014), offered a further lens and application in extending this research, once an understanding of the interactions between system stakeholder roles had been established.

Gaining an understanding through research of the power of interactions within systems using innovative methodologies was viewed as necessary by Daly (2017) and further research into institutional collaboration and cooperation was recommended by both White (2010) and Mannonen, Aaltonen and Nieminen (2012). White (2010) recommended further investigation of “the types and levels of interactions” (p. 201) that occurred in collaboration versus cooperation. The role of policies was also viewed as requiring further investigation as it was unclear what the ambiguous role of university policy played in influencing e-learning innovation adoption (Czerniewicz & Brown, 2009; Laurillard et al., 2009). It was also not clear if policy was the outcome or a strategic process in the adoption of e-learning innovations. In viewing policy as an outcome, Conole (2017) asked: “how do we ensure the rich research findings from the field of digital learning research have an impact on policy and practice?” (p. 18). In a report produced by the Australian Council of Learned Academies (Williamson, Raghnaill, Douglas & Sanchez, 2015) concluded that “policies which take into account the dynamic and multidimensional nature of technology will encourage adoption rather than protecting and favouring the status quo” (p. 19). The research challenge in achieving this goal presents itself in the duality of policy in generating both outcomes (findings) and strategies (methods), with policy findings reflecting the outcomes of practice and policy methods creating new practices. Ultimately, as Malone, Rincón-Gallardo and Kew (2018) concluded, it was institutional "capacity building" (p. 166) rather than policies that provided the mechanism needed to "drive ownership and long-term change" (Malone et al., 2018, p. 166). Other recurring themes in the literature suggested establishing relevant research questions (Smith, 2012; Conole, 2017) and seeking out and adapting new methodologies, theoretical frameworks and research designs (Singh & Hardaker, 2014; Daly, 2017; Lather, 2018). New research questions and methods appear to be needed to address the four institutional challenges presented by the complexities of adoption of e-learning innovations in higher education, discussed in Section 2.4.3, and the ten dimensions (shown in Figure 11) that define a wicked problem.

2.5.2 Research directions suggested by literature review

The following *how* questions arose when the four challenges presented by institutional complexity (Section 2.4.3) and ten dimensions of wicked problems (Figure 11) were combined with themes from the research literature, suggesting further research was needed about:

- How is the problem in each university unique?
- How can the problem be defined?
- How is the problem multi-faceted?
- How are multi-stakeholders motivated?
- How are organisational boundaries in universities straddled?
- How is the problem connected to other problems in universities?
- How do solutions have system ramifications?
- How do better/worse solutions compare with right/wrong solutions?
- How does time needed for evaluation impact on solving the problem?
- How is the problem never completely solved?

These questions informed the development of a new methodology for conducting this study and the formulation of the primary and secondary research questions.

2.5.3 Research questions that guide this study

> Attempting to formulate the research question into a single statement (Denzin, 2001, p. 71)

Hargadon (2017) defined the process of formulating research questions as "how we perceive changes that are taking place and the context within which they are doing so" (p. 2). The change investigated in this study focussed on mainstreaming the adoption of e-learning innovations and the context for this investigation was institutional capacity building in universities for achieving this change. Thus, the primary question for this study, formulated as a single statement, is: **How can universities build institutional capacity for mainstreaming e-learning innovation adoption?**

The previous *how* questions (Section 2.5.2), together with the six phases in the Denzin (2001) research design (listed in Section 3.3.2), were incorporated in the following secondary questions:

1. What are the critical success factors in the process of innovation adoption?
2. Who are the key actors as institutional stakeholders in innovation adoption?
3. What roles are played by the key actors in innovation adoption?
4. How do the roles of key actors interact in an institutional setting?
5. What are the impacts of real and ideal interactions between institutional roles in innovation adoption?
6. What implications arise from the impact of institutional role interactions in innovation adoption?

These six questions fall into two parts. Questions one to three address adoption of e-learning innovations as a process made up of factors and actors which are identified from secondary data analysis of extent case studies, while questions four to six investigate universities as complex organisational systems in which innovation adoption occurs, informed by primary data drawn from the lived experiences of research participants. In the last three questions, e-learning innovation adoption in higher education teaching practice is viewed through the lens of complexity as encompassing ontology, epistemology, paradigm and theory.

CHAPTER 3. METHODOLOGY

Deconstructing prior conceptions of the phenomenon. (Denzin, 2001)

As discussed in the literature review chapter, case studies have remained the dominant method of inquiry for investigating the problem of mainstreaming e-learning innovations in the past two decades. The e-learning innovations that are the focus for this study have originated in higher education teaching practice and become mainstream through a process of top-down and bottom-up support. This chapter starts with an examination of the benefits and limitations of using a qualitative methodology, such as case study (Yin, 2014), in researching the problem of mainstreaming bottom-up innovation adoption. The chapter proceeds to address conclusions from previous studies which acknowledge the limitations of using a case study methodology alone for investigating the non-linear and dynamic relationships involved in mainstreaming innovation adoption in universities. The conclusions from previous studies suggest a need to investigate the complexities of innovation adoption cases in universities from both an interpretive and systems perspective.

Responding to this challenge, the features and characteristics of case study, complexity and interpretive interactionism are explored, and a new bricolage methodology is proposed. (The term bricolage is defined in Section 3.4.) The new methodology described in this chapter draws on features and benefits of case study and complex systems modelling (using ABM, see Section 4.7) and applies them in an interpretive interactionism orientation that is descriptive- and behaviourally-based. The chapter concludes with the presentation of a conceptual model of a new framework in which six phases mirror and respond to the six research questions that guide this study (Section 2.5.3). The study therefore contributes a new research methodology as well as original findings from cases to address the primary research question about how universities can build institutional capacity for mainstreaming the adoption of e-learning innovations?

The main sections in this chapter introduce and discuss:

- Harnessing benefits and addressing limitations of case studies.
- Forming a case-based complexity-informed methodology.
- Applying an interpretive, interactionism research framework.
- Developing a new interpretive, case-based modelling bricolage.

3.1 Benefits and limitations of case studies

The first two questions in this study (Section 2.5.3) supported using a case study methodology as the starting point for conducting research by asking: “What are the critical success factors in the process of innovation adoption?” and “Who are the key actors as institutional stakeholders in innovation adoption?” The purpose of these questions was to isolate key factors and actors involved in mainstreaming bottom-up innovation adoption.

Identification of factors and the roles of actors are key features of case studies. The ontology of case studies assumes that something is real and "constructed in the minds of the actors involved in the situation" (Creswell, 2007, p. 248). In defining case study as a methodology, Yin (2014) extended this assumption by describing the constructed situation in case studies as representing a real-life contemporary phenomenon. Mainstreaming of e-learning innovation adoption in higher education teaching practice appears to fit this description.

In this study, the choice to use case studies was not a methodological choice for conducting the whole study but was a choice about the starting point for investigating and gathering data about a contemporary phenomenon. Stake (2000) made the distinction between methodology and content by arguing that "case study is not a methodological choice but a choice of what is to be studied" (p. 435). This study started by seeking to identify the critical success factors that played a role in the process of innovation adoption and the key university actors, as the stakeholders in this process. The identification of these factors and actors came from a comparative analysis of the selected studies provided in the secondary data sources for this study, as listed in Table 2.

Cases were sought through interviews to gather primary data that validated and extended the secondary data. The primary data gathered from these individual cases was applied through computer modelling conducted *in situ* during the case-based interviews. The study adopted the epistemological view of the relationship between the storyteller in a case study and the researcher as being interrelated rather than separate and independent, with this interrelationship providing both benefits and limitations for theory development (Creswell, 2007). The benefit of drawing on an interrelationship between a researcher and study participant can be found in having a conversation that captures rich stories together with observations and artefacts that can describe a phenomenon in detail. A limitation is that comparability and generalisability of findings, essential for theory development, are limited from both single and even multiple cases beyond an analysis of themes. This is because case studies, on their own, have been found to be limited in their ability to uncover the underlying structure of a phenomenon and thus the potential for universal generalisations (Tubaro & Casilli, 2010). This limitation of relying on case studies alone is addressed in this study by revealing the underlying structure of the relationships between actors and factors in mainstreaming innovation adoption through the development of Interpretive Case-based Modelling.

From the studies selected as secondary data sources for this investigation, it was possible to uncover common themes about critical success factors and segment actors, representing institutional stakeholders, involved in the process of mainstreaming the adoption of e-learning innovations in universities. However, as Tubaro and Casilli (2010) observed, it was not possible from such an analysis to make informed generalisations about direct connections between factors and actors identified in case studies: thus this could only be assumed.

The third question in this study sought to identify these connections by asking: “What roles are played by the key actors in innovation adoption?” Organisational culture and e-learning product features identified from the analysis of extant case studies were excluded in investigating this question as this was outside the scope of this study (see Section 1.2). The focus of this study was solely on institutional roles in universities. Roles were identified through grouping factors with actors and then validated and explored during interviews. These validation and exploration stages were guided by the final three questions in this study, with a view to furthering theory development and informing changes to policies and practices for building institutional capacity for mainstreaming innovation adoption in higher education teaching practice.

As noted in Section 2.2.1, DoI (Rogers, 2003) has remained the predominant theory applied to case studies of innovation adoption. Citations of Rogers’ DoI theory were found throughout the case studies of innovation adoption reviewed in the previous chapter. By 2004, there had been over 5000 studies conducted on the diffusion of innovations which spanned a wide variety of academic disciplines over six decades (Rogers, 2004). These studies predominantly used a qualitative case study methodology, with comparatively fewer studies using quantitative surveys or a mix of both (Massy & Zemsky, 1995; McKenzie et al., 2005; Johnson et al., 2011; Hardaker & Singh, 2011; Gunn & Herrick, 2012). The widely cited Rogers (2003) DoI model was adapted by Pacansky-Brock (2015), shown in Figure 5, to illustrate where the problem, depicted as a chasm, occurred in mainstreaming the adoption of educational technologies in universities.

A comparative analysis of themes from selected extant case studies was found to be useful in this study for identifying common factors and key actors in innovation adoption within a university system. This analysis led to grouping factors with actors into ten key roles which were allocated across four key stakeholder (actor) groups, as shown in Figure 17 in the Methods chapter (Section 4.7.2). Grouping of factors and actors provided a baseline model in the study for seeking primary data from study participants to address the final three questions in this study: “How do the roles of key actors interact in an institutional setting?”, “What are the impacts of real and ideal interactions between institutional roles in innovation adoption?” and “What implications arise from the impact of institutional role interactions in innovation adoption?” Guided by these final three questions, the investigation was able to move beyond the limitations of previous case studies and the gaps in previous studies reported in the literature review.

Conclusions from a review of the extant studies (listed in Table 2) acknowledged a common failure to connect and contextualise the key interactions between actors that occurred in innovation adoption across education systems, such as universities. This failure can be attributed to the methodological limitations of case studies and surveys. Both case studies and surveys, applied either separately or together, appear to be limited in answering:

- Where interactions occur between actors across systems.
- How interactions influence and directly impact each other.
- Extent of the level of influence of each interaction.
- What, where and how external contexts influence interactions.

Therefore it would have been of limited value in investigating questions about the complexity of the interactions in the relationship between the roles of university actors in innovation adoption to continue with a case study methodology alone, or to apply any alternative qualitative or quantitative methodology beyond addressing the first three questions in this study.

Stake (2000) noted that the value of case studies was in refining theory, suggesting future research directions and establishing the limits of generalisability. Rogers (2004), although making extensive use of case studies in developing his own DoI theory, continued to suggest further areas of investigation and new methodologies for theory development. Rogers recognised the need to constantly refine his DoI theory throughout the years following its first publication. In later years he provided the following additions to this theory in defining mainstreaming as related to achieving critical mass and how the chasm in the DoI adoption process could be overcome (Rogers, 2004, p. 19):

- Critical mass, defined as the point at which enough individuals have adopted an innovation that further diffusion becomes self-sustaining [or mainstream].
- Focus on networks as a means of gaining further understanding of how a new idea spreads through interpersonal channels [to straddle the chasm].

In his last paper, published a year after his death, Rogers proposed that a hybrid of DoI and CAS models was needed to straddle the diffusion of innovations/technology adoption chasm (Rogers, Medina, Rivera, & Wiley, 2005). Rogers et al. (2005) envisaged a role for new computational tools and theoretical perspectives in developing such a hybrid DoI/CAS model. Computational ABM offers this opportunity today. In developing an ABM computer simulation tool for modelling case studies of educational change, Levin and Datnow (2012) demonstrated how data from case studies could be applied using ABM to inform the development of dynamic non-linear models of complex interactions in change processes.

The following section examines the debate around studies of complexity as epistemology, paradigm and theory which have led to the emergence of ABM and the associated development of the Multi-Mediator Modelling (MMM) tool (Levin, 2015), described in Section 4.8, which was used in this study to harness both the benefits and address the limitations of case studies.

3.2 Case-based complexity-informed methodology

There appear to be many possible paths in forming a methodology for understanding complex problems in an education system which are presented in numerous wide-ranging debates within both educational and organisational research literature, as noted by Kincheloe, (2004), Davis and Sumara (2006) and Alhadeff-Jones (2013). The many possibilities generated by these debates led Hetherington (2013) to conclude that in educational research "complexity is not one unified approach" (p. 72) and that the term "complexity-informed methodology" (Hetherington, 2013, p. 72) should be used, even while acknowledging that studies of complexity would continue to provide a challenge for educational researchers. These discussions provide an indicator of the emerging nature of various notions of complexity in research studies of education systems (Levin & Jacobson, 2015).

There appears to be some agreement that a complexity-informed methodology defies attempts to be neatly defined within traditional social research schema, which typically depict cascading levels of ontology/epistemology, theoretical perspective, methodology and methods, as described in Crotty (1998). In proposing alternative schema that defy this cascading traditional view, Schapper, De Cieri and Wolfram Cox (2005); Davis and Sumara (2006); Alhadeff-Jones (2013); and Denzin and Lincoln (2018) all appear to acknowledge that proposing any new methodology for investigating notions of complexity can also be a "messy" process. As Davis and Sumara (2006) noted, a study focused on complexity "refuses tidy descriptions and unambiguous definitions" (p. ix). Debates continue about whether complexity should be referred to as "a field, a domain, a system of interpretation, or even a research attitude" (Davis & Sumara, 2006, p. ix). One solution proposed by Davis and Sumara (2006) was to use *complexity thinking* as an alternative to talking about *complexity science* or its predecessor, *"complexity theory"* (p. 17). The challenge this lack of clarity continues to pose for researchers applies particularly where a study, such as this one, involves the investigation of a complex problem *within* a complex system.

To avoid any further confusion, the term *complexity* is used throughout the rest of this thesis in its broadest sense as the central notion investigated by this study, and the term *case-based complexity-informed methodology* is proposed to encompass the key assumptions adopted in conducting this study. The following discussion attempts to locate a "link between ontology, epistemology and theory" (Hetherington, 2013, p. 72) with a view to drawing out and weaving together key assumptions about complexity. From these assumptions, a new methodology is developed to provide a unified research design for conducting a case-based complexity informed study.

3.2.1 Complexity as both ontology and epistemology

In this study, the notion of organisational complexity is applied to an examination of the institutional capacity of universities for mainstreaming the adoption of e-learning innovations. From an ontological dimension, the variables that make up organisational complexity in this study are viewed as both measurable and representative of organisational experience (Schapper et al., 2005). According to Schapper et al. (2005), when viewed through the lens of an objective ontological reality, organisational experience can be found in large scale bureaucracies, organisational technologies, task complexity and environments. In the literature review it was found that universities were frequently represented as large scale bureaucracies in which the emergent use of technologies was associated with an increasing complexity of tasks experienced by teachers who worked within constantly changing social, academic policy, managerial and higher education teaching practice environments (Conole et al., 2007; Laurillard et al., 2009; Nascimbeni, 2013; Stepanyan et al., 2013; Buchan, 2014; Robertson 2015; Bates, 2017; Conole, 2017; Russell, 2017; Marshall, 2018; Ellis & Goodyear, 2019).

Pacansky-Brock (2015) suggested that a new way was needed to view the parts of this complexity, stating:

> Our models of faculty support are out-dated remnants of machine-age thinking and we are missing rich opportunities for collaborative solutions. We must begin to understand each higher education institutions [sic] as members of a complex ecosystem. Each is an organic system that is in a continuous state of change. (Pacansky-Brock, 2015, para. 5)

While such an ontological conception of organisations as ecosystems provides a starting point for examining the nature of organisational complexity in this study, it does not expand on how the relationships within complex organisations, such as universities, occur in response to change. Schapper et al. (2005) argued that understanding “the complexity of organisations lies not in the presence of particular ontological variables, but on the vast potentiality of what may be known and more importantly, what may never be known, about organisations” (p. 9). It was concluded that “complexity of organisations is not a matter of ontology but is clearly an epistemological issue” that requires the consideration of “multiple theories, perspectives and paradigms” (Schapper et al., 2005, p. 9). Castellani (2014) acknowledged this multiplicity in furthering his argument that “complexity theory is not so much a substantive theory, as much as it is an epistemologically explicit attempt to model social life in complex systems terms” (p. 10). The use of modelling as a way of revealing complexity was championed by Jacobson (2015) who argued for a simplicity-complexity epistemic view of complex systems by proposing that “the central task of natural science is to make the wonderful commonplace: to show that complexity, correctly viewed, is only a mask for simplicity; to find pattern hidden in apparent chaos” (p. 311). Jacobson (2015) demonstrated how patterns in chaos could be revealed using computer simulations based on ABM principles, in which the application of simple rules defined the behaviours of relationships between variables in a model. Rather than merely describing the variables in complex systems based on what was known, Jacobson (2015) suggested that ABM could help to explain the complexity in systems.

Hetherington (2013) noted that discussions around contrasting epistemological positions in educational research studies of complexity only started to appear in the literature during the past two decades. These discussions centred on questions about the epistemology of *complexity science* versus *complexity thinking,* contrasting a reductionist *hard stance* (complexity science) with a *soft stance* (complexity thinking). In the Davis and Sumara (2006) inquiry into complexity and education, they defined a hard stance as an objective reductionist approach found in analytic science, based on the assumption that “reality is determined and hence determinable” (p. 18). This objective, reductionist, hard stance contrasts with the epistemological position adopted in a soft stance that seeks an interpretive subjective representation of reality “to describe living and social systems” (Davis & Sumara, 2006, p. 18). A subjective, soft-stance, interpretive representation of complexity within a higher education setting might describe “individual capacity and organizational, institutional and cultural dynamics” (Alhadeff-Jones, 2013, p. 42) as emerging from the key relationships within a university system. In applying an objective hard-stance position, these relationships can also be viewed as occurring within a university system that is “fragmented and compartmentalized” (Alhadeff-Jones, 2013, p. 42), having, for example, faculties, colleges, departments, units, courses, subjects, topics and modules. In two contrasting examples of hard and soft stances provided by Alhadeff-Jones (2013), a hard-stance view reduced parts within a system to describe “what is” (Davis & Sumara, 2006, p. 25) represented by structures and processes, while a soft stance connected and interpreted the dynamic interplay and emergence in relationships between actors, as groups of people in a system. By connecting the relationships between the roles of actors (soft-stance view) within the structures and processes (hard-stance view) of a university, it is possible to examine what *is* in a “real” case of lived experience and to explore “what might be” (Davis & Sumara, 2006, p. 25) as future possibilities are considered in developing an “ideal” scenario.

Drawing on the distinctions between hard and soft epistemological positions, the first three of the secondary questions in this study (Section 2.5.3) assumed a *hard* reductionist stance by seeking to reveal organisational levels and associated roles in e-learning innovation and adoption. The first three secondary questions in this study, referred to in parentheses:

- Guided an objective analysis of extant case study data to identify common causal and critical success factors that played a role in the process of innovation adoption (Question 1).
- Identified the stakeholders in this process and placed them into organisational level actor categories (Question 2).
- Grouped actor categories together with associated stakeholders’ roles (Question 3).

The final three questions in the study assumed a *soft* subjective interpretive stance by:

- Eliciting the lived experiences of actor representatives to connect and then explore the roles and relationships between institutional actors in the system (Question 4).
- Revealing both real and ideal perspectives of innovation adoption (Question 5) and then, from the views provided by each institutional actor, about what *is* and what *might be*.
- Drawing out implications to inform policies and practices for institutional capacity building (Question 6).

Implications drawn from this study provided a response to an overall practice-oriented question about "how should we act" (Davis & Sumara, 2006, p. 25) which was reflected in the opening of the primary question (Section 2.5.3) that guided this study by asking: *How can universities build institutional capacity?* Davis and Sumara (2006) might have viewed this guiding *how* question as assuming a third epistemological position, which they referred to as *complexity thinking* and described as an "attitude that lies somewhere between the hard and soft approach" (p. 18) in understanding complexity.

All three epistemological positions (*hard stance*, *soft stance* and *complexity thinking*) are intertwined throughout this study. By simultaneously assuming both a hard and a soft stance underpinned by complexity thinking, this study sought answers to questions about what is, what might be and how should we act. Assuming a complexity-thinking stance enables the adoption of both a rigorous and a pragmatic epistemological position "in which the researcher is situated within and constructs an understanding of the real world" (Hetherington, 2013, p. 72) as both designer and observer. This dual role of researcher, as both designer and observer, also assumed one of the key concepts proposed in the Morin (1982) complexity paradigm. In this study, this dual role locates the researcher as an active participant in modelling transformational change.

3.2.2 Complexity as a paradigm

Between 1971 and 1991, Edgar Morin formulated his four-volume paradigm of complexity titled *La Methode* (Morin, 1982) that challenged fragmentation and reductionism he saw in modern scientific research (Alhadeff-Jones, 2013). Viewed through Morin's complexity paradigm, an "organization is not an institution, but a continually generative and regenerative activity at all levels" (Morin, 1982, p. 13). Morin's paradigm of complexity proposed 11 principles to fundamentally challenge "the ways one conceives of knowledge production, from epistemological, psycho-socio-anthropological and ethical points of view" (Alhadeff-Jones, 2013, p. 21), as follows:

1. Promoting interpretations starting from the *local* and the *singular.*
2. Recognising and integrating the *irreversibility* of time and the necessity to include *history* in any description or explanation.
3. Recognising the impossibility of isolating single elementary units and the necessity to

link the knowledge of any elements to the knowledge of the wholes they belong to.

4. *Organisation* and *self-organisation* represent problematics [sic] that cannot be ignored.
5. *Complex causality* (including mutual causalities, feedback loops, etc.).
6. Interpreting phenomena through the circular logic linking *order, disorder*, *interactions* and *organisation.*
7. *Distinction*, instead of disjunction, between object or subject and its environment.
8. Relationship between the observer/designer and the object of study.
9. Possibility of a scientific theory of the self and the necessity to recognize physically, biologically, and anthropologically, the categories of *being* and *existence*, as well as the notion of *autonomy* (e.g., through a theory of *self-production* and *self-organisation*).
10. Recognition of the *limits of logical demonstration* with formal complex systems (e.g., Gödel, Tarski) and the discursive principle privileging the *association of complementary, concurrent and antagonistic notions* with each other.
11. *Thinking dialogically* and through *macro-concepts*, as a strategy of research aiming to establish and question links and relationships between notions and concepts, and by extension between and beyond discipline.

From this list, seven principles have been applied in this study with the original position in Morin's list provided in parentheses:

a. Promoting interpretations starting from the local and the singular (1).
b. Including history in the description or explanation (2).
c. Linking knowledge of any elements to knowledge of the wholes they belong to (3).
d. Complex causality (including mutual causalities, feedback loops, etc.) (5).
e. Interpreting phenomena through the interactions (6).
f. Relationship between observer/designer and the object of study (8).
g. Thinking dialogically to establish and question links and relationships (11).

The interview stage in this study commenced with (a) and (b) by obtaining a single, local case study of technology adoption from each study participant. Roles of individuals involved in the process of technology adoption that had been previously identified in the first analytical stage of the study (as findings for the first three secondary questions in the study – Section 2.5.3), were then connected during each interview using a computer simulation to indicate the inter-relationships between these roles, guided by (c) and (d). This *in situ* modelling process enabled an interpretation of the results of interactions between the connected innovation adoption roles, as described in (e). Throughout the interview and modelling process the researcher, as both observer and designer, defined in (f), directed the conversations that explored the relationships in the models, using (g) as a guide. Thus, Morin's paradigm was applied in this study using a complexity thinking stance that situated the researcher in the real world, as envisioned by Hetherington (2013).

3.2.3 Complexity as theory

While there are numerous references in scientific literature to complexity theory, no single unified theory appears to provide a general context for developing a process for studying complexity (Johnson, 2007; Hetherington, 2013), although there appears to be some agreement that complexity theories have a capacity to extend traditional theories found in studies of systems in the social sciences. Levin and Jacobson (2016) noted that “the use of complexity theory to study complicated physical and social systems over the past three decades has led to significant insights about the world that classical approaches tended to oversimplify or to ignore” (p. 2).

An example of a classical approach can be found in the Rogers (2003) DoI theory, acknowledged by Buchan (2014) as a seminal theory in innovation adoption studies. Such studies have continued to view the process of innovation adoption from a linear orientation based on the notion of a push-pull scaling up process, starting with small and ending up with large scale implementations of new technologies, as described in the Rogers (2003) DoI theory. In the adoption of innovations, this diffusion process was viewed as spreading both over time (exponentially) and across populations (along a bell curve), starting with innovators (and early adopters), transitioning through an early majority to a late majority and finishing with laggards. In the educational technology adaption of Roger’s bell curve (Figure 4) the five Rogers (2003) key population groups were further described, within a university setting, as technology enthusiasts, visionaries, pragmatists, conservatives and sceptics by Pacansky-Brock (2015).

As noted earlier in this chapter, Rogers et al. (2005) broke away from an original portrayal of DoI theory as a linear process by proposing their hybrid theory of DoI and CAS in which a key feature was nonlinearity, characterised by the “relationships among members of a system” (p. 3). Further theoretical discussions about features of nonlinearity and relationships within systems are emerging in studies of complexity in education.

One such recent discussion, in which education was examined as a complex system, was provided by Levin and Jacobson (2016) who suggested that “the properties of educational systems align with general complex systems conceptual perspectives” (p. 2). In contrast to viewing education as a simple or even a complicated system, in which “the relationship between cause and effect is smooth and proportionate” (Rogers et al., 2005, p. 3) made up of “simple cause-effect pairings” (Levin & Jacobson 2016, p. 2), education, viewed as a complex system, was proposed by Levin and Jacobson (2016) as being made up of “networks of multiple simultaneous interaction and mediation” (p. 2). This replacement of linear cause and effect with the notion of non-linear multiple-mediated simultaneous, interactive, networked relationships was found in other emerging theoretical discussions associated with studies of complexity in education. For example, Snyder (2003), wrote about such differences between simple, complicated and complex relationships from the viewpoint of educational reform, but also added the notions of actors, randomness, positive and negative feedback, as well as the concept of emergence, by stating:

> Put simply, complexity theory posits that systems begin as collections of individual actors who organise themselves and create relationships. These relationships form in response to positive or negative feedback – though a degree of randomness is inarguably involved as well. New structures and behaviours then emerge as the actors act and react to each other. (Snyder, 2013, p. 11)

Emergence along with its converse notion, collapse, are also concepts found in DoI theory (Rogers et al., 2005). A choice between either emergence or collapse can impact on the adoption of innovations in systems either through a process of diffusion, in which transformational change and new structures and behaviours in systems *emerge*, or through a process of dissipation or *collapse* in which systems revert “to a variation of their initial stable state” (White & Levin, 2016, p. 45). As discussed in the literature review (Section 2.4.3), collapse was a problem frequently encountered in adoption of e-learning innovations, with e-learning innovations that originated bottom-up in higher education teaching practice often being dissipated or lost. This point of collapse is depicted as a chasm in the process of diffusion of e-learning innovations (Figure 5). Robinson (2009) cited Rogers et al. in concluding that situating “complexity in the context of diffusion [of innovations] enables researchers to draw on a new toolbox to map irregularities in diffusion and the multiplicity of factors that shape the process” (p. 5). This need for a new “toolbox” of methods reflects the suggestion by Rogers et al. (2005) that “complex adaptive systems models provide a most promising theoretical and methodological source for innovation research” (p. 22). Rogers et al. (2005) added that modelling could “also make innovation diffusion more predictable, and therefore more subject to planning, implementation, evaluation, and replication measures” (p. 22). These measures all appear necessary for universities in building institutional capacity for mainstreaming the adoption of e-learning innovations and seeking transformational change. The “toolbox” that was applied in conducting this study applies ABM for investigating these measures.

Levin and Jacobson (2016) proposed ABM “as a methodological complement to quantitative and qualitative approaches in educational research” (p. 3), citing Jacobson and Kapur (2012) who successfully demonstrated that ABM was particularly suited to case study research approaches for investigating complexity in education. In also proposing a case-based complexity theory for conducting health research studies, Castellani, Rajaram, Gunn and Griffiths (2015) noted that "cases are complex profiles comprised of a set of inter-dependent variables, which are contextually dependent, nonlinear, dynamic, evolving, self-organizing, emergent, etc ... in short, cases have the same characteristics as a complex system” (p. 162). They concluded that these common characteristics allowed case studies to “be treated and modeled as complex system [sic]" (Castellani, et al., 2015, p. 162). Thus, studies of cases combined with ABM are proposed as providing complementary methods for investigating measures in building institutional capacity for mainstreaming innovations.

A combined case-based complexity-informed methodology appears to be well-suited for investigating the problem of how to build institutional capacity for innovation adoption, when this is viewed as a wicked problem (Section 2.4.4). Bore and Wright (2009) argued that when viewed as a wicked problem, building institutional capacity in large public systems was characterised by the unpredictable actions of interconnected individual agents. In this study, the term *agent* denotes a key element in the process of mainstreaming innovation adoption, represented by a distinct role associated within a group of key stakeholders in a university who were the main actors in this process. The context-based, unpredictable, dynamic, interconnected, non-linear, enabling and inhibiting relationships between these roles, as the agents in innovation adoption, along with viewing mainstreaming innovation adoption as an emergent and interpretive phenomenon, formed the key assumptions behind the case-based complexity-informed methodology developed for and applied in this study, in which the researcher, as both designer and observer, also acted.

3.3 Interpretive interactionism research framework

When setting out in 2000 to develop a framework to guide his doctoral research, Alhadeff-Jones (2013) stated that he was dismayed to discover that "there was no ready-made procedure to guide … [his] inquiry" (p. 20). He eventually spent seven years developing the research methods he used for his own investigation of complexity in education. The position at the start of this PhD research was similar to that of Alhadeff-Jones (2013). Fortunately, the search for a suitable research design for this case-based, complexity-informed study of mainstreaming e-learning innovation adoption in higher education, led much sooner to a unifying research design that could be applied in guiding this study. This design was founded in *Interpretivism*, variously attributed as ontology and epistemology by Ponelis (2015) but favoured by Leitch, Hill and Harrison (2010) as "based on a life-world ontology that argues all observation is both theory- and value-laden and investigation of the social world is not, and cannot be, the pursuit of a detached objective truth" (p. 67) which was the stance adopted for this study.

The research design found in Norman Denzin's *Interpretive Interactionism* six phase framework (Denzin, 2001) adopted an interpretive stance by positioning the researcher as designer, participant and observer within the study "to understand a social setting from the actors' point of view" (Burton-Jones, McLean & Monod, 2011, p. 19). In this study, the social setting of higher education innovation adoption is occupied by the researcher as an actor in conducting the study, the research participants as institutional actors in a higher education setting and an interactive computer model simulation of four actor groups representing institutional actors. In the computer simulation model, each represented group plays a different set of roles that reflect variables in mainstreaming the adoption of e-learning innovations in higher education teaching practice.

The following justification for incorporating the Denzin (2001) framework in the design of this study starts with a discussion about the investigative opportunities that applying an interpretive lens provides for extending the use of digital models in a case-based complexity-informed study (Section 3.3.1). This discussion is followed by a description of the six phases in the Denzin (2001) interpretive research design (Section 3.3.2). These discussions lead to a new interpretive case-based modelling bricolage (Section 3.4) and culminate in the presentation of an interpretive case-based modelling conceptual framework (Section 3.5). This original conceptual framework informs the research method in which the six phases in the Denzin (2001) research design are aligned with the six secondary research questions (Section 2.5.3) this study investigates.

3.3.1 Applying an interpretive lens to extend digital models

Digital models generated through an application of ABM computer software code are increasingly appearing in studies that seek to capture the dynamic interactions that occur within complex organisational systems. The case-based MMM study of a US education system conducted by Levin and Datnow (2012) was found to be one of the few available examples of the application of ABM in education. The MMM digital model developed for the Levin and Datnow (2012) study simulated the impact of complex sets of relationships between the respective roles of different groups of actors comprising principals, teachers, students and district personnel in implementing a new data-driven, decision-making initiative in schools across the United States. As Levin and Datnow (2012) showed, application of digital code demonstrated a powerful capacity for generating models of data derived from a case study by providing visual representations of the results of interactions in complex relationships between multiple variables. As these kinds of interactions are involved in the process of innovation adoption, the use of ABM and MMM seemed promising.

An analysis of studies conducted over the past two decades in universities around the world revealed multiple institutional variables in e-learning innovation adoption in higher education (see Appendix 3). As Levin and Datnow (2012) further demonstrated, digital models can be used to reveal relationships between such variables by indicating both enabling (positive) and inhibiting (negative) connections between the variables and adding representations of varying levels of influence associated with each variable (also known as an agent – see Section 3.2.3). This process of simulating relationships through digital models can be adjusted to create different views over time – from the past, present and into the future – by adding, changing and adjusting the positive and negative connectors and their direction, plus levels of influence in any given scenario. The benefits of the resulting "bird's eye view" provided in visually modelling these relationships are only fully realised if an interactive interpretative process is embedded throughout the creation of digital models to derive insights about the interactions in the relationships as they occur (Stacey, 2011).

While "a key aim of interpretive research is to understand a social setting from the actors' point of view" (Burton-Jones et al., 2011, p. 19), in digital modelling insights emerge not only after a computer is used to run the inputs (using the modelling software) to produce a final visual representation of the model, but also during interactive co-creation of the model itself. Otherwise, resulting digital models merely serve as artefacts that provide static visual metaphors of an event from an actor's point of view. Stacey (2011) concluded in his discussion about studies of system complexity that, in using digital models for researching organisational dynamics, "an act of interpretation is required in order to utilise the insights derived from the logic of digital code interaction" (p. 259). Giving meaning to the lived experience of an event and deriving insights from capturing this experience were found to occur as part of the process of co-creating digital models, rather than through an interpretation of the final visual artefacts once they had been created (Stacey, 2011). Applying an interactional interpretive lens to case-based modelling provided an opportunity for both researcher and participant to simultaneously design, participate, observe and "examine how problematic turning point experiences are organized, perceived, constructed, and given meaning" (Denzin, 1989, p. 49).

In this study, the researcher, along with each participant, interacted to create, explore and interrogate the digital models as they emerged by applying the Denzin (2001) interpretive interactionism research design. The participant's experience was initially applied in validating the synthesis of extant case study data conducted in the first stage of this study, from which the agents (represented by roles in innovation adoption) in the model, were derived. To this baseline model (see Figure 16 in Section 4.2) the lived experiences of the participants were applied and further adjusted as they emerged throughout the interview process. In this way, using digital models guided by an interpretive interactionism research design provided both the researcher and participant an opportunity "to uncover how the problematic act, or event, in question organizes and gives meaning to the persons studied" (Denzin, 1989, p. 49). Both the interview and modelling "process and structure [became] … blended with lived experiences" (Denzin, 1989, p. 39) and insights emerged as "the world of lived experience [became] directly accessible" (Denzin, 1989, p.14). The unique opportunity enabled by coupling an interpretive interactionism design with case-based digital modelling in this study allowed the visualisation of the lived experience of each participant and its exploration by both researcher and participant in real time. As this study demonstrated, the application of the six phases in Denzin's interpretive interactionism process provided a unifying framework for extending the application of case-based modelling of a complex problem in a complex system.

3.3.2 Phases in the interpretive framework

The phases in the Denzin interpretive research design framework are (Denzin, 2001, p. 70):

1. Framing the research question.
2. Deconstructing and analysing critically prior conceptions of the phenomenon.
3. Capturing the phenomenon, including locating and situating it in the natural world and obtaining multiple instances of it.

4. Bracketing the phenomenon or reducing it to its essential elements and cutting it loose from the natural world so that its essential structures and features may be uncovered.
5. Constructing the phenomenon or putting the phenomenon back together in terms of its essential parts, pieces, and structures.
6. Contextualising the phenomenon or relocating the phenomenon back in the natural social world.

Each of these phases draws on “self-stories of many individuals located in different points in the process being interpreted” (Denzin, 1989, p. 39). The following sub-sections outline how these six phases, together with associated research questions, are applied in guiding this study.

Phase 1. Framing

In Denzin’s first phase, the problem under investigation is defined as occurring within a location in which the persons under investigation interact or “do things together” (Denzin, 2001, p. 71) as part of a process. From an interpretive perspective the primary research question needs to focus on how rather than why these interactions occur. In this study the primary research question asks: how can universities (the location of the study) build institutional capacity (based on the interactions of people) for mainstreaming the adoption of e-learning innovations (the process under investigation) rather than why this does or does not occur? As the literature review in this study has revealed, previous studies of innovation adoption in teaching practice have largely focussed on *why,* identifying the enabling and inhibiting factors, rather than *how* mainstreaming of e-learning innovations occurs in educational institutions by investigating how these factors are connected.

Phase 2. Deconstructing

In Denzin’s second phase, existing research and theoretical literature are deconstructed and analysed to reveal prior findings and assumptions about the process under investigation. These are revealed through the first two of the secondary questions in this study which asks: (1) what critical success factors play a role in the process of innovation adoption; and (2) who are the key university actors in this process? These questions guide an analysis of extant case studies, literature and theories from which descriptors of factors and groups of actors are generated to create a baseline model and the selection criteria for recruiting participants for the study is established.

Phase 3. Capturing

The third phase in Denzin’s interpretive process seeks examples from the personal stories of study participants, identified through the second question in the previous phase, to capture and locate their lived experiences. In this study, the participants represent two groups of university actors in mainstreaming innovation adoption: those working in a central support role and teaching practitioners who are e-learning innovators. The third of the secondary research questions asks:

(3) what are the roles played by these actors in innovation adoption? This is investigated through an interactive interview process in which the lived experiences of the participants are applied to connecting the roles represented in the baseline model developed out of Phase 2.

Phase 4. Bracketing

This fourth phase seeks out interpretations of elements and structures as they are revealed through the modelling process. In this study, these elements and structures are represented by the innovation adoption roles depicted in the model and how these roles behave when they are connected. This part of the research process is prompted by the fourth question that asks: (4) how are these roles interrelated? In the study this is revealed simultaneously through using computer code to run the model at various stages of applying a personal story while eliciting a participant's insights as they emerge, both before and after the model is run.

Phase 5. Constructing

The fifth phase in Denzin's process builds on the previous phase by putting together the results of modelling and the interpretations into a coherent whole. This is achieved through the fifth question that asks: (5) what impacts result from the relationships between actor roles? In this phase, the emerging insights and models are brought together to examine the totality of the relationship structures the models reveal.

Phase 6. Contextualising

In this sixth and final phase, contrasting stories are examined and interpretations are isolated to show how "experiences are altered and shaped as they are given meaning by interacting individuals" (Denzin, 2001, p. 80). In this study, the context for these interactions occurs not only between the actor roles in the model but also in the interactions between the participant and researcher in co-creating *real* and *ideal* versions of the model and eliciting meanings from this modelling process. This last phase in the research process culminates in the concluding sixth question that asks: (6) what implications for changing policies and practices are suggested by these results?

Application of phases

By applying the six Denzin (2001) phases and asking questions related to each phase, models generated through this interpretive process could be evaluated using the following eight criteria (Denzin, 2001, p. 81):

- Do they illuminate the phenomenon as lived experience?
- Are they based on thickly contextualised materials?
- Are they historically and relationally grounded?

- Are they processual and interactional?
- Do they engulf what is known about the phenomenon?
- Do they incorporate prior understandings of the phenomenon?
- Do they cohere and produce understanding?
- Are they unfinished?

These criteria are revisited in more detail in the following section (especially Section 3.4.1) and in the conclusion (Section 3.5) of this chapter to elaborate how the development of an interpretive case-based modelling methodological bricolage is used in this study to address each of the above questions.

3.4 A new interpretive case-based modelling bricolage

The term *bricolage* describes a conceptual drawing together of existing research methods from different disciplinary perspectives with the purpose of extending traditional qualitative, quantitative and mixed method applications to examine complex systems (Denzin & Lincoln, 2000; Kincheloe, 2004; Yardley, 2008; Kincheloe et al., 2017). Papert (1993) provided the following description:

> The basic tenets of bricolage as a methodology for intellectual activity are: Use what you've got, improvise, make do. And for the true bricoleur the tools in the bag will have been selected over a long time by a process determined by more than pragmatic utility. (Papert, 1993, p. 144)

An example of the application of a methodological bricolage was provided in research cited by Kincheloe (2004) that was conducted during the 1970s by James Lovelock and Lynn Margulis in conceiving their Gaia theory of how the complexity of life on our planet produced its own conditions for existence. In developing a method for conducting their research, Lovelock (a chemist) and Margulis (a microbiologist) included “geology, microbiology, atmospheric chemistry, philosophy, sociology” (Kincheloe, 2004, p. 2) along with other disciplines from which they drew different perspectives together. The Gaia theory that emerged from their resulting bricolage methodology viewed the earth as a dimension of life in which “life and its environment feed back on one another, modifying one another in the complexity of the living process” (Kincheloe, 2004, p. 18). Using the Lovelock and Margulis example, Kincheloe (2004) suggested that “without the tensions produced by a bricolage of perspectives, such a new view of the nature of life could not have been conceived” (p. 18). The usage of methodological bricolage as a term in research was attributed by Kincheloe (2004) to Denzin and Lincoln (2000). According to Denzin and Lincoln (2000), "the interpretive bricoleur produces a bricolage - that is, a pieced-together set of representations that are fitted to the specifics of a complex situation" (p. 4). Citing Lincoln and Denzin (2003), Yardley elaborated on her role as a bricoleur researcher, the role also adopted by the researcher in this study. Yardley (2008) described this role as follows:

> I am, as researcher, a bricoleur, a maker of patchwork, a weaver of stories, an assembler of montage (Lincoln & Denzin, 2003, p.5) by which means I construct and convey meaning according to a narrative ethic, an approach to research that is neither naïvely humanistic nor romantically impulsive—nor, by any means, easy to achieve. To do this kind of work effectively I need at my disposal a range of techniques and media capable of containing my multiple texts and making them accessible and coherent to the reader. (Yardley, 2008, para. 12)

Yardley's description of herself as a bricoleur resonated with the researcher in this study, by articulating both the challenging and creative aspects of "piecing together" a representation of complexity while being part of the process. It was encouraging to find that Kincheloe, McLaren and Steinberg (2017) located the bricoleur role as "grounded on an epistemology of complexity" (p.168) in which the researcher, as bricoleur, played an active role. This was a view supported by Davis and Sumara (2006), who suggested that "complexity thinking helps us actually take on the work of trying to understand things while we are part of the things we are trying to understand" (p. 16). In discussing the origins of complexity thinking, Davis and Sumara (2006) noted that the term complexity was "derived from the Indo-European plek-, 'to weave, plait, fold, entwine'" (p. 16). According to Rogers (2012), "the etymological foundation of bricolage comes from a traditional French expression which denotes crafts-people who creatively use materials left over from other projects to construct new artefacts" (p. 1). A combination of this weaving metaphor with the notion of a craftsperson was applied in creating a new interpretive case-based modelling methodological bricolage for conducting the study, while adopting a bricoleur role as the embedded researcher in this study.

The term bricolage can be found in computer modelling studies of complexity. Winsberg (2010) presented a view of modelling, using a computer simulation, as a methodological bricolage that borrowed "from the experimental and theoretical domains" (p. 39) of complexity science, concluding that simulation, as an epistemology, supported "an entirely new methodology ... that ... lies between theory and experiment" (Winsberg, 2010, p. 40). The notion of a new and third mode of scientific inquiry was attributed to Axelrod (2007) who, during the 1990s, was amongst the first to propose "the unique value of simulation as a third way of doing science" (p. 90). Winsberg's argument followed similar assumptions proposed by Axelrod (2007) in suggesting that simulations provided metaphors of real-world systems through experiments that developed "a life of their own" (Winsberg, 2010, p. 44). In elaborating this view, Winsberg (2010) quoted phrases from science sociologist Deb Dowling (1999) in proposing:

> Simulation is like theory in that it involves "manipulating equations" and "developing ideas" but is like experiment in that it involves "fiddling with machines," "trying things out," and "watching to see what happens". (Winsberg, 2010, p. 39)

By adopting the role of bricoleur, Yardley (2008) argued that the power of a bricolage methodology allowed research to move "beyond the boundaries of more formally documented and disseminated research practices" (para. 13) and thus provided "the researcher with the opportunity to explore a more open, expansive terrain, to interpret and reinterpret data across the different textual and visual forms" (Yardley, 2008, para. 13). This study applied these various views of bricolage described by Papert (1993), Denzin and Lincoln (2000), Kincheloe (2004), Yardley (2008), Winsberg (2010), Rogers (2012), Kincheloe et al. (2017) by incorporating the Denzin (2001) six phases of interpretive interactionism with case-based modelling. The bricolage methodology "woven together" for this study combined a traditional case study interview method (Yin, 2014) commonly found in communication, social science and education disciplines, with the application of computer modelling (Levin & Jacobson, 2016) traditionally found in mathematically based studies and, more recently, in the emerging discipline of complexity sciences with the interpretive interactionism research design (Denzin, 2001) to form a unifying interpretive case-based modelling methodological bricolage.

In using this bricolage, the interview process was used in building a computer simulation that provided an opportunity for experimentation and exploration of models, as they evolved. Through this process, the notion of organisational complexity was applied to examine institutional capacity building in universities for mainstreaming the adoption of e-learning innovations. The focus of this examination was on the roles played by institutional stakeholders, as actors in different innovation-adoption contexts, together with the enabling and inhibiting interactions that occurred between these roles in this process and the various levels of influence of each of these roles. The various stakeholder roles in innovation adoption were investigated through modelling and exploring the stories provided by human "actors" as both represented in the model and as the participants in the study. During an interview, the researcher progressively applied each participant's story as a case study in constructing and running a computer model, while guided throughout this process by the study participant. In this way, the notion of a bricolage applied in this study "constructs a far more active role for humans" (Kincheloe et al., 2017, p. 168) by allowing participants and researcher to become simultaneously immersed in the research process. It would not have been possible to achieve such an immersive and collaborative role for both the study participants and the researcher using traditional qualitative, quantitative or mixed methods. The research methods used for achieving this immersion and collaboration were only made possible through the availability of computer modelling and internet software which provided the accessible media and channels for conducting this research. Just as Alhadeff-Jones (2013) discovered in developing a method for his investigation of a complex problem in an education setting, methods for investigating problems of complexity needed to be "put together" rather than "found" in existing methods. This view is reflected in the following advice from Kincheloe (2004):

> In the domain of complexity the bricolage views research methods actively rather than passively, meaning that we actively construct our research methods from the tools at hand rather than passively receiving the "correct", universally applicable methodologies. (Kincheloe, 2004, p. 2)

The following sections discuss how this bricolage extends other approaches in conducting case-based modelling to investigate complex systems within organisational settings, and how the combination of new versions of computer modelling, communications and video capture software in this study make this possible. Section 3.5, which concludes this chapter, contains the new conceptual framework for conducting this study (see Figure 15) in which the six phases of the Denzin (2001) provide a guide to build on and extend previous approaches in case-based modelling.

3.4.1 Building on and extending case-based modelling methods

The combination of case studies with computer modelling as a mixed methods approach is a recent methodological concept that has emerged in the study of complex systems. This is illustrated by the co-location of *case-based complexity* and *mixed methods* in the bottom right corner of Brian Castellani's interactive *2018 Map of the Complexity Sciences,* shown in Figure 13. The full figure is included in Appendix 7 (Figure 25) and a larger interactive view of this map, including viewing instructions and hyperlinks to further references, is available from http://www.art-sciencefactory.com/complexity-map_feb09.html.

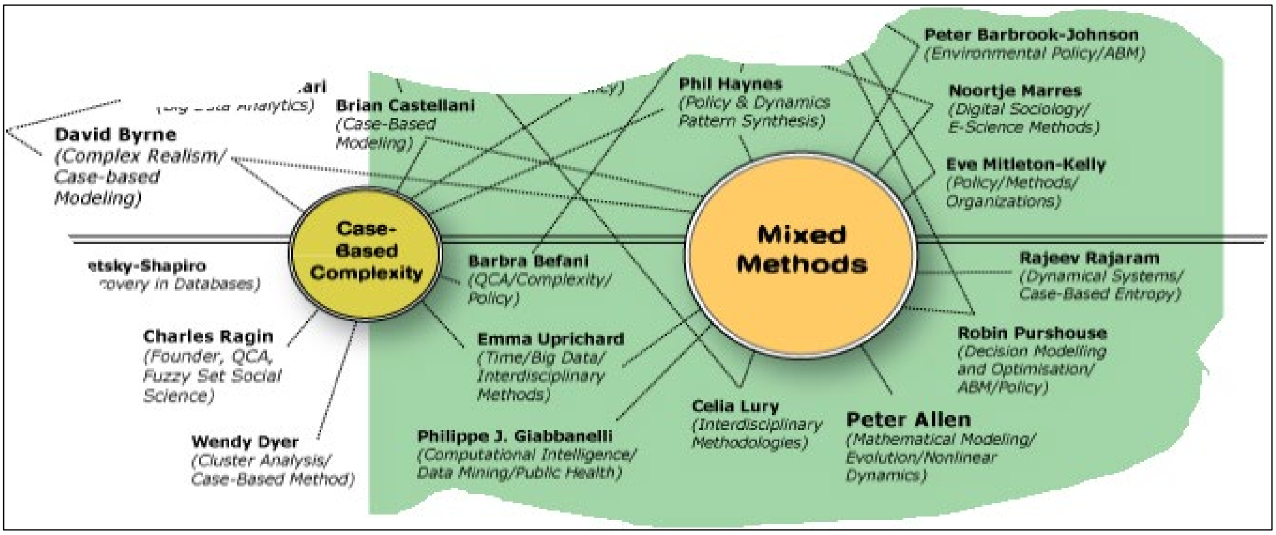


Figure 13. Enlarged section of 2018 Map of the Complexity Sciences. Retrieved from http://www.art-sciencefactory.com/complexity-map_feb09.html. Licensed under a Creative Commons Attribution 3.0 Unported Licence.

Castellani and Rajaram (2012) supported their claim that case-based modelling was "the methodological equivalent of complex systems" (p. 154) by citing "Byrne's (2009) general premise regarding the link between cases and complex systems". In Figure 13, case-based modelling is depicted as a new concept in researching complex systems which aligns with traditional mixed methods research applications. An example of this alignment can also be found in the mixed methods approach for modelling complex social systems using the SACS (Social and Complexity Sciences) Toolkit, developed by Castellani and Rajaram (2009), which contains a theoretical framework that uses social complexity theory and a procedural algorithm for modelling social systems. More recently, Castellani, Barbrook-Johnson and Schimpf (2019) described case-based modelling as "an epistemological bridge between ABM and CBM [Case Based Methods]" (p. 406).

The features of ABM are discussed further in Section 4.7.

The steps in using the SACS Toolkit framework, which can be applied using ABM, follow a "case-based, system-clustering algorithm for modelling social systems" (Castellani & Hafferty, 2009, p. 67). The six steps in this "assemblage" (Castellani & Hafferty, 2009, p .67) were listed as:

1. Help the researcher define a set of research questions in systems terms.
2. Establish the social system's field of relations and determine the web of social practices out of which it emerges.
3. Use this information to catalogue the numerous ways the system is coupled/expressed at a particular moment in time-space.
4. Condense/cluster this catalogue into a smaller grid of the system's most important practices to create the network of attracting clusters.
5. Examine the internal dynamics of this network for a particular moment in time-space, including its interactions with key environmental forces and its trajectory within key environmental systems.
6. Assemble these discrete, cross-sectional snapshots of the system into a moving model, concluding with some overall sense of the system as a whole.

These steps were presented by Castellani and Hafferty (2009) as a cycle in which each iteration of a model (steps one to six and then back to step one) provided an opportunity for asking further research questions. The final stage in this cycle added sharing results with others, while recognising that preparing a model for another set of questions and sharing results may often times "happen simultaneously" (Castellani & Hafferty, 2009, p. 81).

The benefit of sharing the results of this modelling process visually was suggested by Castellani and Hafferty (2009) in quoting the adage that "a picture is worth a thousand words" (p. 81). A further recommendation by Castellani and Hafferty (2009) for researchers to use the internet for this purpose was also applied in developing the research design used for this study. Thus, case-based modelling, classified by Castellani and Rajaram (2012) as a mixed method research application, was further enhanced in this study by using computational visual models that could be created over the internet.

Castellani and Rajaram (2018) defined the SACS Toolkit they developed as "a new, case-based computationally-grounded mixed-methods platform" (para. 5) that enabled scholarly activity to "integrate case-based methods with complexity science for the purpose of modelling complex systems" (Castellani & Rajaram, 2018, para. 2). According to Castellani and Rajaram (2018), this integration could be achieved by using the code derived from agent-based computer models to conduct comparative analyses of data derived from cases. The SACS Toolkit was previously promoted by Castellani and Rajaram (2012) as “a case-based, mixed-method, system-clustering, data-compressing, theoretically-driven toolkit for modeling complex social systems” (p. 154). More recently, this lengthy description was shortened, shifting the focus to “computationally-grounded” (Castellani & Rajaram, 2018, para. 5) mixed methods. This shift from a mathematical to a computational emphasis can also be seen in the "ontology and epistemology matrix" (Snowden, 2005, p. 47) shown in Figure 14. It is worth noting that in the earlier "landscape of management" matrix (Snowden & Stanbridge, 2004, p. 142), *mathematical* complexity appears in the top left quadrant. This was changed one year later to *computational* complexity as shown in the updated matrix in Figure 14.

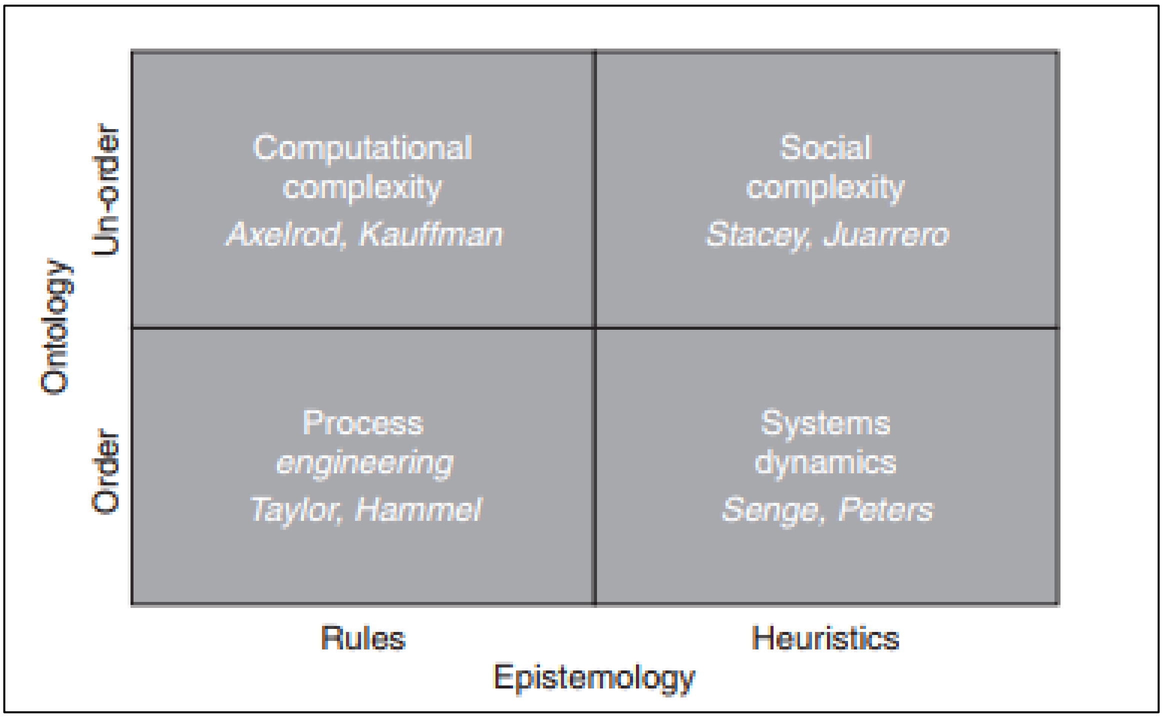


Figure 14. Ontology and epistemology matrix. Retrieved from Snowden, 2005. Reproduced with permission from the author.

The change in nomenclature from *mathematical* to *computational* in Figure 14 coincides with an increasing availability of free and more user-friendly computer software versions of modelling tools, such as *NetLogo* (Wilensky, 1999).

The new Interpretive Case-based Modelling methodology and research design developed for this study builds on steps from the SACS Toolkit (Castellani & Hafferty, 2009) and phases of the Denzin (2001) Interpretive Interactionism Framework. These steps and phases are listed respectively in the first two columns in Table 8. The third column in Table 8 lists the stages that form the Interpretive Case-based Modelling bricolage and guide this study. Similarities between the three columns are highlighted by colour coding to identify common features between the steps, phases and stages listed in Table 8 (please note that while this is an inserted image it is presented as a table for the purposes of this thesis).

Table 8. Comparison of SACS, interpretive interactionism, interpretive case-based modelling.

SACS (case-based modeling) Toolkit (Castellani & Hafferty, 2009)	Interpretive Interactionism framework (Denzin, 2001)	A new Interpretive Case-based Modeling bricolage
1. Help the researcher define a set of research questions in systems terms [RED] 2. Establish the social system's field of relations and determine the web of social practices out of which it emerges [PURPLE] 3. Use this information to catalogue the numerous ways the system is coupled/expressed at a particular moment in time-space [PURPLE] 4. Condense/cluster this catalogue into a smaller grid of the system's most important practices to create the network of attracting clusters [LIGHT GREEN] 5. Examine the internal dynamics of this network for a particular moment in time-space, including its interactions with key environmental forces and its trajectory within key environmental systems [BROWN] 6. Assemble these discrete, cross-sectional snapshots of the system into a moving model, concluding with some overall sense of the system as a whole [BLUE]	1. Frame the research question [RED] 2. Deconstruct and analyze critically prior conceptions of the phenomenon [PURPLE] 3. Capture the phenomenon, including locating and situating it in the natural world and obtaining multiple instances of it [DARK GREEN] 4. Bracket the phenomenon, or reduce it to its essential elements and cut it loose from the natural world so that its essential structures and features may be uncovered [LIGHT GREEN] 5. Construct the phenomenon, or put the phenomenon back together in terms of its essential parts, pieces, and structures [BROWN] 6. Contextualise the phenomenon, or relocate the phenomenon back in the natural social world [BLUE]	1. Prepare the research questions [RED] 2. Analyse extant cases, literature and theories to identify roles for baseline model [PURPLE] 3. Obtain lived experiences [DARK GREEN] 4. Apply lived experiences *in situ* to connect the roles in the model [LIGHT GREEN] 5. Interpret and adjust the connections between roles to produce a model of an ideal scenario [BROWN] 6. Examine the impact of relationships between roles in real cases and ideal scenarios [BROWN] 7. Compare models and data from interviews (quantitative comparison between real and ideal models and qualitative thematic analysis from interpretations and actionable insights) [BLUE]

In the SACS Toolkit, the last step (number six in column one of Table 8) requires assembly into a whole of "discrete, cross-sectional snapshots of a system" (Castellani & Hafferty, 2009, p. 67) while in the last phase of the interpretive research design (number six in column two of Table 8), this re-assemblage occurs by "relocating the phenomenon back in the natural world" (Denzin, 2001, p. 70).

In his slide presentation Castellani (2014) claimed that "cases are the methodological equivalent of complex systems; and alternatively, complex systems are cases and therefore should be studied as such" (Slide 5). In the health informatics studies reported by Castellani et al. (2015), longitudinal data were converted into sets of cases to create non-linear dynamic models. Examples of other case-based modelling were found in the outputs of the multidisciplinary *Integration of Complex*

Social Systems (ICoSS) research project conducted by the EMK Complexity Group in the UK, between 2001 and 2003 (Mitleton-Kelly & Puszczynski, 2004). The studies in the ICoSS report were conducted in partnership with 14 large organisations and led by a group of information systems, business and social sciences researchers. These studies used traditional questionnaires and semi-structured interviews to generate data that was applied in developing agent-based models. The models developed from the questionnaire and interview data were then presented to study participants in "reflect-back workshops" (Mitleton-Kelly & Puszczynski, 2004, p. 7) to elicit the co-creation of conditions for “an enabling environment to facilitate the emergence of new ways of organising or a new organisational form” (Mitleton-Kelly & Puszczynski, 2004, p. 6). A stated research objective of the Mitleton-Kelly and Puszczynski (2004) project, like the study in this thesis, had a strongly organisational focus which was to:

> Identify and articulate the conditions that enable and inhibit the creation and sustainability of new organisational forms, able to co-evolve with a changing environment, thus reducing the need for constant restructuring. (Mitleton-Kelly, 2017, para. 7)

The Denzin (2001) research design phases used in this study mirrored stages of the collaborative action research method used by Mitleton-Kelly and Puszczynski (2004), which were (p. 9):

1. Identify connectivity vectors, dimensions.
2. Visualise connections.
3. Quantify and measure of connectivity.
4. Qualify what may be a “good” organisation in a particular context.
5. Understand organisational properties by linking quantitative with qualitative properties.
6. Experiment with “good” virtual organisations by automatically testing out many possible combinations with given resources and constraints.

Where the method of study reported in this thesis differs from previous studies is that the case-based modelling process is conducted *in situ* by applying the lived experiences of interview participants directly into populating and running the computer simulation to visualise, explore and interpret the models.

3.4.2 Adding an interpretive layer

Data collection strategies in this interpretive case-based modelling methodological bricolage applied the eight criteria listed in Section 3.3.2 for evaluating the Denzin (2001) interpretive process, to extend previous collaborative mixed methods action research. These data collection strategies are listed in the following sections of this thesis:

- Illumination
- Thickly contextualised materials
- Historical and relational grounding
- Process and interaction

- Engulfment of what is known
- Prior understandings
- Coherence and understanding
- Unfinished interpretations.

Illumination

> An interpretation must illuminate or bring alive what is being studied. This can only occur when the interpretation is based on materials that come from the world of lived experience. Unless ordinary people speak, we cannot interpret their experiences.
> (Denzin, 2001, p. 81-82)

In this study, illumination emerged from the interpretation of data (as "materials" in this study) that were collected through the identification and analysis of the secondary data sources (see Table 2) followed by the conduct of case-based modelling interviews. The analysis of secondary data informed the development of the baseline model while the case-based modelling interview process elicited and recorded the lived experiences of study participants that populated the model.

Thickly contextualised materials

> Interpretations are built up out of events and experiences that are described in detail. Thickly contextualized materials are dense. They record experience as it occurs. They locate experience in social situations. They record thought, meanings, emotions, and actions. They speak from the subject's point of view. (Denzin, 2001, p. 82)

The recording of detailed descriptions of the participants' lived experience of innovation adoption provided the university workplace context for this study. Each participant's own recollection of a *real* event, as it occurred in a particular case of innovation adoption in a university, was recorded and then applied in constructing a computer model of this experience from which "what if" scenarios were explored, and an *ideal* model of relationships and influences emerged.

Historical and relational grounding

> Interpretive materials must also be historical and relational. That is, they must unfold over time and they must record the significant social relationships that exist among the subject being studied. Historically, or temporally, the materials must be presented as slices of ongoing interaction. They must also be located within lived history. (Denzin, 2001, p. 82)

The recollections of participants followed a historical chronology, starting with why and when an e-learning innovation originated in a higher education teaching environment, onto to how this innovation was implemented, moving then to how and why it was adopted by others in the university. These recollections were applied by connecting the relationships between the roles of the groups of people depicted in the model to indicate the interactions between these roles during the process of innovation adoption. Further insights emerged, as each case-based modelling interview progressed, and the impact of connecting the relationships depicted in each model were examined by the participant who had directed the creation of the connections and application of influences in the model. The generation of the modelling data along with the insights that emerged remained ongoing throughout the interview.

Process and interaction

> These two dimensions should be clear. An interpretive account must be both processual and interactional. (Denzin, 2001, p. 82)

The process of innovation adoption was examined in this study through the impact of interactions between the actor roles and their levels of influence in this process. The dual dimensions of process and interaction became interrelated through the modelling of each case, resulting in coded data for comparative analysis of the models and triangulation using qualitative interview data and references to the research literature.

Engulfment of what is known

> Engulfing what is known about the phenomenon in question involves including all that is known to be relevant about it. This means that the interpreter must be an "informed reader" of the phenomenon. (Denzin, 2001, p. 82)

Both the researcher and the participants acted in this study as informed interpreters. The researcher was informed through conducting an extensive literature review, analysis of extant case studies and synthesis of the data collected from the modelling process. The participants formed their interpretation of the interactions between university roles in innovation adoption throughout the modelling stage of the study. Both the researcher and each participant, paired with the researcher, interpreted the model as it unfolded, prompted by the questions asked by the researcher and by the behaviour of the computer model each time a model was run.

Prior understandings

> Engulfing merges with the problem of incorporating prior understandings into the interpretation of a segment of experience. Prior understandings include background information and knowledge about the area of interest; concepts, hypotheses, and propositions contained in the research literature; and previously acquired information about subjects and their experiences. Nothing can be excluded, including how the researcher judged the phenomenon at the outset of the investigation. (Denzin, 2001, p. 82)

What was known about the process of mainstreaming innovation adoption in a university emerged from data collected prior to conducting interviews (by the researcher) and from participants' previous experiences of innovation adoption in a university, shared through the modelling process. The researcher applied prior understandings, based on research literature, in building the structure of the baseline model and elicited the responses of participants in the study by asking questions about participants' prior experiences of innovation adoption and engaging in a co-creation process by applying participants' prior experience to the models. This co-creation of models ensured that judgments of both researcher and each participant were included throughout the interpretive case-based modelling process.

Coherence and understanding

> This criterion concerns whether the interpretation produces an understanding of the experience that coalesces into a coherent, meaningful whole. A coherent interpretation includes all relevant information and prior understandings. It is based on materials that are historical, relational, processual, and interactional. A coherent interpretation is based on thickly described materials. (Denzin, 2001, p. 83)

The interpretive approach adopted in this study sought to locate patterns “in the taken-for-granted structures of the everyday world of conversation and interaction” (Denzin, 1989, p. 14). The meaningful whole that emerged from the patterns in the interactions within each model in this study provided a snapshot in time of the complexity of the everyday world of the participants. In this way, the social complexity of mainstreaming innovation adoption in universities was recognised “by interpreting the target system as a whole which is more than the sum of its parts" (Tubaro & Casilli, 2010, p. 61).

Unfinished interpretations

> As a researcher comes back to an experience and interprets it, his or her prior interpretations and understandings shape what he or she now sees and interprets. This does not mean that interpretation is inconclusive, for conclusions are always drawn. It only means that interpretation is never finished. (Denzin, 2001, p. 83)

The modelling process culminated in speculating about the interactions between roles that would be needed in an ideal case of mainstreaming innovation adoption within a university. Data and recorded insights generated by modelling these ideal scenarios suggested a range of endless possibilities, characterised as a dimension of wicked problems, as described in Figure 11. This dimension of a wicked problem was described as exhibiting “no stopping rules” (Rittel & Weber, 1973, p. 162) with the lack of a finishing point explained by suggesting "there are no ends to the causal chains that link interacting open systems" (Rittel & Weber, 1973) such as those found within universities when viewed as complex education systems (Jacobson, 2015).

3.5 A new conceptual framework

Rittel and Webber (1973) concluded their search for a scientific solution to wicked problems by noting that "the process of solving the problem is identical with the process of understanding its nature" (p. 162). Thus, when seen as a complex/wicked problem, building institutional capacity for mainstreaming adoption of e-learning innovations requires universities to seek an understanding of the nature of the interactional processes involved in solving this problem.

In the final stage of this study, the researcher returned to the data to “offer a cross-case analysis of the materials that have been collected, paying more attention to the process being studied than to the persons whose lives are embedded in those processes” (Denzin, 1989, p. 39). While descriptions of these processes originated in this study through “thickly described personal experience stories” that were “connected to problematic human interactions" (Denzin, 2001, p. 27), the interpretive case-based modelling enabled the process of innovation adoption to be informed by these descriptions as they were visualised in the models.

The final models generated by this study presented the sum of these interactions from a “bird’s eye view” that was both “accessible and coherent” (Yardley, 2008, para. 12) yet maintained a complexity perspective. In seeking to simplify complexity using computer modelling, Castellani and Hafferty (2009) noted that “complexity scientists take the view that a picture of a complex system is worth a thousand words” (p. 241). Dix (2007) drew a clear distinction "between a framework, as a general structure that provides an overarching set of concepts and processes, and a model, as a specific structure of interrelated factors hypothesised to be tested” (p. 116). With these quotes in mind, Figure 15 presents a simple illustration, developed by the researcher, as a conceptual framework that draws together the key elements in the methodological bricolage that guides this study.

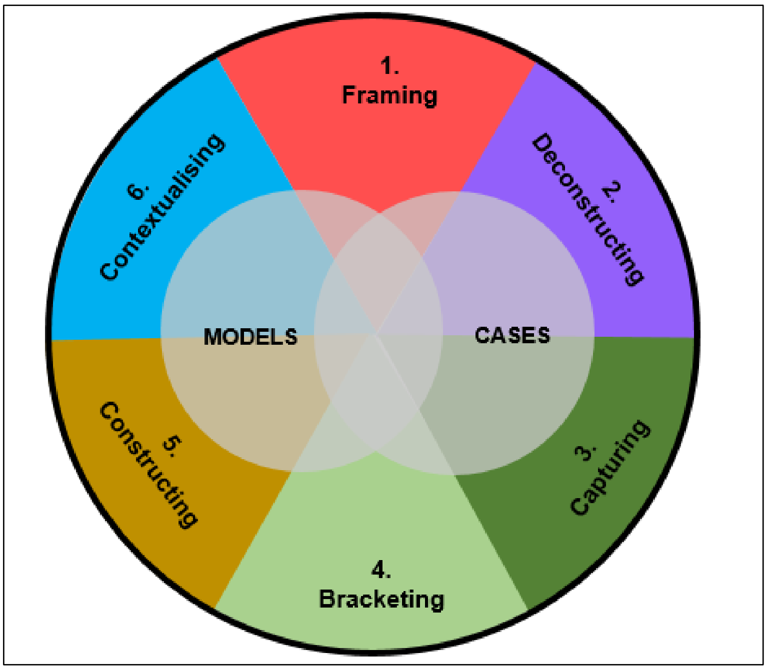


Figure 15. An original conceptual framework for interpretive case-based modelling.

In the conceptual framework depicted in Figure 15, the process of developing and applying case studies to computer models is nested within the six Denzin (2001) interpretive research design phases represented by the numbered coloured segments. The coloured segments in the framework correspond to the colour-coded Denzin (2001) phases in Table 8.

The following chapter demonstrates how this Interpretive Case-based Modelling conceptual framework is put to the test in applying a range of “narrative, reflective, and creative processes as interpretive tools” (Yardley, 2004, para. 1) used in conjunction with computer models for the purpose of investigating how universities can build institutional capacity for mainstreaming the adoption of e-learning innovations that originate in higher education teaching practice.

CHAPTER 4. METHODS

Capturing the phenomenon. (Denzin, 2001)

This chapter elaborates on the six phases of the conceptual framework for interpretive case-based modelling (shown in Figure 15) that is applied in conducting this study. The six phases of the conceptual framework, introduced in the previous chapter (Section 3.3.2) acted as a general structure throughout this study from which the research questions and stages in the case-based modelling method were derived.

The research questions (2.5.3) and baseline model (Figure 17) used in conducting the study emerged from the framework's first three phases (framing, deconstructing and capturing) while the case-based modelling stages guided the last three phases (bracketing, constructing and contextualising). Each of the main elements in the conceptual framework (Figure 15) - interpretive phases, cases and models - were drawn together and tested in conducting this study. The framework guided the selection of cases and participants as well as the interview process and methods used for analysis and reporting of data. The phases of the framework are described in Sections 4.1 through 4.6. The chapter concludes with an overview of ABM (Section 4.7) followed by a description of the specific purpose and structure of the MMM computer simulation tool that was adapted and applied in this study (Section 4.8) and descriptions and links to all software tools used and considered for this study (Section 4.9).

4.1 Framing the research question

In this study, the *phenomenon* under investigation is e-learning innovation adoption in higher education teaching practice. The term *innovation adoption* is also used throughout this thesis as an abbreviated form of this phenomenon. The main research question examines the problem of building institutional capacity for achieving the mainstream adoption of e-learning innovations that originate in higher education teaching practice.

The framing of the main research question in this study was guided by the steps provided by Denzin (2001, p. 71) as follows:

1. Locating, within his or her own personal history, the problematic biographical experience to be studied.
2. Discovering how this problem, as a private trouble, is or is becoming a public issue that affects multiple lives, institutions, and social groups.
3. Locating the institutional formations or sites where persons with these troubles do things together (Becker, 1986).
4. Beginning to ask not why but how it is that these experiences occur.
5. Attempting to formulate the research question into a single statement.

These five steps guided research for the background and literature review presented in this study, which informed development of the main research question. The background to this study started with the first step in the first phase of the Denzin (2001) framework by reflecting on the researcher's professional history of 30 years working with educational technologies, in both design and marketing roles (Section 1.1). In each of these roles the researcher experienced the frustration of seeing high levels of teacher resistance to innovations in teaching practice coupled with uses of technologies limited to PowerPoint presentations and the routine posting of PDFs and assessment results into a mandated institution-wide LMS. This experience led the researcher to investigate the research literature, presented in Chapter 2, to ascertain the extent of this apparent resistance to innovation adoption in higher education teaching practice. Steps two and three in the first phase of the Denzin (2001) framework guided the revelation of a history spanning 20 years of failed attempts to introduce e-learning innovations in universities around the world, particularly where these innovations originated in teaching practice, even when there was evidence to support the effectiveness of the innovation (see Section 2.1). In Section 2.4.3, other themes from the literature emerged about the nature of universities as silo-based institutional systems in which the roles and relationships between university academic and professional staff were continually being impacted by the introduction of new technologies. The fourth step examined how causal factors identified from the research literature were interrelated. Conclusions in research literature suggested that mainstreaming innovation adoption was in fact a phenomenon of complexity rather than one of causality alone. In the research literature this complexity was described as presenting a wicked problem (Section 2.4.4) and required new ways of investigation that went beyond simply identifying causal factors. The fifth step led to the formulation of the primary research question in Section 2.5.3, as a single how question which asked: **How can universities build institutional capacity for mainstreaming e-learning innovations?**

From the primary question, six secondary questions were formulated (from ten *how* questions in Section 2.5.2) that defined the wicked problem. These questions led to the development of a new conceptual framework for an interpretive case-based modelling methodology (Section 3.4). The six secondary questions were derived from phases two to six of the Denzin (2001) framework, as described in Section 3.3.2.

4.2 Deconstructing and analysing the phenomenon

Applying the second phase of the Denzin (2001) interpretive research design, deconstruction and analysis of prior conceptions and questions was achieved through the investigation of previous studies of innovation adoption in higher education teaching practice (the *phenomenon* under investigation in this study) by:

1. Laying bare prior conceptions of the phenomenon, including how it has been defined, observed, and analysed.
2. Critically interpreting previous definitions, observations, and analyses of the phenomenon.
3. Critically examining the underlying theoretical model of human action implied and used in prior studies of the phenomenon.
4. Presenting the preconceptions and biases that surround existing understandings of the phenomenon.

In following these steps, the deconstruction and analysis phase of the study sought to answer the first two of the secondary questions that guided this study: **What are the critical success factors in the process of innovation adoption** and **who are the key actors as institutional stakeholders in innovation adoption?**

These questions guided deconstruction and analysis of research literature, exploration of key definitions, theories and frameworks about innovation adoption in organisations (Section 2.2) and selection and analysis of extant case studies and related reports as secondary data sources (Section 2.3). Examination of research methods found in an initial review of studies (listed in Appendix 3) revealed that case studies, surveys and combinations of both methods were the most common, with either single or multiple case studies dominating. The diffusion of innovations model (Rogers, 2003) appeared as a dominant explanatory model throughout these studies that segmented the role of key actors in the innovation adoption process.

Critical success factors in these previous studies, identified during the initial review of literature, were variously categorised (Appendix 3) as related to institutional, individual, cultural and functional roles within universities. E-learning innovations examined in these initial previous studies mostly focused on “top-down” rather than “bottom-up” adoption of e-learning innovation, with university-wide implementation of LMS representing the most common innovation. Only one major study (Gunn & Herrick, 2012), conducted using OLT funds (see 2.1.2), was found that specifically examined bottom-up adoption of e-learning innovations in higher education teaching practice in both Australian and New Zealand universities which is where this study was conducted.

Ten critical success factors and four groups of actors representing key stakeholders were identified as playing pivotal institutional roles in the process of innovation adoption. The identification of these roles was achieved using a constant comparative method (Lincoln & Guba, 1985) to derive key factors and actors from an analysis and interpretation of 22 studies identified in the research literature (listed in Table 2). *Quirkos* software (Turner, 2014) as described in Section 4.9, was used for thematic coding of identified studies. Each time a reference (quote) from a study was deemed as relevant to the study of e-learning adoption in higher education teaching practice, the new reference was compared to existing coded references to determine its suitability for inclusion or a new code was created. This process continued until all codes appeared saturated and no new code categories emerged (Plumb & Kautz, 2015). Some references were coded as matching more than one category.

Each of the studies was reviewed to identify both enabling and inhibiting barriers to innovation adoption, which were then matched with critical success factor categories. Factors from case studies continued to be compared until no new categories were generated.

Four key institutional actor categories (management, central support, innovators and adopters) emerged as representing three institutional levels within universities, labelled by Robertson (2008) as *macro*, *meso* and *micro*. The *macro* level was interpreted for the purposes of this study as representing university management, the *meso* level as representing university professional staff working in a range of central support services roles and the *micro* level as representing both innovators and adopters with front-line teaching roles.

The ten critical success factors were translated into actor roles distributed across the four institutional actor groups. These actor roles, which are discussed in more detail in Section 5.1.2 and Section 5.2.2, became:

- Leadership and vision
- Project funding
- Project management
- Central systems
- Experimentation
- Evidence of effectiveness
- Development of innovation
- Dissemination
- Readiness to adopt
- Sharing ideas and ownership.

These actor roles are depicted as labelled orange dots that were then distributed across the four quadrants representing the actors as shown in Figure 16. The allocation of roles to actors was made through a process of axial coding in developing the baseline model for conducting the study. Axial coding was conducted by reviewing the “contexts, conditions, interactions, and consequences” (Saldana, 2013, p. 261) of each critical success factor associated with each actor’s role in e-learning innovation adoption within a university setting. According to the definition provided by Saldana (2013), axial coding “describes a category’s properties (i.e., characteristics or attributes) and dimensions (the location of a property along a continuum or range) and explores how the categories and subcategories relate to each other” (p. 261). The baseline model together with a content guide, shown in Figure 16, became the MMM computer interface seen by participants during interviews for this study.

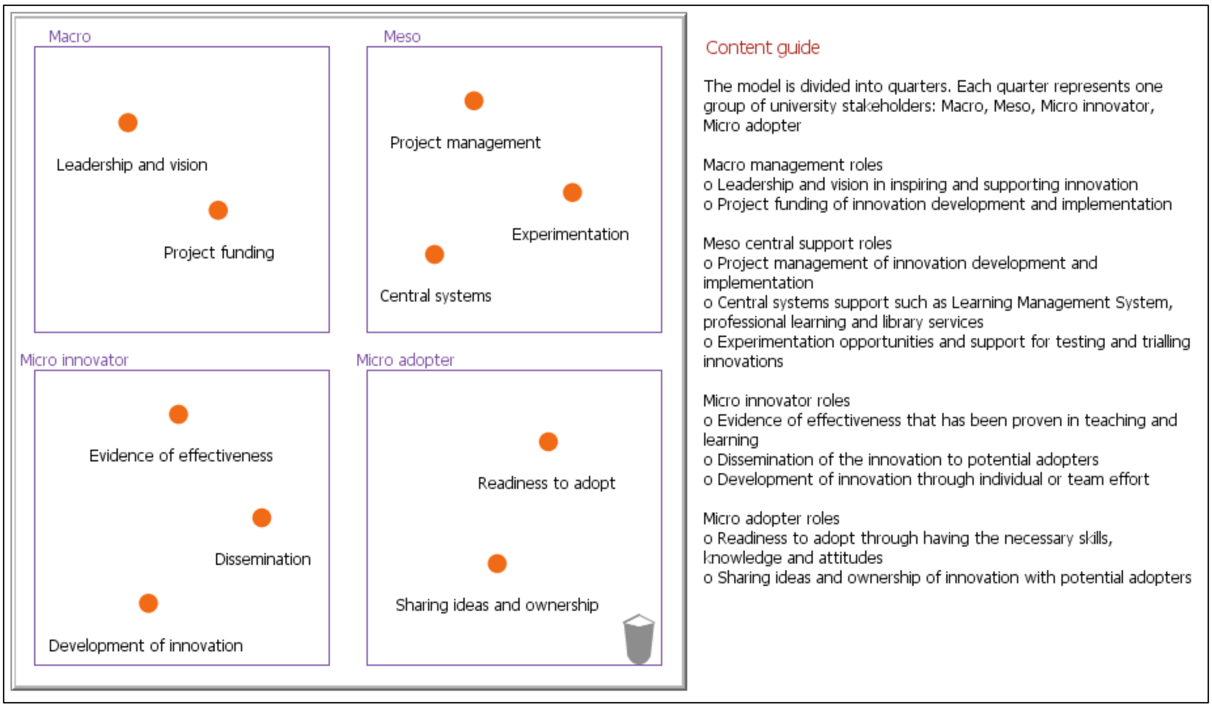


Figure 16. Baseline model and content guide provided in case-based modelling interviews.

The actor roles in the baseline model shown in Figure 16 also provided a coding frame for the analysis of the models and transcripts that were generated from the case-based modelling interviews with participants. These interviews were prepared, conducted and analysed during the following final three phases of the study.

4.3 Capturing the phenomenon

The third phase of the study sought to capture the phenomenon, including “locating and situating it in the natural world and obtaining multiple instances of it” (Denzin, 2001, p. 70). In this phase, interview questions and the selection criteria for participant recruitment were prepared, along with ethical considerations for capturing the complexity of innovation adoption in higher education teaching practice using human subjects. These preparations led to the recruitment of the participants and the development of processes for modelling and documenting their lived experiences and scenarios for the future.

The recruitment and documentation processes in this study were guided by the following three steps (Denzin, 2001, p.74):

1. Securing multiple cases and personal histories that embody the phenomenon in question.
2. Locating the crises and epiphanies of the lives of the persons being studied.
3. Obtaining multiple personal experience stories and self-stories from the subjects in question concerning the topic or topics under investigation.

These steps guided the recruitment of de-identified voluntary study participants from Australian and New Zealand universities as actor representatives who were willing to share their individual lived experiences in response to interview questions. Responses were used to address the third secondary question in this study: **What roles are played by the key actors in innovation adoption?**

4.3.1 Intended participants

The initial intention at the outset of the recruitment process was to recruit 20 to 24 volunteer participants from three Australian universities. This original recruitment target aimed at securing an even representative sample of participants from each of the four actor (stakeholder) groups: (1) university management; (2) central support services; academic teaching staff who had experience as an (3) innovator of an e-learning innovation and academic teaching staff who had experience as an (4) adopter of an e-learning innovation.

This target was amended to a total of 15 participants who represented two (central support and innovators) of the actor groups. Each participant was from either an Australian or a New Zealand higher education institution in which successful mainstreaming of adoption of a teacher-led e-learning innovation had occurred during the past three years. Where a New Zealand polytechnic provided equivalent higher education teaching to a university, it was included as an eligible institution for the purposes of this study. The decision to reduce the original number of participants as representatives of two groups rather than all four was informed by the outcomes of a pilot study that was conducted before recruitment of participants took place.

4.3.2 Pilot study

A pilot study was conducted with five participants from three Australian universities before the formal recruitment of participants for the study commenced. The pilot study tested the stages in the interview process and the use of recording and modelling software. The pilot study was recommended by a reviewer following the researcher's presentation of the proposal for this research. The pilot study predated ethics application and therefore the transcripts from the pilot were not reported in this thesis.

A key purpose of the pilot study was to ensure that interview questions were relevant to the main study and the modelling process in interviews could be conducted in a timely manner that considered the comfort and needs of participants. The aim was to conduct individual interviews within one hour, at a time and place that was private and convenient for each participant. Other purposes for conducting the small-scale pilot study included testing the suitability of:

- Descriptors used for actor roles represented in the MMM baseline model.
- Constructing cases from lived experiences, using a prototype MMM computer simulation, during interviews.
- Conducting, recording and transcribing both face-to-face and online interviews together with capturing the MMM simulations.
- Selection criteria for recruitment of participants.
- Process for recruitment and gaining permissions.
- Instructions to participants.
- Interview questions and prompts for eliciting responses from participants.
- Sequencing of stages for conducting each interview.
- Methods for analysing data from the study.

During the pilot study it became apparent that participants from either an innovator or central support role were able to demonstrate a sufficient knowledge of all organisational stakeholder actor roles and would know the full history of an e-learning innovation in their university.

4.3.3 Ethics approval

Ethics application to conduct this research was approved on 16 August 2016 by the Flinders University Social and Behavioural Research Ethics Committee (Project number 7326). The application was submitted following the pilot study.

4.3.4 Participant recruitment

Following ethics approval for this study, open calls for participants were made. Recruitment selection criteria included the need for participants in the study to have had direct recent experience, defined as occurring within the previous three years, during which an e-learning innovation had originated and been adopted in higher education teaching practice within the participant’s institution.

Recruitment of participants was conducted with the support of two peak e-learning professional associations in Australia and New Zealand: ASCILITE, the Australasian Society for Computers in Learning in Tertiary Education and ACODE, the Australasian Council on Open, Distance and e-learning. Invitations calling for participants were posted online by ASCILITE and ACODE. Recruitment also occurred through a poster presentation by the researcher at the ASCILITE conference in November 2016 and through a presentation by the researcher at the THETA 2017 conference in May 2017, which was jointly hosted by ACODE and CAUDIT, the Council of Australian University Directors of Information Technology.

An application form was provided for all interested participants to complete and submit (either online or in person) at each of the two conferences (ASCILITE 2016 and THETA 2017), in which they could self-identify as meeting the eligibility criteria for the study. The first page of the application form (Appendix 5) allowed participants to self-identify as being from one of the four actor groups in the study and outlined the conditions under which the study would be conducted.

4.3.5 Respondents

There were 15 eligible respondents, all of whom identified as either innovators or as providing central support. No respondents identified themselves specifically as either managers or adopters. Four of the 15 respondents were working at the time of the study in New Zealand universities or polytechnics with the remaining 11 from Australian universities in four different states/territories. As noted in Section 1.2, no students were targeted for the study as the focus of the research was on the lived experiences of higher education staff and how these experiences could inform the development of institutional capacity building for mainstreaming the adoption of e-learning innovations that originated in higher education teaching practice.

The recruitment of these respondents met the Gunn and Herrick (2012) recommendation for inclusion of representatives of IT departments in future studies. Of the 15 respondents, 10 identified themselves as working in e-learning support roles that included a focus on the provision of IT services and five identified as innovators with a role in teaching in their university. Two respondents also identified as having held dual management/support roles during the development and adoption of the e-learning innovation.

The total of 15 respondents was considered a valid sample for conducting the study, based on the advice of Yin (2014) who recommended that a study “with many cases - for example 15 to 20 or more - makes additional analytic strategies possible” (p. 174). Each of the 15 respondents was sufficiently familiar with the roles within all four actor groups to be able to provide rich descriptions of how the adoption of an e-learning innovation had evolved in their own institution. As a result, further recruitment of participants was considered unnecessary as the respondents also represented a diverse cross-section of locations.

4.3.6 Interviews

All 15 interviews for the study were conducted between 7 June and 1 August 2017 with the duration of each interview lasting one hour on average.

To ensure congruity across the study, each of the participants in the study was asked the same set of interview questions to guide them in sharing a personal story of their involvement in the development of an e-learning innovation and its adoption by others in teaching practice.

Each interview started by asking individual participants to describe, in their own words, the features and benefits of the e-learning innovation they wanted to share with the researcher together with its history of development and adoption. The baseline model for the MMM computer simulation (Figure 16) was displayed on a computer screen throughout each interview as it was conducted and recorded. Recordings were made directly from the computer screen using *Camtasia* video recording and editing software (see Section 4.9) to capture only the model images and audio. *Skype* (also see Section 4.9) was used for those interviews that could not be conducted face-to-face. An example of a complete edited transcript of an interview is provided in Appendix 4.

In the following *bracketing* phase, the interview continued as each participant's experience of innovation adoption was applied to populating the models in the MMM computer simulation and in eliciting actionable insights throughout this process. In this way, each MMM model provided "a specific structure of interrelated factors hypothesised to be tested" (Dix, 2007, p. 116), drawn from an analysis of secondary case study data in the previous phase (Section 4.2), as distinct from this third phase of the Denzin (2001) framework which captured participants' case studies as primary data.

4.4 Bracketing the phenomenon

Denzin (2001) described the fourth phase of his interpretive research design framework as moving "from part to whole and from whole to part" (p. 77) by "bracketing the phenomenon, or reducing it to its essential elements and cutting it loose from the natural world so that its essential structures and features may be uncovered" (Denzin, 2001, p. 70). While the cases of lived experiences of participants obtained in the previous *capturing* phase reflected a description from *the natural world*, the application of each case in populating the MMM computer simulation *in situ* during an interview, allowed the Denzin (2001) process of "cutting it loose" (p. 70) to reveal the interactions between institutional roles within each case.

In this fourth phase of the study, the bracketing of the *essential elements* in innovation adoption started by locating and connecting in the baseline model (Figure 16) the enabling and inhibiting relationships between the ten actor roles and applying indicators where roles had a particular level of influence, based on each lived or *real* case. The bracketing process then continued by first running the *real* model and then generating a model of an *ideal* scenario, from changes suggested by the participant to the *real* model.

The modelling process, together with the elicitation of participant insights throughout this process, was guided by the following steps in the fourth phase of the interpretive research design process (Denzin, 2001, p. 76):

1. Locating within the personal experience story or self-story key phrases and statements that speak directly to the phenomenon in question.
2. Interpreting the meanings of these phrases, as an informed reader.
3. Obtaining the subjects interpretations of these phrases, if possible.
4. Inspecting these meanings for what they reveal about the essential, recurring features of the phenomenon being studied.
5. Offering a tentative statement about or definition of the phenomenon in terms of the essential recurring features identified in Step 4.

The above five steps revealed answers to the fourth secondary research question in this study which asked: **How do the roles of key actors interact in real and ideal institutional settings?**

Answers to this question were prompted by the researcher who asked each participant the following questions:

- What were the enabling relationships between university roles in your experience of innovation adoption?
- What were the inhibiting relationships in this experience?
- Which roles were the most influential?
- How does running this model reflect your experience?
- What adjustments would you make to create an ideal model of sustainable adoption of an e-learning innovation?
- How does running this ideal model reflect your expectations about ideal relationships for sustaining the adoption of e-learning innovations?

The researcher's own role became embedded along with each participant's role during this bracketing phase. Under the direction of the participant, the researcher applied enabling and inhibiting links and levels of influence to connect the actor roles depicted in the model and then ran the simulation, once participants were satisfied that they had fully described their respective experiences. The above list of interview prompts provided by the researcher gave opportunities for each participant to inspect the results of the simulation each time a model was run to reveal both *real* cases and *ideal* scenarios. A live narration by the researcher of a four-minute video provided to each participant before the commencement of the bracketing phase, demonstrated how the prompts would be used in applying participant cases and scenarios to the MMM simulation. (A link to this video is available at http://hdl.handle.net/2328/37345 together with links to a THETA 2017 conference paper and a narrated slide presentation by the researcher from the conference.) The interviews concluded by seeking participant's responses about how they felt after the case-based modelling process.

Edited transcriptions of the interviews removed the researcher's questions. Transcriptions were made using the researcher's private password protected *YouTube* channel using the live caption feature (see Section 4.9). The content was saved from Camtasia recordings using the password protected *Private* setting to ensure anonymity of the participants and their data. Transcriptions of all edited de-identified recordings are available on request. A sample of a complete de-identified interview transcript (referred to previously in Section 4.3.6) for participant *Meso 3* is provided in Appendix 4. A total of 45,000 words were transcribed by the researcher from these interviews.

Selections from each transcript are reported in Chapter 5 of this thesis, along with visualisations generated through the modelling process in this fourth phase of the study. The next two phases of the study examined the construction (in the fifth phase) and context (in the sixth phase) in respectively analysing findings and discussing insights from the *real* and *ideal* model visualisations.

4.5 Constructing the phenomenon

In the fifth phase of the study, an analysis of the findings from participant insights and model data was conducted. This analysis was aimed at "constructing the phenomenon, or putting the phenomenon back together in terms of its essential parts, pieces, and structures" (Denzin, 2001, p. 70). In this phase, quantitative comparisons between numerical values in models of *real* and *ideal* scenarios were possible, resulting from the impact of connecting the enablers, inhibitors and influences of the roles in the models. These numerical comparisons were augmented by themes generated from a qualitative analysis of interview transcripts of the case-modelling process.

The analysis of both quantitative and qualitative data was guided by the following the four steps in the fifth phase of the interpretive research design process (Denzin, 2001, p. 78):

1. Listing the bracketed elements of the phenomenon.
2. Ordering these elements as they occur within the process or experience.
3. Indicating how each element affects and is related to every other element in the process being studied.
4. Stating concisely how the structures and parts of the phenomenon cohere into a totality.

Analysis of data generated by the study sought to answer the fifth secondary research question in this study: **What are the impacts of the interactions between institutional roles in innovation adoption?**

The first step in answering this question exposed the numerical value of roles in the models through manipulation of the MMM code. Bar graphs using *Excel* (see Section 4.9) were then prepared from this numerical data to compare the level of impact of interactions and influences on each role in the *real* cases with the same roles in the *ideal* scenarios (see Figure 23). The next step compared all *real* cases with each other and similarly all the *ideal* scenarios to identify trends in frequency of enabling and inhibiting links, two-way enabling links and influences (see Table 27). Themes generated from an analysis of the interview transcripts were interpreted by the researcher and matched to trends in the numerical data with a view to seeking out convergent patterns in the relationships between actor roles in the cases and scenarios. The results of modelling are summarised in Section 5.2.5. Quantitative and qualitative analysis of the findings from the participant interviews led into the final discussion phase in the research design process.

4.6 Contextualizing the phenomenon

In this last phase of the study, the findings in the previous phase informed the process of "contextualizing the phenomenon, or relocating the phenomenon back in the natural social world" (Denzin, 2001, p. 70) that formed the discussion and conclusions in this thesis. This phase re-located the findings from the study within the context of the main research question which sought to examine how institutional capacity building by universities for mainstreaming the adoption of e-learning innovations could be achieved. In this final phase the findings from the lived *real* experiences described by participants through conducting the case-based modelling interviews, were re-examined and compared with the *ideal* scenarios and recommendations for university policies and practices that had been explored through modelling and were identified in the research literature.

The review process that informed the discussion of findings was guided by the following four steps in the sixth phase of interpretive research design process (Denzin, 2001, p. 79):

1. Obtaining and presenting personal experience stories and self-stories that embody, in full detail, the essential features of the phenomenon as constituted in the bracketing and construction phases of interpretation.
2. Presenting contrasting stories that will illuminate variations on the stages and forms of the process.
3. Indicating how lived experiences alter and shape the essential features of the process.
4. Comparing and synthesizing the main themes of these stories so that their differences may be brought together into a reformulated statement of the process.

The comparison of *real* cases and *ideal* scenarios along with the actionable insights elicited from participants through modelling, within the context of university policies and practices, addressed the final secondary research questions in this study: **What implications arise from the impact of institutional role interactions in innovation adoption?**

Re-examination of findings in this phase demonstrated that interpretive case-based modelling was able to reveal new and actionable insights about building institutional capacity for supporting both the development of and mainstreaming the adoption of e-learning innovations that originated in higher education teaching practice. Conclusions in this phase from the discussion of findings about the impact of institutional stakeholder relationships suggested some important implications for overcoming barriers to mainstreaming innovation adoption of e-learning innovations in higher education teaching practice, while the process of modelling these relationships *in situ* during interviews gave evidence of the effectiveness of applying Interpretive Case-Based Modelling as a new methodology in research studies. These conclusions are presented in detail in Chapter 6 of this thesis. Table 9 summarises the relationships between the phases of the research design, the research questions and outcomes of the study.

Table 9. Research design phases, research questions and summary of outcomes

Research design	Research questions	Summary of outcomes
Phase 1: Framing the research question	How can universities build institutional capacity for mainstreaming the adoption of e-learning innovations?	Background and literature review > research questions
Phase 2: Deconstructing and analysing the phenomenon	What are the critical success factors in the process of innovation adoption? Who are the key actors as institutional stakeholders in innovation adoption?	Analysis of extant case studies (as secondary data source) > development of baseline model
Phase 3: Capturing the phenomenon	What roles are played by the key actors in innovation adoption?	Interview questions, ethics approval, recruitment of participants > case studies (as primary data source)
Phase 4: Bracketing the phenomenon	How do the roles of key actors interact in *real* and *ideal* institutional settings?	Case-based modelling interviews > MMM models and interview transcripts
Phase 5: Constructing the phenomenon	What are the impacts of the interactions between institutional roles in innovation adoption?	Real versus ideal > analysis of findings
Phase 6: Contextualizing the phenomenon	What implications arise from the impact of institutional role interactions in innovation adoption?	Actionable insights > discussion > conclusions

The final section of this chapter discusses why ABM, “a third way of science” (Axelrod, 2007, p. 90), was selected for this study and how a derivative of ABM, the MMM software developed by Levin (2015), was adapted in conducting the study.

4.7 Agent Based Modelling (ABM)

If you grow the phenomena, you'll understand how it works. (Epstein, 1999, p. 47)

Epstein (1999) described ABM as a generative experimental social science that attempted to "situate an initial population of autonomous heterogeneous agents in a relevant spatial environment; allow them to interact according to simple local rules, and thereby generate — or ‘grow’ — the macroscopic regularity from the bottom up" (p. 47). ABM is also described as both a methodology and a tool (Wilensky & Rand, 2015) that uses computer simulations for visualising patterns of non-linear dynamic behaviours that occur when individual elements or actors, known as *agents*, interact with one another in a complex system. In a systematic review that examined ABM use in studies of higher education, Gu and Blackmore (2015) found only one study that reported the use of ABM “to study a university as an independent ‘organisational’ system” (p. 888).

This section is divided into following subsections to describe ABM, including its application in DoI studies:

- Brief history of ABM
- Features and benefits of ABM as a methodology
- ABM as a set of tools
- *NetLogo* software

This section is then followed by a description of the Multi-Mediator Modelling (MMM) tool (as an application of ABM) in Section 4.8 and the chapter concludes with a summary of all software tools used in this study (Section 4.9).

4.7.1 History of ABM

During the past 50 years there has been a gradual incursion of ABM into social science research (Axelrod, 2007; Kiesling et al., 2012). It is only since the 1990s that ABM, as a visualisation method in social research, has become more accessible as a tool for researchers. This has been made possible through a greater availability of free and increasingly more user-friendly code and programming tools for modelling computer environments, such as *NetLogo* (Wilensky & Rand, 2015). Access to a free, simple-to-use ABM-derived MMM computer simulation tool (Levin, 2015) made it possible for interview participants in this study to visualise patterns of interactions between institutional actors in the complex organisational system of a university.

During the modelling stage of this study, the exploration and interpretation of patterns of interaction and their impacts when running the MMM computer simulation, generated actionable insights for informing institutional capacity building for innovation adoption in higher education teaching practice. The analyses of these results are presented throughout the findings in Chapter 5.

According to Wilensky and Rand (2015), the powerful visualisation and exploration capabilities of ABM established it as “both a primary methodology and a set of tools” (p. 445) for conducting research about complex systems. As a methodology, ABM enables the forming of an understanding of organisational complexity. As a set of tools that uses computer language applied through simple rules, ABM enables visualisation and exploration of complex systems, such as those found within the organisational context of universities. Kiesling et al. (2012) noted that “agent-based methods have been applied in this [organisational] context both as intuition aids that facilitate theory-building and as tools to analyze real world scenarios, support management decisions and obtain policy recommendations" (p. 1). Tubaro and Casilli (2010) described ABM as providing "a blossoming field of transdisciplinary research" (p. 61) with contributions from “social scientists but also psychologists, computer scientists, biologists, evolutionary theorists, and physicists” (Tubaro & Casilli, 2010, p. 72).

While early conceptions of ABM were traced back to the 1940s, Axelrod (2007) and Wilensky and Rand (2015) considered ABM to be “still quite young” (Wilensky & Rand, 2015, p. 445) as a tool in social research. Thomas Schelling was credited with developing the first agent-based social simulation models in 1971 (Wilensky & Rand, 2015).

4.7.2 Features and benefits of ABM as a methodology

ABM has been found to be well-suited for studies of the diffusion of innovations in complex systems (Bonabeau, 2002; Macy & Willer, 2002; Kiesling, Günther, Stummer & Wakolbinger, 2012). Previous studies concluded that ABM was useful for studies of the “diffusion of innovation and adoption dynamic” (Bonabeau, 2002, p. 7281) particularly “when the topology of the interactions is heterogeneous and complex” (p. 7287). Macy and Willer (2002) noted that ABM provided “theoretical leverage” (p. 143) for a “shift from factors to actors” (p. 163). Tubaro and Casilli (2010) similarly described ABM as providing “an epistemological posture sometimes illustrated by the catchy slogan 'from factors to actors'” (p. 61).

In this study, the critical success factors found in previous case studies of e-learning innovation adoption were applied to modelling the interaction of institutional stakeholders who represented the actors in university innovation adoption. This modelling of interactions represents a shift in epistemological posture from the Cartesian “linear rationality of cause and effect” (cited in Boomer, 1992, p. 283) to viewing innovation adoption as non-linear, dynamic and complex. Kiesling et al. (2012) concluded that, by enabling a shift in thinking from causality to complexity, “ABMs have advanced the understanding of innovation diffusion and yielded theoretical insights” (p. 43). ABM also addresses shortcomings of alternative models used in DoI studies, such as the system dynamics DoI Bass model discussed in Section 2.2.4. Bass models, such as the example shown in Figure 7, were based on aggregates depicted as feedback loops rather than interactions between non-linear and dynamic real-world behaviours and, therefore, Kiesling et al. (2012) argued “do not reproduce the complexity of real-world diffusion patterns” (p. 6).

Both Smaldino et al. (2015) and Wilensky and Rand (2015) demonstrated that ABM was particularly beneficial in studies of complex systems when the agents in a model were heterogeneous and thus triggered different rather than similar patterns of behaviour in their interactions. A key benefit of ABM demonstrated in this study was that it allowed the formation of an understanding of the complex unique patterns of interaction between institutional stakeholders’ heterogeneous roles in e-learning innovation adoption. The different roles played by the four groups (population segments) of institutional stakeholders, as depicted in Figure 17, represent a translation of factors and actors into the heterogeneous agents in innovation adoption modelled in this study.

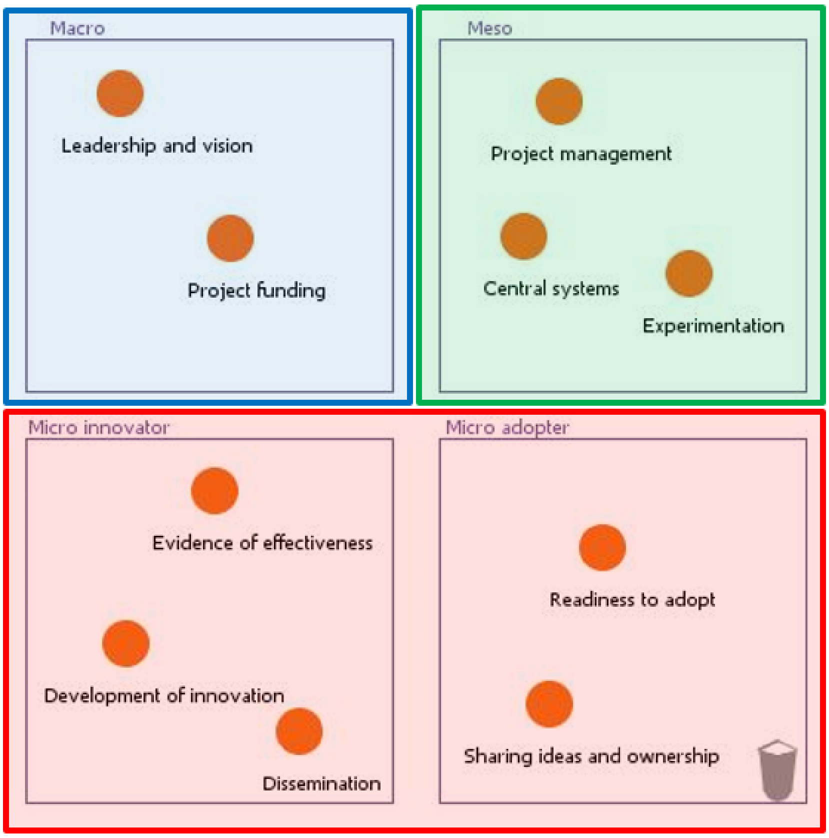


Figure 17. Segmentation of institutional stakeholder roles within a university as factors and actors in mainstreaming e-learning innovation adoption.

In Figure 17 each agent in the modelling process represents a unique role associated with a unique stakeholder group involved in the adoption of an e-learning innovation within a university. For example, *sharing of ideas and ownership* and *readiness to adopt* are associated with the stakeholder group of *micro adopters*, depicted in the lower right quadrant of Figure 17.

Wilensky and Rand (2015) claimed that having agents in a model that represent heterogeneity of roles would lead to “a more concise description of a complex system” (p. 35) than previously possible through case studies, surveys or alternative modelling methods. The use of an alternative method, such as system dynamics modelling, would have limited the study to the aggregation of homogeneous agents that would have grouped university stakeholders into *macro*, *meso* and *micro* institutional levels (Robertson, 2008) or innovators, early adopters, early majority, late majority and laggards (Rogers, 2003), but without identifying and examining the interactions between the unique roles across each of these groups during the diffusion of innovations. Kiesling et al. (2012) questioned the explanatory power of the widely cited Bass system dynamics aggregate diffusion model (Section 2.2.4) as failing to “truly reflect the underlying diffusion mechanisms" (p. 6) of DoI and as "not designed for *what-if* type questions" (Kiesling et al., 2012, p. 2) essential in eliciting an exploration of models. Lichtenstein et al. (2006) similarly highlighted the need to ask *what might be* questions that explored beyond “what has transpired” (p. 6), concluding that “computational models are particularly useful in respect to research on organizational complexity, as real-world complex adaptive systems do not lend themselves to controlled experimentation” (Lichtenstein et al., 2006, p. 6). As a methodology, ABM makes it possible in studies of interactions within institutions to “explore the complex effects of explanatory variables in a systematic way (Lichtenstein et al., 2006, p. 6) and thereby reveal the mechanisms behind patterns in the diffusion of innovations.

The features of ABM, as both a methodology and a method in research, have been shown to demonstrate numerous benefits when applied in theory development. Macy and Willer (2002) noted in developing their typology of agent-based models that ABMs "show how simple and predictable local interactions can generate familiar but enigmatic global patterns" (p. 143). This ability to generate and explore intriguing patterns of interactions led Smaldino, Calanchini and Pickett (2015) to describe ABM as a prosthesis for the imagination that created “the potential for unexpected outcomes to arise” (p. 305) and thus increased the “power to develop theory" (Smaldino et al., 2015, p. 311). Macy and Willer (2002) described ABM as providing “theoretical leverage where the global patterns of interest are more than the aggregation of individual attributes” (p. 143). This attribute of ABMs was captured by the meme “a whole which is more than the sum of its parts” (Tubaro & Casilli, 2010, p. 61), a sentiment articulated in the aims and scope of this study (Section 1.2). In declaring an institutionalist perspective, Gräbner (2016) depicted agent-based computational modelling as "holistic, systemic and evolutionary" (p. 1). Seeking a description that straddled both imagination and pattern making, Gräbner (2016) concluded that ABM provided "the golden middle" (p. 13) between description and analysis in research.

In heralding the wider adoption of ABM in research, Axelrod (1997) suggested that, as a methodology, ABM provided “a third way of doing science” (p. 21) that could extend the traditional inductive and deductive, qualitative and quantitative methods that continued to dominate scientific research, social research and theory building. Levin and Jacobson (2017) argued that the “properties of educational systems align with general complex systems conceptual perspectives” (p. 2) and were amongst the first to propose ABM as “a methodological complement to quantitative and qualitative approaches in educational research" (Levin & Jacobson, 2017, p. 3). Levin and Datnow (2012) suggested that "models may be useful for … seeking to draw themes out of qualitative case studies of educational change" (p. 199) and, in their own ground-breaking research, applied data from case studies in developing and applying MMM, derived from ABM, to demonstrate how case studies could inform the development of dynamic models of complex interactions in change processes.

In summing up the features and benefits of ABM, Smaldino et al. (2015) concluded:

> ABMs are explicitly multi-dimensional and can efficiently and simultaneously model dynamics at multiple levels of organization while incorporating feedback processes and system memory. ABMs are therefore especially well-suited to study complex systems whose dynamics are inherently dependent on heterogeneous actors and organizational structure.
> (Smaldino et al., 2015, p. 304)

4.7.3 ABM as a set of tools

Macy and Willer (2002) described ABM, when viewed as a set of tools, as providing a method for applying data using elements in computer models through an iterative, step-by step and transparent process for conducting "virtual experiments" (p. 145). In ABM, elements in a model are "represented via the computer code" (Gräbner, 2016, p. 14). Gräbner (2016) explained that the programming language used in ABM computer models made it possible to "understand how individual actions lead to patterns, how these patterns in turn shape individual behaviour and what dynamics result from this interplay on the level of the societal system as a whole" (p. 3). Results from running simulations of *real* cases and *ideal* scenarios in this study were achieved through applying a logical structure, proposed by Stacey (2011), and simple rules in "computational algorithms to precisely specify the elements of a system, the relationships between those elements, and the subsequent dynamics of the states of and relationships among those elements" (Smaldino et al., 2015, p. 301).

In this study, an algorithm applied through computer code specified and controlled the behaviour of key stakeholder roles as the agents in the model; the enabling and inhibiting interactions between the roles; levels of influence on specific roles; and the resulting impact of simultaneous interactions and influences, when running the model simulation. ABM algorithms are created using a computer programming language paradigm known as Object Oriented Programming (OOP). Gräbner (2016) explained: "the idea behind OOP is to build programs by defining objects corresponding to some entity in the real world, and methods on these objects corresponding to processes in the real world" (p. 15). Objects defined in ABM are designed to "move and change on screen in real time" (Smaldino et al., 2015, p. 305) making it possible in this study to run simulations *in situ* during interviews with participants.

Wilensky and Rand (2015) noted the ease of use of ABM as a tool in stating:

> Because agent-based models describe individuals, not aggregates, the relationship between agent-based modeling and the real world is more closely matched. It is therefore much easier to explain what a model is doing to someone who does not have training in the particular modelling paradigm. This is beneficial because it means that no special training is required to understand an agent-based model. It can be understood by all of the stakeholders in a modelling process. (Wilensky & Rand, 2015, p. 33)

This ease of use was noted by participants in this study, who reported that the MMM tool (Section 4.8) that used NetLogo software, together with the process used in interviews (Section 4.3.6), provided an easy platform and enjoyable experience (Section 5.2.6).

4.7.4 *NetLogo* software

The *NetLogo* software code used in this study was developed in the 1990s by Uri Wilensky at Northwestern University (Wilensky, 1999) and has continued to be supported as a free (no cost) and open source (modifiable) software. Feller, Fitzgerald, Hissam and Lakhani (2005) defined *free* and *open source* as follows:

> The terms “free software” and “open source software” refer to software products distributed under terms that allow users to: use the software; modify the software; redistribute the software, in any manner they see fit, without requiring that they pay the author(s) of the software a royalty or fee. (Feller, et al., 2005, p. xvii)

Levin and White (2013) described *NetLogo* as a "free, multi-platform, agent-based, model building environment" (p. 25). *NetLogo* is available from http://ccl.northwestern.edu/netlogo/ where it is described as a “dialect of the Logo language” (Wilensky, 1999). *NetLogo* uses syntax from the *Logo* programming language that was originally developed during the 1960s by Seymour Papert in collaboration with others at the Massachusetts Institute of Technology (MIT) Artificial Intelligence Laboratory (Wilensky & Rand, 2015). Wilensky and Rand (2015) noted that "the influence of Papert and Logo can be seen not only in NetLogo, but also in the way that many agent-based modeling platforms conceptualize agents as entities with their own properties and actions" (p. 440).

NetLogo version 6.0 was adapted using the MMM tool used for use this study. This version continues to be freely available, along with current and previous versions of *NetLogo*, at https://ccl.northwestern.edu/netlogo/6.0.0/.

Wilensky described *NetLogo*, as a set of tools and modelling environment for developing ABM “specifically designed to be accessible to non-programmers” (as cited in Smaldino et al., 2015, p. 312). This ease of use was confirmed when making necessary modifications in the *NetLogo* software code used in the application of MMM for this study.

Use of open source code enables that code and the underlying assumptions made by researchers to be transparent and visible to anyone (Gräbner, 2016). As, in agent-based models, every assumption made by a researcher is represented in the code. Publishing code (or making it available) enables checking of results and replication of studies, meaning “the very process of deduction becomes itself subject for public assessment" (Gräbner, 2016, p. 14). Code used in constructing models for this study is available on request and, after publication of this thesis, will be made freely accessible through the Flinders Academy Commons https://dspace.flinders.edu.au/xmlui/.

The development of MMM and modifications applied in this study are described in the next and final section of this chapter.

4.8 Multi-Mediator Modelling (MMM) tool

The choice of MMM as an ABM tool for this study followed advice from Smaldino et al. (2015) to "seek out published models that [sic] illustrate how other researchers have applied ABMs" (Smaldino et al., 2015, p. 311). The search for an ABM simulation modelling tool for this study led to a published collection of agent-based multi-mediator models developed with *NetLogo* by James Levin at the University of California San Diego (UCSD) Department of Education Studies and available at http://mmm.ucsd.edu/mmm.html. The models had been developed and tested over several years in a variety of education settings (Levin & Datnow, 2012; Halter & Levin, 2013; Levin, 2015; Levin & Ching, 2016; Levin & Jacobson, 2016; White & Levin, 2016).

4.8.1 Definition and development of MMM

The term *multi mediator* derives from a statistical process known as *mediation*. In Multi-Mediator Modelling (MMM), the process of mediation:

> Allows positive and negative actions by one concept on another, but it also allows for interaction between two concepts (mutual actions), and for mediation among three or more concepts, as represented by a network of positive and negative directed connections among a set of concepts. In addition, a concept can be impacted by context (everything outside the domain that is being modelled), and part of the model is specified by the levels of activity of each concept that is supported by its context. All of these impacts occur in parallel, and so activity levels flow throughout a given model, based on the connections among the concepts and the impact from context. (Levin & Ching, 2016, p. 13)

Levin and Datnow (2012) first applied a mediation process to modelling the impact of interactions between US school system stakeholders involved in the implementation of a data-driven decision-making initiative aimed at educational reform. The multi-mediator model, developed through the Levin and Datnow (2012) led collaboration, applied data in modelling from interviews, focus groups, document analysis and observation from one of twelve case studies reported in a large-scale study of school systems conducted between 2007 and 2008. The data from the selected case study was used to design, populate and run a hypothetical multi-mediator model. The purpose of this model was to visualise the impact of actions of four education system-level groups of stakeholders in the case study. This was achieved by connecting positive and negative interactions and the influence of external contexts on concepts that described the actions of the four stakeholder groups in the case study: school principals, teachers, students and district personnel. Figure 18 depicts a completed model from the Levin and Datnow (2012) study.

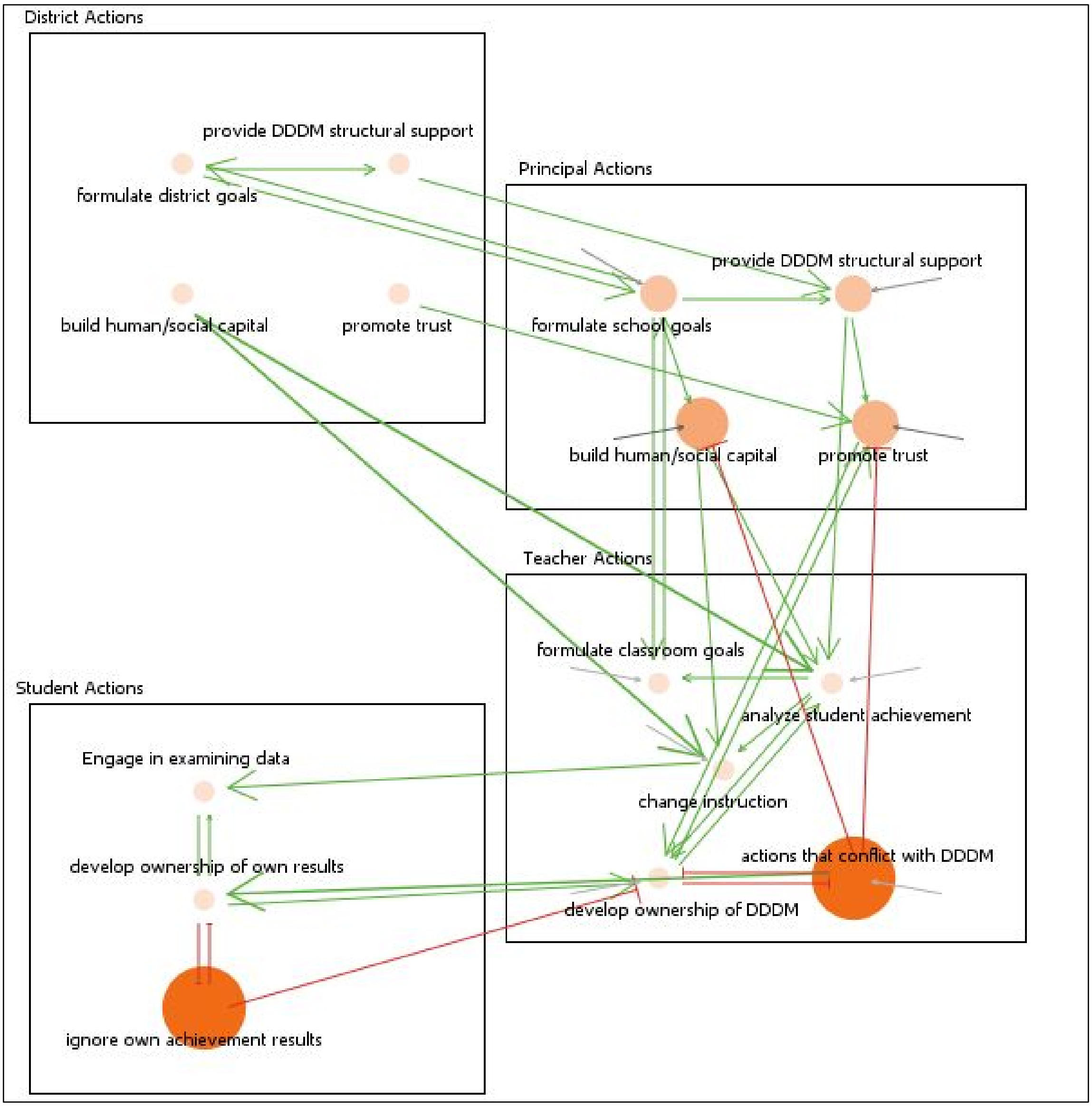


Figure 18. Example of a Multi-Mediator Model. Retrieved from Levin & Datnow, 2012.

Actions of stakeholders, described by Levin and Datnow (2012) as "concepts" (for example, *formulate school goals*, *promote trust*, etc), are shown in Figure 18 as labelled orange dots. These concepts all start with a zero value. When the model is run, the size of each concept (orange dot) either stays at zero (for example, *engage in examining data*) or increases up to a maximum of 100 (for example, *ignore own achievement results*) with results generated according to how each is connected to other concepts.

The value of each concept can also respond to connections from an *external* context (depicted in Figure 18 as a grey arrow but shown in later multi-mediator models, such as Figure 19, as a globe icon). Each *external* has a potential *input* value up to a maximum of 100 that is applied when attaching it to a concept. While *externals* have an *input* value, concepts have an *output* value that is revealed only when the model is run. This output value results from the association of a concept with positive (excite) and/or negative (inhibit) interaction or lack of interactions, with other concepts plus the added value of any externals (influences) attached to it and to other connected concepts.

In the model, green arrows indicate positive interactions and red barred lines depict negative interactions between and within the four groups of stakeholders.

Within the model algorithm, positive interactions provide an addition function while negative interactions provide a subtraction function. The functions and behavioural rules in the model algorithm that describe the "digital-code-based, interaction" (Stacey, 2011, p. 259) are provided through the *NetLogo* programming code. Figure 19 provides a visual representation of the functions of the MMM algorithm in this study.

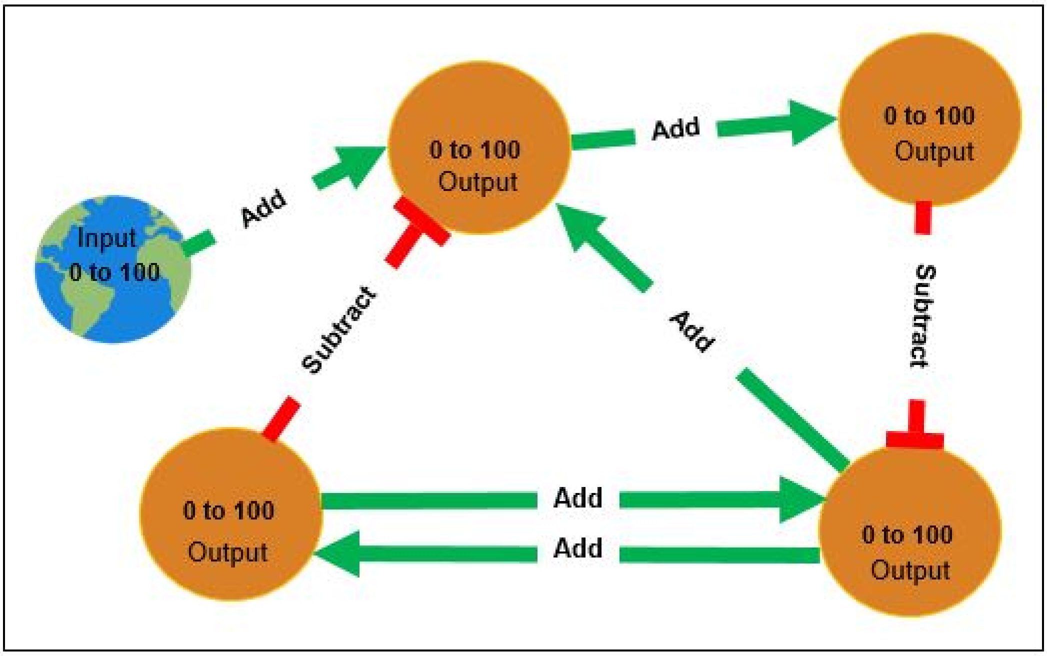


Figure 19. Visual representation of MMM algorithm.

In Figure 19 orange dots represent the roles of stakeholders in this study and have an output value of 0 to 100 when the model is run. A globe icon attached to a role represents the level of influence (*external* in Figure 18) that role has in innovation adoption and may have an input value of up to 100. The enabling green arrows provide an addition function and the inhibiting red barred lines a subtraction function.

In a *live* multi-mediator model:

> All the concepts are simultaneously active, and simultaneously have impacts on the concepts that they are connected to. A concept that has a zero activity level has no impact; a concept that is highly active has a substantial impact on the other concepts it is connected to, either raising or lowering their activity levels depending on the kind of connection.
> (Levin & Datnow, 2012, p. 192)

4.8.2 Adapting MMM for this study

In previous examples of case-based MMM, data was applied to creating models after the data had been collected. In this study models were populated directly from the lived experiences of participants during interviews by encoding these experiences through a collaborative, co-creation and exploration process that occurred between participant and researcher. To maximise this collaboration, the interactive modelling environment used in interviews needed to act as a graphic elicitation stimulus, a suggestion made by Crilly, Blackwell and Clarkson (2006), who noted the following advantages this visualisation process:

> Diagrams are effective instruments of thought and a valuable tool in conveying those thoughts to others. As such, they can be usefully employed as representations of a research domain and act as stimulus materials in interviews. This process of graphic elicitation may encourage contributions from interviewees that are difficult to obtain by other means.
> (Crilly et al., 2006, p. 3)

Modifications to the MMM tool made in preparation for this study were guided by the need to provide a user-friendly graphical interface that would encourage participant contributions. The model interface acted as an interactive graphic elicitation tool that enabled each participant to apply, visualise and explore a lived experience through creating models of both a *real* case and an *ideal* scenario. Applied during conversations between participant and researcher in the interview, this interpretive case-based modelling process provided an environment for eliciting actionable insights.

As each interview was scheduled for between 60 to 90 minutes, it was important that the model interface was user-friendly and provided quick, easy and simple processes and a common terminology for both the researcher and participant to utilise in populating each model iteration and eliciting insights. The user-friendly modelling process also needed to provide "a fully interactive modelling experience to non-expert modellers" (Fulton et al., 2015, p. 51). Non-expert modellers in this study included both the researcher and each of the participants and this, combined with the time limitation for interviews, required a minimum number of processes. Fulton et al. (2015) classified models that provided a minimum number of parameters for representing and interpreting interactions across a system as *shuttle* models. According to this classification:

> Shuttle models include the minimum number of processes required for a basic understanding of broader issues the project needs to address. Rather than going into deep detail on one aspect (e.g. fishing) it is a light touch across entire subsystems. Such models help to “shuttle” information from a simple to a fuller description of a problem. This is a journey necessary both for developers, during model definition and parameterisation, and for stakeholders in the interpretation of the final whole-of-system model results. (Fulton et al., 2015, p. 50)

The creation of the multi-mediator model interface for conducting this study followed a journey that had started with locating examples of models from the “Multi-Mediator Models of Learning” website http://mmm.ucsd.edu/mmm.html that could be modified for use as an interactive graphic elicitation tool in interviews. The original *NetLogo* interface editor had been adapted by Levin (2015) specifically to simplify it for “building and modifying multi-mediator models” (p. 6). After several iterations using this editor and testing during a pilot study a final interface was created, as shown in Figure 20.

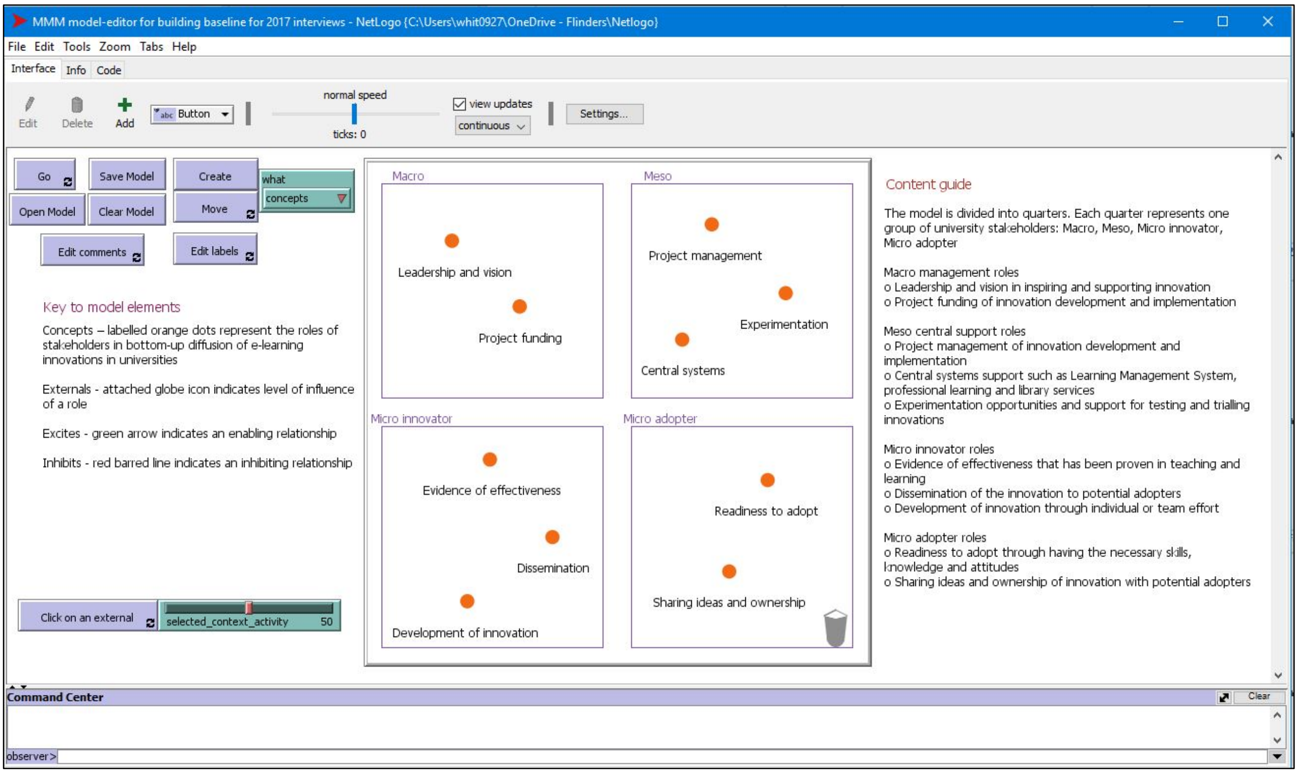


Figure 20. MMM baseline model computer interface. See Appendix 6 (Figure 27) for enlargement.

4.8.3 Use of MMM in this study

The interface shown in Figure 20 was visible to participants throughout the interview. A key to the model elements and a content guide were provided as part of the interface to aid participants in gaining familiarity with the modelling interface. The key to the model elements explained *concepts* as representing the roles of stakeholders in bottom-up diffusion of e-learning innovations in universities; *externals* as indicating level of influence of a role; *excites* as indicating an enabling relationship; and *inhibits* as indicating an inhibiting relationship between roles.

The content guide provided a more detailed description of the roles and explained how the model was divided in quadrants that represented the four groups of university stakeholders: *macro*, *meso*, *micro innovator, micro adopter* (see Section 1.2). *Macro* (management) roles were ascribed to *leadership and vision* in inspiring and supporting innovation and *project funding* of innovation development and implementation. *Meso* (central support) roles were ascribed to *project management* of innovation development and implementation; *central systems* support such as LMS administration, professional learning and library services; *experimentation* opportunities and support for testing and trialling innovations. *Micro innovator* roles were ascribed to providing *evidence of effectiveness* of the innovation in teaching and learning; *dissemination* of the innovation to potential adopters; *development of innovation* resulting from individual or team effort. *Micro adopter* roles were ascribed to *readiness to adopt* through having the necessary skills, knowledge and attitudes and *sharing ideas and ownershi*p of innovation with potential adopters.

Participants could request addition of other concepts to the models and ask for concepts to be moved into different stakeholder quadrants to reflect their story and to create their *ideal* model. Before the modelling process began, the researcher explained all elements (including content guide, layout and behaviours of the model) to each participant by narrating a four-minute video demonstration (available at http://hdl.handle.net/2328/37345) and checking for understanding throughout to ensure participants understood the steps in modelling their own individual case.

The steps in developing and populating the MMM interface during each interview were based on a sequence established by Levin and Datnow (2012) and applied by Levin and Ching (2016, p. 15):

1. Identify the most important elements in the domain being modelled. These become the concepts in the model.
2. Specify, based on the data, which of these elements have a positive impact on other elements and which have a negative impact. These are the directional links between the concepts.
3. Identify, based on the data, the impact that everything outside of the domain being modelled has on each concept in the model.

In this study, steps two and three (*application of positive and negative directional links* and *indicators of influence*) in populating the MMM interface occurred during the participant interview stage in the bracketing phase of the study (Phase 4) during which participants were asked to indicate:

- What were the enabling relationships between university roles?
- What were the inhibiting relationships?
- Which roles were the most influential?
- How does running this model reflect your experience?
- What adjustments would you make to create an ideal model?
- How does running this ideal model reflect your expectations?

4.9 Summary of software tools used in this study

A wide range of software tools were employed both separately and together throughout this study. Literature review sources for this study were collected and annotated in *Evernote*, a notetaking software package available from evernote.com. Qualitative analysis was conducted using *Quirkos* Qualitative Data Analysis Software (QDAS) available from quirkos.com. Creation of *Excel* spreadsheets was made available through Flinders University from microsoft.com, and used for basic quantitative analysis. *Scrivener*, an online writing creation and binder tool, available from literatureandlatte.com/scrivener/overview, was used throughout the study in preparing drafts of this thesis. Recording of interviews was conducted directly from the computer screen using *Camtasia* video recording and editing software available from https://www.techsmith.com/video-editor.html provided by Flinders University. *Skype*, available from skype.com, was used for interviews that could not be conducted face-to-face. Transcriptions of interviews were made by saving private password protected Camtasia recordings to the researcher's *YouTube* channel https://www.youtube.com/channel/UC69jInsnE5natirMk1MyvtQ and applying the live caption feature.

The application of COMPLEX-IT as a potential case-based modelling software (available at art-sciencefactory.com/complexit.html) was investigated but rejected for conducting an analysis of Multi-Mediator Models (MMM) in this study as it was considered to be not sufficiently advanced at the time for providing a reliable tool for analysing MMM results. COMPLEX-IT is a free open source modelling software which is an addition to the SACS Toolkit. In 2017, COMPLEX-IT was still in a beta version. At that time, the software appeared promising as it offered preparation of case-based datasets, clustering of cases, neural net mapping of the data, visualisation of results through data mining, the running of existing multi-agent models, creation of complex networks and construction of multiple accounts of case-based models. These functions offered to extend both the last step in the SACS Toolkit and the Denzin Interpretive Interactionism framework (see Table 8). Byrne and Ragin (2009) initially promoted the steps in the COMPLEX-IT procedure as extending consolidation and comparison through modelling of case-based data by following Charles Ragin's case comparative method. There were numerous examples of using the early beta versions of the COMPLEX-IT software and SACS Toolkit for case-based modelling in the health sciences (Castellani, Rajaram, Gunn & Griffiths, 2015). It appeared from the research literature that this method had not previously been applied in an educational institution setting or in investigations of innovation adoption in organisations. More recent versions of the COMPLEX-IT R-studio software App promise to allow "everyday users seamless access to such high-powered techniques as machine intelligence, neural nets, and agent-based modelling" (Castellani, Barbrook-Johnson & Schimpf, 2019, p. 415) by automating much of the input and analysis previously required for case-based modelling. For these reasons, the findings from this study reported in the next chapter were manually collated using *Quirkos* QDAS for qualitative thematic analysis of transcripts and *Excel* spreadsheets for basic quantitative analysis.

Until now, documentation of a method for applying MMM has been limited to the sequence of steps described by Levin and Ching (2016). The new Interpretive Case-based Modelling conceptual framework developed for this study, together with methods described in this chapter, bridge the former separation of data collection and modelling of previous studies, building on those previous studies to "extend prior research in new ways" (Levin & Datnow, 2012, p. 40) while also providing a method for documenting such studies. Denzin and Lincoln (2000) predicted that the emergence of new technologies would transform how research was conducted, citing an email received in 1998 from William G. Tierney, an American scholar of higher education, who wrote, "I keep getting this sense that the way we do qualitative research over the next generation will change incredibly because of technology" (p. 1039). In fulfilling this prediction, the methodology and methods used in this study have made it possible for innovation adoption itself to be examined through the adoption of technologies. Availability of MMM as a user-friendly ABM computer simulation tool, together with the affordances of *Skype* and *Camtasia* made it possible in this study to gather and record data for this study *in situ*. Ease in modification and use of the MMM tool for interviews enabled the researcher to conduct the study without a need for the high-level computer coding skills required in the past to develop and run ABM computer simulations. As the findings reported in the next chapter show, the use of MMM in this study demonstrates that "models may be useful for … seeking to draw themes out of qualitative case studies of educational change" (Levin & Datnow, 2012, p. 199).

A video recording by Flinders University in October 2019 of a presentation by the researcher to doctoral students and supervisors about an array of technologies used in this study is available at https://youtu.be/e_y7I81CBj4 which features Evernote, Quirkos, Skype, Camtasia and YouTube.

CHAPTER 5. FINDINGS

Results of deconstruction and analysis, capturing, bracketing and constructing the phenomenon. (Denzin, 2001)

The research questions and corresponding applications of four of the Denzin (2001) research design phases (described in parentheses) in obtaining findings for this study are as follows:

- What are the factors and who are the actors? (Phase 2: Deconstructing and analysing the phenomenon: development of baseline model)
- What roles are played by key actors in innovation adoption? (Phase 3: Capturing the phenomenon: quotes from participants' lived experiences)
- How roles of key actors interact in *real* and *ideal* institutional settings? (Phase 4: Bracketing the phenomenon: participant inputs that connect roles in the model)
- What are the impacts of interactions between institutional roles on innovation adoption? (Phase 5: Constructing the phenomenon: results from running and comparing models and participant insights)

The findings presented in Section 5.1 result from the deconstruction and analysis of secondary data sources, guided by the application of phase two in the Denzin (2001) research design. Findings from secondary data in 22 extant studies are presented from which actors and factors are drawn to provide the baseline model (Figure 16) used in conducting the study with 15 participants. In Section 5.2, the findings reflect phases three, four and five in the Denzin (2001) research design by capturing, bracketing and constructing the phenomenon of mainstreaming e-learning innovation adoption from primary data provided by the study participants. The final two sections of this chapter examine benefits of the interpretive case-based modelling method developed for and used in this study (Section 5.3) followed by suggestions for improvement (Section 5.4).

5.1 Deconstruction and analysis from secondary data

Deconstructing and analysing critically prior conceptions of the phenomenon. (Denzin, 2001, p. 70)

As described in Section 4.2, *Quirkos* (Turner, 2014) was used for thematic coding of secondary data sources provided by the 22 extant studies listed in Table 2 (Section 2.3). References that focussed on descriptions of actors and factors in e-learning innovation adoption from these studies were selected by the researcher to provide the secondary data which was then coded for analysis using the *Quirkos* software. A constant comparative method (Lincoln & Guba, 1985), described in Section 4.2, was applied in selecting references and applying an interpretation in deriving codes.

Quirkos provided a simple graphic interface for coding references as shown in Figure 21. In this figure, each reference source is shown highlighted in a different colour on the right, with a canvas area of the left containing corresponding colour-coded circles related to each reference. Codes are depicted as labels that overlay circles and represent themes. The size of each circle corresponds to the total number of references associated with each code, with each total also displayed within each circle.

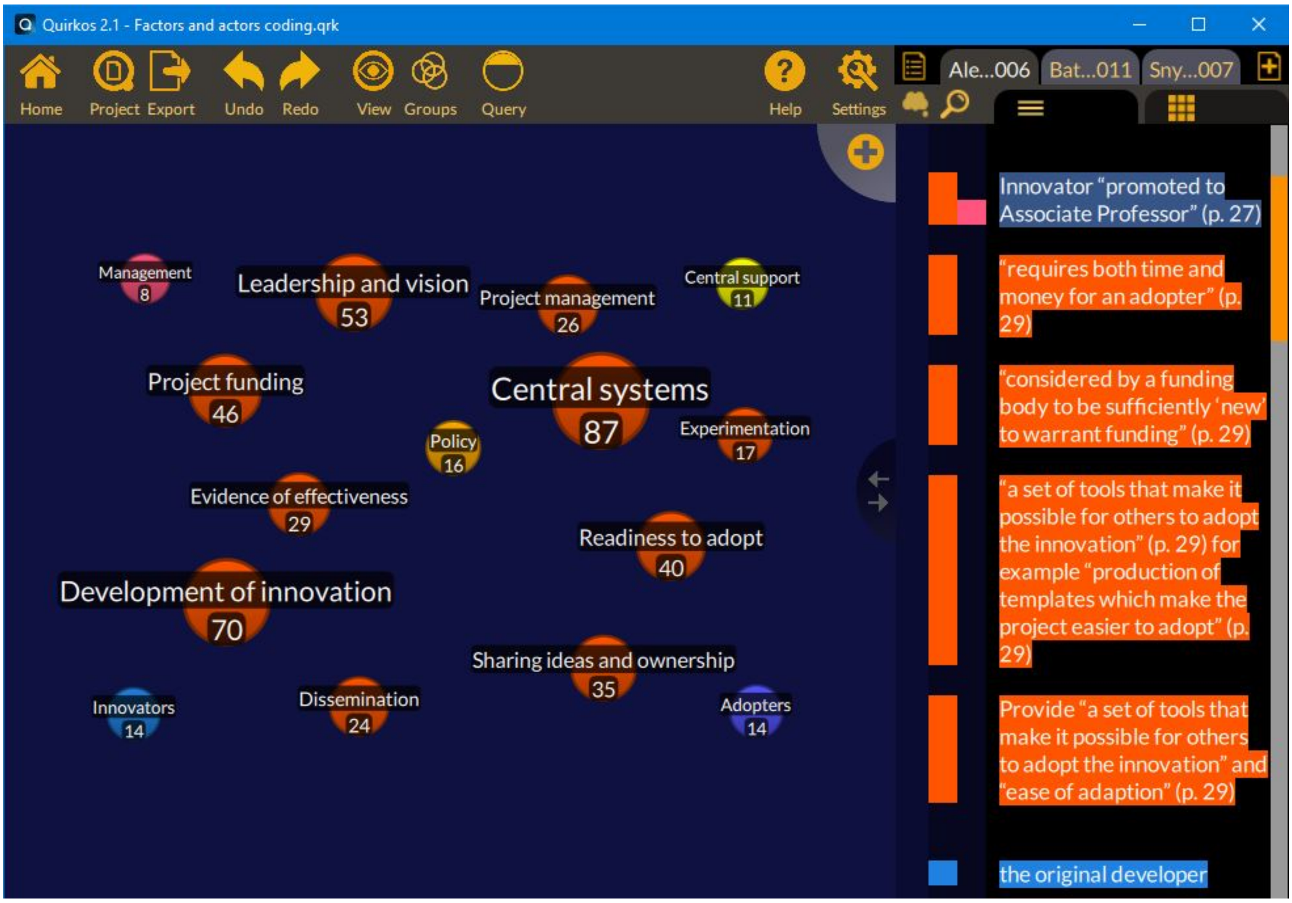


Figure 21. *Quirkos* interface for thematic coding of secondary data.

Orange circles in Figure 21 represent interpretations by the researcher of the critical success factors in e-learning adoption, as introduced in Section 4.2:

- Leadership and vision
- Project funding
- Project management
- Central systems
- Experimentation
- Evidence of effectiveness
- Development of innovation
- Dissemination
- Readiness to adopt
- Sharing ideas and ownership.

Differently-coloured circles located at each corner of the canvas area in Figure 21 represent the four groups of institutional actors identified as key e-learning innovation and adoption stakeholders within universities: management (*macro*), central support (*meso*), innovators (*micro*) and adopters (*micro*). The factors depicted by the orange circles were selected as having a specific association with at least one of these four actor groups.

The yellow circle in the centre, labelled *policy*, was included in coding as there were 16 references to various aspects of policy in the secondary data. Policy appeared to play an ambivalent pivotal role in e-learning adoption but was unable to be associated with any specific actor group from the available secondary data.

The results of the distribution of thematic coding are displayed in Table 10, with codes (factors followed by actors in italics) listed in column one, factors from column one matched against related actors in column two, descriptions of each code provided in column three and the total number of references for each code shown in column four.

Table 10. Distribution of thematic coding from secondary data sources.

All codes	Actors	Description	Coded references #
Evidence of effectiveness	*Innovators*	Factor in evaluation of teaching and learning	29
Readiness to adopt	*Adopters*	Factor in having the necessary skills, knowledge and attitudes	40
Project funding	*Management*	Factor in innovation development and implementation	46
Leadership and vision	*Management*	Factor in inspiring and supporting innovation	53
Central systems	*Central support*	Factor in support through Learning Management System, professional learning and library services	87
Project management	*Central support*	Factor in innovation development and implementation	26
Experimentation	*Central support*	Factor in opportunities and support for testing and trialling innovations	17
Development of innovation	*Innovators*	Factor achieved through individual and team effort	70
Sharing ideas and ownership	*Adopters*	Factor in sharing innovation with potential adopters	35
Dissemination	*Innovators*	Factor in sharing innovation with potential adopters	24
Policy		Central role in innovation adoption	16
Management		Actor group that represents *macro* level institutional stakeholders	8
Central support		Actor group that represents *meso* level institutional stakeholders	11
Innovators		Actor group that represents *micro* level institutional stakeholders	14
Adopters		Actor group that represents *micro* level institutional stakeholders	14
Total 15			**Total 490**

5.1.1 Factors in e-learning innovation adoption

The following themes relating to critical success factors in e-learning innovation adoption were identified:

- Evidence of effectiveness in teaching and learning.
- Readiness to adopt expressed through skills, knowledge and attitudes.
- Project funding for innovation development and implementation.
- Leadership and vision for driving and inspiring innovation.
- Central systems support through learning management system, professional learning and library services.
- Project management of innovation development and implementation.
- Experimentation opportunities and support for testing and trialling innovations.
- Development of innovation through individual and team effort.
- Sharing ideas and ownership of an innovation with potential adopters.
- Dissemination of innovations among potential adopters.
- Policy for guiding innovation adoption.

Of these eleven factors, six appear in Gunn (2014) – *sharing ideas and ownership*, *development of innovation*, *central systems support*, *project management*, *evidence of effectiveness* and *dissemination* – who noted:

> Innovators deserve recognition and reward for the valuable contribution they make to teaching and learning development and curriculum renewal. They also need to acknowledge the benefits of **sharing ideas** and working as far as possible with established **project development** processes and institutional systems if they wish to gain support. Systematic **software development**, **project management**, and robust **evaluation** processes may be anathema to their creative natures, but they are an important part of the processes for planning, **disseminating**, and ensuring long-term sustainability of innovative educational practices. **Shared ownership** of innovations supports greater flexibility and reduces risk, as well as promoting a higher degree of relevance to the professional practice of a larger number of faculty. (Gunn, 2014, p. 403)

The eleven themes identified in this study are examined in more detail in the following sections.

Evidence of effectiveness in teaching and learning

Anderson (2012) noted that providing strong evidence of the effectiveness of an e-learning innovation was necessary to overcome faculty suspicion and scepticism about potential impacts on their existing teaching, learning, administration workloads and academic autonomy. According to Alexander (2006), Dennison (2014), Gunn and Herrick (2012), and Pomerantz and Brooks (2017), evidence of effectiveness needed to demonstrate improvement in student learning outcomes as well as enhancement of teaching practice. A collection of evaluation data that demonstrated the quality of courses was also rated as important by Gunn and Herrick (2012) and Selwyn et al. (2016b) in motivating faculty adoption of e-learning innovations.

To demonstrate institutional rates of take-up of e-learning innovations, Salmon and Angood (2013) recommend the use of asset audits such as “IT and IS maturity models” (p. 923). Their recommendation contrasts with a lament by Gunn and Herrick (2012) about an absence of “common methodologies or uniform sets of data to present a coherent picture” (p. 16), a lament that mirrors concerns expressed by Pomerantz and Brooks (2017) about a lack in higher education of a comprehensive and robust set of criteria for basing an evaluation of quality e-learning. Both Gunn and Herrick (2012) and Pomerantz and Brooks (2017) proposed that types of data collection included rating the ease and effectiveness of the technologies used in e-learning. Gunn and Herrick (2012) added to this the need to demonstrate the originality of the teaching and learning innovation and how well the innovation integrates with the functions of a university’s LMS. Evidence gathering was seen as both assisting dissemination of an innovation and in building an institutional business case (Gunn & Herrick, 2012). Dissemination through publication of research evidence that also shared “insights into practices” (Selwyn et al., 2016b, p. 58) was considered by Pomerantz and Brooks (2017) to be underutilised in higher education. Overcoming this underutilisation was viewed as a priority for universities by Selwyn et al. (2016b) and Pomerantz and Brooks (2017), a position Salmon and Angood (2013) regarded as achievable across institutional groups of actors by engaging stakeholders in “joint research and development activities” (p. 922).

A difference of emphasis in the secondary data occurred between types of evidence needed for proving effectiveness of e-learning innovations that originate and are adopted *bottom-up* (faculty-driven) versus *top-down* (university management-driven). In studies based on bottom-up adoption, the recommended focus for gathering evidence was on providing value to students and improving the quality of their learning outcomes (Alexander, 2006). While some concern for improving learning outcomes and teaching effectiveness was reflected in the analysis of studies of top-down driven adoption, the focus of these studies appeared weighted towards providing evidence of administrative cost- and time-savings and reduction of environmental impact (Collyer & Campbell, 2015) rather than on teaching and learning.

Readiness to adopt expressed through skills, knowledge and attitudes

The capacity to overcome faculty suspicion and scepticism was also viewed as necessary by Laurillard et al. (2009) and Anderson (2012) for preparing faculty to be in a ready state of mind to adopt an innovation. Smigiel (2013) reported the extensive presence amongst potential adopters of a “veiled suspicion” (p. 85) of a university’s motivation for introducing online teaching and learning. Singh and Hardaker (2014) associated similarly reported suspicions with perceived negative impacts on teachers’ academic roles and autonomy. Resistance to change by academics was listed by Selwyn et al. (2016b) along with “ignorance” (Selwyn et al., 2016a, p. 30) and negative attitudes in reducing capacity for readiness to adopt. In some reported cases, resistant and negative attitudes led to a total ban on using computers in classrooms (Pomerantz & Brooks, 2017) even though those same teachers imposing the bans may "believe that their teaching would be improved by their use" (p. 7). Pomerantz and Brooks (2017) described this stance as having "a love-hate relationship with online teaching and learning" (p. 7), a view they reported as also present amongst students.

Acquisition of self-confidence (Alexander, 2006; Anderson, 2012; King & Boyatt, 2015; Selwyn et al., 2016b) was expressed as faculty willingness to volunteer (Selwyn et al., 2016b) and as enthusiasm (Alexander, 2006) associated with faculty readiness to adopt an e-learning innovation. Confidence and enthusiasm were regarded as being enhanced by gaining expertise, not just in online content design and creation (Bates & Sangra, 2011) but also by planning and facilitation skills (Bates & Sangra, 2011; Selwyn et al., 2016b) gained in supporting students (Bates & Sangra, 2011; Pomerantz & Brooks, 2017) and competence with technical skills (Singh & Hardaker, 2014; Selwyn et al. 2016a), such as digital literacy and experience with the university's LMS (Selwyn et al., 2016b). It was also suggested that consideration needed to be given to aligning training with teachers' own educational values, beliefs and previous practices (Alexander, 2006; Selwyn et al., 2016b) as well as providing an opportunity to "opt in" (Gunn & Herrick, 2012, p. 8), and allocating sufficient time (Alexander, 2006; Selwyn et al., 2016b) and resources (Singh & Hardaker, 2014). Providing such training and support was seen as a greater challenge for universities which relied increasingly on a widening diversity and higher numbers of sessional teaching staff (Selwyn et al., 2016b).

Project funding for innovation development and implementation

The provision of adequate funding was viewed in 13 of the 23 sources of studies as a key factor for ensuring successful mainstreaming of e-learning innovation development and adoption. This was because many e-learning innovations in universities were reported as relying on some form of establishment funding, commonly known as project "seed funding" (Selwyn et al., 2016a, p. 35), which was applied in the initial development and take-up stages of an e-learning innovation (Gregory et al., 2015). Initial project funding that covers two to three years was considered sufficient by Gunn and Herrick (2012) for prototype development of an innovation and for providing "staff salaries and various types of internal grants" (p. 7). This funding may include incentives in the form of stipends and release time for potential adopters to attend training (Pomerantz & Brooks, 2017; Davis & Fill, 2007), as well as extra staff and teaching preparation time (Davis & Fill, 2007). Typically, funding for e-learning innovation was allocated mostly to software and online resource development (Davis & Fill, 2007). Some limitations in funding and budget allocation were overcome where a university provided free software and technologies (Selwyn et al., 2016b).

In studies of bottom-up e-learning innovation, it was common to find that wider take-up of an innovation rarely progressed after the initial funding stage, unless expertise in financial management and a range of sources of ongoing funding were found (Gunn & Herrick, 2012). Davis and Fill (2007) noted that there was rarely any surplus funding available in universities for implementing innovation (Davis & Fill, 2007), with funds either running out (Davis & Fill, 2007; Gunn & Herrick, 2012) or redeployed (Gunn & Herrick, 2012) before further investment in promoting take-up was possible. Ellis and Goodyear (2019) warned that reliance on obtaining funding through sources external to a university was likely to lead to failure in furthering adoption of an e-learning innovation. However, this threat could be averted by gaining “commitment from a consortium” (Gunn & Herrick, 2012, p. 9) that may include investment from the private sector (Nascimbeni, 2013) coupled with institutional funding (King & Boyatt, 2015) and financial management expertise (Robertson, 2015). Centralised (rather than distributed) financial management was viewed as necessary in top-down driven change (Davis & Fill, 2007), while decentralised academic financial autonomy and capacity were viewed as essential (but rarely present) in change that is driven bottom-up (Snyder et al., 2007). In cases of bottom-up e-learning innovation adoption, Selwyn et al. (2016a) recommended funding on a “fail fast and fail often” (p. 28) basis rather than by scoping projects over a longer term, as usually applied in large-scale top-down driven e-learning innovation development and implementation.

Leadership and vision for driving and inspiring innovation

Strategic planning, decision-making, providing direction and governance were commonly associated with management of change and were recognised as institutional leadership functions in driving e-learning innovation adoption (Dennison, 2014; Gunn & Herrick, 2012; King & Boyatt, 2015; Robertson, 2015; Salmon & Angood, 2013; Singh & Hardaker, 2014). Czerniewicz and Brown (2009) extended this view of the strategic role of institutional leadership, describing it as “the ‘glue’ that holds institutions together” (p. 118). Salmon and Angood (2013) viewed university leadership roles as also serving to dismantle institutional silos through sharing a common vision and providing support, a view also supported by Robertson (2015). Clearly communicating a shared vision that fostered a harmonious climate for development and adoption of e-learning innovations (Singh & Hardaker, 2014; Snyder et al., 2007) entailed not only having “a clear roadmap for the future” (Gunn & Herrick, 2012, p. 8), but also the sharing of knowledge (Salmon & Angood, 2013) supported by examples of practice (Selwyn et al., 2016b).

Mechanisms for demonstrating leadership support were suggested including: valuing the work of innovators (Collyer & Campbell, 2015); promoting innovations (Gunn & Herrick, 2012); appointing e-learning champions (King & Boyatt, 2015) including academic heads and senior management (Salmon & Angood, 2013); job promotions (Alexander, 2006; Gunn & Herrick, 2012; Nascimbeni, 2013); recognition and reward systems (Selwyn et al., 2016b; Pomerantz & Brooks, 2017); and providing “enabling work conditions” (Snyder et al., 2007, p. 200). Salmon and Angood (2013) also recommended establishing partnerships and direct lines between management, information technology specialists and teachers and the establishment, recruitment and promotion of the role of “learning technologists” (p. 922) in universities as leaders and change agents.

Central systems support through learning management system, professional learning and library services

Delivery of learning technology services was typically viewed as a function of a centralised Information Technology (IT) unit within universities. Salmon and Angood (2013) described IT units as being perceived by the rest of the university as occupied by "rather shadowy communities of 'geeky' people" (p. 919), a perception suggested to imply the presence of further suspicions (as noted previously in this section) about impacts of technology-enabled change (Gunn & Herrick, 2012). The long list of roles performed by such central units included:

- Making decisions about software acquisitions and technology delivery infrastructure as well as ensuring their maintenance (Gunn & Herrick, 2012).
- Providing technical expertise (Smigiel, 2013).
- Support in design, programming and multimedia (Csete & Evans, 2013) and for a range of non-enterprise software and services (Selwyn et al., 2016b).
- Providing technical help desk support (Salmon & Angood, 2013; Pomerantz & Brooks, 2017) and troubleshooting (Selwyn et al., 2016b) on an ongoing basis (Gregory et al., 2015).
- Ensuring compatibility across all university network services and reliable, including wireless, access for all devices and flexible learning spaces while reducing and managing risks (Selwyn et al., 2016b), such as protection against virus and hacker attacks and meeting legal obligations related to plagiarism (Robertson, 2015), also maintained by university libraries, particularly in relation to copyright (Selwyn et al., 2016b).

One key part of infrastructure on a university campus for managing delivery of e-learning was identified as the LMS (Selwyn et al., 2016b) when administered and supported centrally (Davis & Fill, 2007). While an LMS usually represented a major infrastructure investment by universities in e-learning, it was criticised for allowing "lecturers to adopt a surface approach to e-learning" (Elgort, 2005, p. 184), leading to the proclamation of views of e-learning innovations as "same wine, new wineskin" (Cross, 2004, p. 107) and "old wine in new bottles" (Selwyn, 2016a, p. 30), further reflecting scepticism about innovation adoption. Such scepticism was blamed on standardised approaches to implementations of the LMS through a top-down approach within universities, enacted centrally through the provision of step-by-step "online how-to guides" (King & Boyatt, 2015, p. 1276) and "the production of templates" (Alexander, 2006, p. 29) and protocols (Selwyn et al., 2016b).

Further support from central units in universities is provided through professional development, also known as "professional learning" and "staff development and training" (Dennison, 2014; Elgort, 2005; Gunn & Herrick, 2012), which ideally integrates technology with pedagogy (King & Boyatt, 2015; Salmon & Angood, 2013) and supports teachers "to recognise the affordances of technology and how it might help them to maintain a high-quality learning experience for their students" (p. 1275). However, this training was criticised for being too simple, technical, out-of-date and lacking in customisation and personalisation (Pomerantz & Brooks, 2017). Gunn (2010) warned that for bottom-up innovation adoption to succeed "a balance needs to be struck between standardisation and central control" (p. 101) even while university leadership continued to indicate a reluctance for reducing institutional control and appeared unwilling to support permissive systems (Selwyn et al., 2016b) that would overcome LMS restrictions, preventing integration of non-enterprise software and online services. Despite this, Pomerantz and Brooks (2017) reported that faculty satisfaction with the "functions of their institution's LMS is high and varies little across different LMSs" (p. 7).

Project management of innovation development and implementation

Recommendations in previous studies were widely supported for having a methodology for formal project management in universities to guide e-learning adoption. However, there were differing views about when and how this should be applied, ranging from a "whole of project approach" (Selwyn et al., 2016b, p. 88) to "an incremental approach" (p. 103). Gunn and Herrick (2012) suggested introducing project management once proof of concept of an e-learning innovation had been established. By contrast, Salmon and Angood (2013) supported putting "a structured innovation 'pipeline' in place that moves project [sic] to prototype and then to mainstreaming where evidence is generated" (p. 922). Gunn and Herrick (2012) recommended that testing of an innovation started much earlier, during the conception stage in which a needs analysis and selection of software products also needed to be part of the initial scoping process. Gunn and Herrick (2012) recommended that, following the conception stage, an implementation strategy provided "a clear roadmap for the future in terms of development, dissemination, support or sustainability" (p. 1). As part of planning this implementation strategy, likely stakeholders needed to be identified (Robertson, 2015) along with allocating roles and responsibilities (Gunn & Herrick, 2012; Robertson, 2015) in decision-making (Salmon & Angood, 2013), marketing (Gunn & Herrick, 2012), providing teaching and learning support (Csete & Evan, 2013; Selwyn et al., 2016b), as well as evaluation (Csete & Evan, 2013) which included "reporting of challenges and difficulties encountered in the projects" (p. 171).

Gregory et al. (2015) noted a key difference between the common practice of "space-utilization audits" (p. 10) of university assets and conducting e-learning evaluations for which no universally agreed measures existed at the time. This had also been noted previously by Gunn and Herrick (2012) in examining the role of evidence of effectiveness earlier in Section 5.1.1. Other challenges for project management in universities were noted as arising if planning and management from the top was too tight and thus ended up stifling the process of bottom-up innovation and adoption of e-learning (Gunn & Herrick, 2012).

Experimentation opportunities and support for testing and trialling innovations

The view that exploration through experimentation was necessary for achieving proof of concept of an e-learning innovation was widely supported (Gunn & Herrick, 2012; Salmon & Angood,2013; Selwyn et al., 2016b; Pomerantz & Brooks, 2017). While experimentation and trials were considered essential for e-learning innovation and adoption to occur, Gunn (2010) cautioned that a balance was needed "between standardisation and central control on the one hand, and freedom to experiment and choose on the other" (p. 101). Environments such as incubators (Selwyn et al., 2016b) and innovation centres (Salmon & Angood, 2013) in universities were regarded as useful for managing potential risks and as a space for "joint research and development activities" (p. 922). One way of avoiding risks, recommended by Collyer and Campbell (2015), was the selection of tested technologies. Selwyn et al. (2016b) emphasised that faculty involved in trials needed to feel safe to participate "without fear of repercussions of failure" (p. 73) and were appreciative when given support to test new teaching strategies is provided.

Piloting early in the development of an e-learning innovation was recommended by Csete and Evans (2013) because it enabled feedback from end users. In piloting this study, end user feedback came from the five pilot study participants (Section 4.3.2) which ensured quality of findings, achievement of timelines and increased confidence in applying the methodological innovation of interpretive case based-modelling.

Development of innovation through individual and team effort

As well as having a champion to drive a project, the drawing together and engagement of a collaborative and committed team with diverse skills from across a university was viewed as essential for successful development of an e-learning innovation and in building a community of practice as a base for furthering the adoption of the innovation (Gregory et al., 2015; Gunn & Herrick, 2012; Davis & Fill, 2007; Nascimbeni, 2013; Robertson, 2015; Salmon & Angood, 2013; Selwyn et al., 2016b). Involvement of students in the early development and evaluation stages of e-learning innovations was also recommended (Salmon & Angood, 2013; Selwyn et al., 2016b) to ensure their needs were being met. In addition, it was suggested that development of an e-learning innovation might benefit from external partnerships (Selwyn et al., 2016b), including from other universities (Davis & Fill, 2007), in providing further expertise, experience and different perspectives. There were also recommendations that project teams required a mix of skills in educational design (Robertson, 2015), teaching, technology and management (Gunn & Herrick, 2012) and for the establishment of "an internal advisory board or steering group with specific terms of reference focused on dissemination and sustainability" (p. 2) to provide the diversity of expertise and guidance necessary for developing and mainstreaming e-learning innovations, including the financial expertise mentioned previously in this section.

While combining the right people, processes and management support was noted as important by

Gunn and Herrick (2012) in findings about project management, this combination was also viewed as playing a key role in the success of e-learning innovation development and adoption, especially for projects that ended up relying on the passion, commitment and hard work of a single person with an original idea who became identified as the project champion (Gunn & Herrick, 2012; Gregory et al., 2015). Reliance on these champions was seen as a potential threat to further development and adoption of an e-learning innovation. Gunn and Herrick (2012) cautioned that if a champion "'fell under a bus' the product would probably falter and 'die'" (p. 9). Similarly, Davis and Fill (2007) warned that when "champions retire or move on they may sometimes be replaced by staff who are not as enthused" (p. 822).

Another potential risk to the development of an innovation and its further adoption (also related to project management as noted earlier in Section 5.1.1) came from management actions that could lead to stifling the innovation (Gunn & Herrick, 2012), for example, by threatening academic autonomy (including issues of inter-disciplinary jurisdiction) of those involved in developing the innovation (Csete & Evans, 2013; Snyder et al., 2007). Management "looking the other way" (Selwyn et al., 2016a, p. 35) was reported as one way such autonomy had been protected in case studies of bottom-up innovation adoption. Another commonly reported threat to the development and furthering of adoption of e-learning innovations was a lack of sufficient time allocated to faculty to secure their ongoing involvement (Sing & Hardaker, 2014; Smigiel, 2013; Selwyn et al., 2016b). This threat to mainstreaming adoption of bottom-up e-learning innovations was also noted by participants in this study, as reported in Section 5.2.2 and discussed in Sections 6.4 and 6.6.

King and Boyatt (2015) concluded their analysis of both top-down and bottom-up e-learning innovation adoption by recommending a "combined top-down and bottom-up approach" (p. 1277) in overcoming obstacles to bottom-up driven development and adoption of e-learning innovations. Laurillard et al. (2009) acknowledged that bottom-up e-learning development and adoption remained a slow process in top-down driven education systems, even though the potential benefits of these innovations for transforming higher education practice were high (Nascimbeni, 2013).

Sharing ideas and ownership of an innovation with potential adopters

Alexander (2006), and King and Boyatt (2015) identified faculty champions (other than the original developer) as playing a key role in furthering adoption of e-learning innovations. This could be achieved by "persuading others of its [the innovation's] value" (Alexander, 2006, p. 29) through conversations and thus "increasing [stakeholder] engagement" (King & Boyatt, 2015, p. 1278) which led to a "sense of [innovation] ownership" (Laurillard et al. 2009, p. 304). Selwyn et al. (2016b) recommended sharing new practices through simple videos, written guides and websites, along with providing teaching teams with professional learning and development opportunities, such as conferences. In conducting professional learning and development, Selwyn et al. (2016b) highlighted the need also to raise awareness of content ownership and copyright implications.

Gunn and Herrick (2012) warned that continuing to depend on the original developer for support threatened the building of a sense of ownership by faculty adopters. To counter this threat, Gregory et al. (2015) recommended the availability of “a ‘go to’ person or group" (p. 10) with the capacity to share experience and resources. Gunn (2010) and Dennison (2014) noted the need for creating opportunities for sharing within a cross-functional collaborative environment. This sharing of ideas in order to further ownership of an e-learning innovation was linked by Salmon and Angood (2013) to the building of capabilities in others to facilitate adoption of the innovation by breaking down institutional silos. It was also recognised that faculty acted as “gatekeepers to changes in teaching practices” (Robertson, 2015, p. 148). Establishing professional communities of practice was proposed as an effective way for bypassing obstructive gatekeepers by building cross-functional collaborative environments (Gunn, 2010; Gunn & Herrick, 2012).

Dissemination of innovations among potential adopters

Alexander (2006) observed that dissemination of an innovation in one case study was conducted by the *originator* of the innovation through publication of journal articles and presentations aimed at *external* audiences from other universities (p. 29). By contrast *internal* recognition could also be gained through internal teaching and learning awards that led to “opportunities for conversations with potential adopters” (Alexander, 2006, p. 29) within an institution. However, Selwyn et al. (2016a) found that generally early adopters “do not necessarily further disseminate practice to others” (p. 35) in their multiple case studies of bottom-up adoption of e-learning innovations in Australian universities. Alexander (2006) acknowledged that conversations, on their own, about e-learning innovations were not enough to ensure further adoption and recommended “a multi-faceted distribution mechanism” (p. 29).

Another means of dissemination included a suggestion by Singh and Hardaker (2014) for using social networking as a channel for interpersonal communication amongst faculty. Selwyn et al. (2016b) recommended the availability of project specific websites, while Gunn and Herrick (2012) recognised a need for guidelines that assist dissemination. Collyer and Campbell (2015) recommended providing case study examples “based on peers not technologists” (p. 473) to change the focus from technology to learning (Selwyn et al., 2016a), while King and Boyatt (2015) recommended that dissemination included recognising barriers as well as benefits.

Gunn and Herrick (2012) raised concerns about a lack of available skills in universities in promotion, marketing and dissemination of e-learning innovations that originate bottom-up, noting “there is little evidence of a strategic top-down view of dissemination and adoption such as that typically applied to an enterprise learning management system” (p. 13). Gunn and Herrick (2012) concluded that a clear road map in universities for dissemination was needed, coupled with marketing expertise. Such a road map appears necessary given findings in this section, that suggest mixed and at times contrasting views about who needs to be involved in promoting and disseminating the benefits of e-learning innovations in universities, what skills and resources are needed and how these skills and resources might most effectively be applied.

Policy for guiding innovation adoption

A literature review by Clayton, Fisher, Harris, Bateman and Brown (2008), for an Australian government report on registered training organisations, viewed the role of policy in education and training as acting as "organisational glue" (cited in Czerniewicz & Brown, 2009, p. 114). A similar metaphor was applied by Czerniewicz and Brown (2009) to the role of higher education leadership and vision in universities.

Gunn and Herrick (2012) and Robertson (2015) viewed policies as important in defining institutional roles in universities for achieving sustainable e-learning innovations. While also appearing to support a positive role for central policy in higher education institutions, Czerniewicz and Brown (2009) acknowledged the potential for ambiguity in attempting to encourage "innovation without stifling it" (p. 118). Anderson (2012) found that policy, as an aspect of institutional culture, "seemed to have little direct effect" (p. 41) in driving innovation adoption, contrary to the perceptions of faculty who believed it did. Laurillard et al. (2009) offered an explanation for such apparent contradictions when noting that "using policy to encourage change is often ineffective because many practitioners see these [policy and change] as disconnected from their own experience" (p. 292) leading to increased (rather than reduced) scepticism amongst faculty. To overcome this conflict, Gunn (2010) recommended "a collective rather than a collaborative approach" (p. 101) to policy and guideline development that assisted decision-making (Gunn and Herrick, 2012).

5.1.2 Actors in e-learning innovation adoption

A further purpose for conducting an analysis of extant studies was to identify the institutional groups of actors who represented key stakeholders in higher education e-learning innovation adoption. Four groups were identified as playing key institutional roles in e-learning innovation adoption: management, central support, innovators and adopters. These groups are discussed in the following subsections, as are the terms *macro*, *meso* and *micro* levels which locate these groups within a university setting.

Management

Two groups of actors with management roles were identified: *academics*, with accountability for leadership and administration; and *professional officers*, with responsibility for inspiring and driving technology-enabled teaching and learning innovations. The list of academic job titles with a management role in e-learning innovation adoption identified from the analysis of secondary data included: Associate Professor (Alexander, 2006); Head of the Academic Development Unit (Gunn, 2010); Professor of Educational Innovation in Post-compulsory Education (Davis & Fill, 2007);

Head of the Learning Technology Research Group (Davis & Fill, 2007); Heads of Schools (Davis & Fill, 2007); deans and heads of departments (Salmon & Angood, 2013); deans of learning and teaching and program directors (Selwyn et al., 2016). Professional staff with a management role in e-learning innovation adoption included: CIO (Chief Information Officer) and CEO (Chief Executive Officer) (Salmon & Angood, 2013) and middle managers (Czerniewicz & Brown, 2009). Ellis and Goodyear (2019) placed the greatest accountability for e-learning innovations with senior leaders in universities, while recognising that it also remained the responsibility of all academics.

Central support

Actors in universities with a key central role in supporting e-learning innovation adoption were identified as: IT (Information Technology) leaders (Dennison, 2014); technologists, researchers, learning designers and dedicated technical work groups (Robertson, 2015); learning technologists (a title strongly favoured by Salmon and Angood, 2013); e-learning support staff members that included librarians (Gunn, 2010); blended learning staff, including Blended Learning Advisor, information services staff and skilled technicians (Selwyn et al., 2016a, 2016b); teaching and research assistants (Pomerantz & Brooks, 2017); professional development (Elgort, 2005; Smigiel, 2013; Dennison, 2014). Robertson (2015) also added the term *champion* in describing the role played by some individuals in central support units within a university.

Innovators

The role of faculty and departmental champions was associated with individual and small teams of innovators of e-learning innovations by King and Boyatt (2015), staff members Robertson (2015) also described as “trusted colleagues” (p. 147). Innovators were described by Alexander (2006) as the original developers of an e-learning innovation and who Nascimbeni (2013) defined as “individual grassroots innovators” (p. 4.). The use of the term “lone rangers” by Bates and Sangra (2011) to describe grassroots e-learning innovators, suggested that these individuals often also worked in isolation from others in a university. The terms *faculty* (Dennison, 2014; King & Boyatt, 2015; Pomerantz & Brooks, 2017) and *lecturer(s)* (Selwyn et al., 2016a, 2016b) were used interchangeably to describe staff whose primary responsibility for teaching and learning was pedagogical (Nascimbeni, 2013). Faculty could be part- or full-time; involved in teaching and/or research; working with undergraduates, graduates, and/or professionals; tenured or non-tenured; and had a variety of titles including full-, associate- or assistant-professor, lecturer, adjunct, and instructor (Pomerantz & Brooks, 2017).

Adopters

Faculty, as described by Pomerantz and Brooks (2017), also represented the adopters of “grassroots” e-learning innovations (Nascimbeni, 2013). Dennison (2014) also placed *faculty* in the adopter category while Gunn (2010) and Singh and Hardaker (2014) preferred the term *lecturer* in this category, to which Davis and Fill (2007) also added *academics* and Singh and Hardaker (2014) added *tutors*. King and Boyatt (2015) described adopters as “staff who teach or support teaching and learning” (p. 1279). Both Alexander (2006) and Robertson (2015) applied the term *champions* to active adopters who were also promoters of e-learning innovations, a term also applied to innovators (King & Boyatt, 2015; Robertson, 2015) and central support (Robertson, 2015) who fulfilled this promotional role.

***Macro*, *meso* and *micro* levels**

The roles shared by both innovators and adopters, identified from the secondary data sources, reflect a view of innovation and adoption of e-learning innovations as occurring as part of "e-learning grassroots micro-innovation practices" (Nascimbeni, 2013, p. 1) in university teaching. Drawing on the literature review in Chapter 2, system-level categories, as proposed by Robertson (2008), can be applied to management as representing *macro*-level practices and the *meso*-level to central support practices. From an Activity Theory perspective (Section 2.2.7), Robertson (2008) described the diffusion of e-learning innovations as occurring across three system levels: *macro*, *meso* and *micro*. Applied to higher education, the three institutional system levels found in universities are described as “the organisational activity system – largely represented by management … the technological activity system – largely represented by information technology specialists … the pedagogic activity system – represented by those with primary responsibility for teaching and learning” (Robertson, 2008, p. 821). A further separation of the *micro* (teaching practice) level to include Rogers (2003) DoI categories of innovators and adopters can then be made, resulting in teaching practice that comprises both *micro innovators* and *micro adopters*. The resulting categorisations appear as follows:

- Management (*macro*)
- Support services (*meso*)
- Teaching practice (*micro innovators*)
- Teaching practice (*micro adopters*).

As noted in Section 2.2.9, the above categories suggest the Quinn and Fullan (2018) Coherence Framework metaphor of four chambers of the heart and the notion of quadrants in the Salmon (2015) Transformative Framework for Learning Innovation.

5.1.3 Roles played by key actors in innovation adoption

The coding of factors and actors for this study led to associating each factor, as a critical role in e-learning innovation adoption, with a related institutional actor category as follows: *macro*, *meso*, *micro innovator* and *micro adopter*. The distribution of factors amongst the actors was made through the process of axial coding described in Section 4.2. In preparation for conducting primary data collection for this study, the association between actors and factors in e-learning innovation adoption was synthesised from the secondary data analysis into the baseline model, as shown in Figure 16. The synthesis into a baseline theoretical model provided a working framework for conducting interviews for this study.

The baseline model is shown as colour-coded and enlarged in Figure 17 and depicts 10 factors (indicated by orange dots) that play key institutional roles in e-learning innovation adoption. In the model these factors are allocated across the institutional actor categories as follows: the *macro* (management) blue area (leadership and vision, project funding); the *meso* (central support) green area (project management, central systems, experimentation); and the *micro* (teaching practice) red area which is split into sub-groups that represent *micro innovators* (evidence of effectiveness, development of innovation, dissemination) and *micro adopters* (readiness to adopt, sharing ideas and ownership). The baseline model used throughout this study omits the role of policy, as this was viewed by Gunn (2010) as the product of collaboration and therefore not a role that could be directly allocated to any specific *macro*, *meso* or *micro* category. Policy was also viewed by Czerniewicz and Brown (2009), Anderson (2012) and Laurillard et al. (2009) as problematic in e-learning innovation adoption in universities because it could be viewed as ambiguous and contradictory.

5.2 Capturing, bracketing and constructing the phenomenon from primary data

> Capturing the phenomenon, including locating and situating it in the natural world and obtaining multiple instances of it.
> Bracketing the phenomenon, or reducing it to its essential elements and cutting it loose from the natural world so that its essential structures and features may be uncovered.
> Constructing the phenomenon, or putting the phenomenon back together in terms of its essential parts, pieces, and structures. (Denzin, 2001, p. 70)

The *Quirkos* software (see Sections 4.2 and 4.9) was used to analyse and obtain findings from the secondary data (Section 5.1) which provided the model factors and actors and identified common themes from previous studies. This same software was also used in coding the 45,000 words of interview transcripts from the 15 case studies. The results of coding these transcripts provide the primary data for this study, as shown in Figure 22 which shows a screen capture from the Quirkos software interface.

Figure 22. *Quirkos* interface for thematic coding of primary data from interview transcripts.

Coding against the 11 factors identified through the secondary data analysis produced the following results in terms of frequency of key quotes from the transcripts:

- Evidence of effectiveness = 35
- Central systems = 59
- Project funding = 48
- Experimentation = 33
- Dissemination = 32
- Development of innovation = 30
- Sharing ideas and ownership = 29
- Leadership and vision = 27
- Readiness to adopt = 21
- Project management = 20
- Policy = 4.

References to groups of institutional actors in e-learning innovation adoption produced the following results:

- Innovators = 34
- Central support = 19
- Management = 10
- Adopters = 3.

References to enabling and inhibiting relationships and influences produced the following results:

- Enabling = 71
- Inhibiting = 51
- Influential = 40.

5.2.1 E-learning innovation cases

The case studies reported in this thesis describe 13 different e-learning innovations that have been adopted in ten universities from Australia and New Zealand and the experiences of 15 people involved with these innovations (detailed in Table 11). There were wide variations in the participant experiences and types of innovations represented in the case studies. For example, in Section 5.2.3 two cases describe the adoption of a Virtual Case-based Learning Environment (VCLE) developed in a small South Australian university (see Table 12 and Table 23) while two other cases describe the adoption of Yammer discussion forums in a large Queensland university (see Table 13 and Table 25). Participants in other case studies each described different e-learning innovations with four of these from two universities.

Table 11 presents details of all case locations, e-learning innovations and the two stakeholder groups represented by study participants, identified as having worked in either an innovator (Inno) or central support (Meso) role. An alphanumeric code, for example *Inno 1*, is used to identify each of the participant case studies. The columns are divided into university (location and relative size); Innovator and Central Support participant categories (Inno and Meso), the gender of the participant and a description of the adopted innovation; and number of interviews at each location.

University locations are identified by country (AU - Australian and NZ - New Zealand) identified further as follows: ACT - Australian Capital Territory, SA - South Australia, NSW - New South Wales, QLD - Queensland, South Island, North Island. University sizes are indicated as *large* (40,000 to 49,000 students), *medium* (30,000 to 39,000 students) or *small* (20,000 to 29,000 students). Gender is recorded as either F (female) or M (male).

Table 11. Case locations, e-learning innovations and study participants.

University location (size)	Innovator Participant (gender) *innovation*	Central support Participant (gender) *innovation*	Interviews
NZ South Island (small)	Inno 4 (F) ePortfolio choices in teacher education Inno 5 (F) Pathbrite ePortfolio		2
NZ North Island (large)		Meso 6 (F) Online course builder	1
NZ North Island (small)		Meso 5 (M) Touch screen TV group work	1
AU ACT (small)		Meso 4 (M) Poll Everywhere lecture response tool	1
AU ACT (small)		Meso 10 (M) Student as producer	1
AU SA (small)	Inno 1 (M) Virtual Case-based Learning Environment Inno 3 (F) Learning management system gamification	Meso 7 (M) Virtual Case-based Learning Environment	3
AU SA (medium)		Meso 3 (M) Location-based mobile learning games	1
AU NSW (large)		Meso 2 (F) Google Forms quiz and polling in lectures	1
AU NSW (large)		Meso 1 (M) Wordpress ePortfolio	1
AU QLD (large)	Inno 2 (M) Yammer discussion forums	Meso 8 (F) Course map infographic Meso 9 (F) Yammer discussion forums	3

For the purpose of reporting interview excerpts and models, each participant is identified only by the case study code, for example, Inno 3, Meso 6, etc. No universities are identified, other than their country location and relative size, to ensure further the confidentiality of the data provided by participants who each volunteered to be part of this study.

There were seven Australian universities (ACT 2, SA 2, NSW 2, QLD 1) and three New Zealand universities (South Island 1, North Island 2), whose sizes were large (4), medium (1), and small (5). There were 15 interviews in total: five innovator (Inno) plus ten (Meso) central support participants. Gender was divided almost evenly, with seven female (3 Inno and 4 Meso) and eight male (2 Inno and 6 Meso) participants.

Each interview transcript started by describing the background and context in each case study. This was followed by responses to each of the six questions, as listed in Section 4.4, which guided modelling and promoted interpretation of results throughout each interview. A sample of a complete edited interview transcript from one case study is provided in Appendix 4. Excerpts from each of the case-study interviews are provided throughout the rest of this thesis and are also included in Tables 12 to 26, which show the results of modelling each case as both *real* and *ideal* (elaborated in Section 3.4.2). All participants reviewed and approved the researcher's edited versions of their own transcripts and selected models..

5.2.2 Actor characteristics

In this study the interview participants represented actor roles from the Inno and Meso quadrants in the baseline model (detailed Figure 16 in Section 4.2) and provided the primary data for this study. The 15 participants and their cases are identified in these findings as Inno 1 through Inno 5 (five studies of e-learning innovation adoption from an innovator perspective) and Meso 1 through Meso 10 (ten studies from a central support perspective).

During the interviews, job titles associated with an e-learning innovator function were described variously as: academic director (Inno 2); topic coordinator (Inno 3); project manager (Inno 3, Inno 4); project lead (Inno 3); combination of teacher and educational designer (Inno 4); clinical tutor (Inno 5); subject coordinator (Meso 2); course developer (Meso 3); head of school (Meso 3), program director (Meso 9); director of online courses (Meso 9).

Central support/*meso* job titles were associated with the following functions: learning designer (Meso 2, Meso 5, Meso 6); learning system, library and professional learning staff (Meso 3); project officer (Meso 3); education innovation officer (Meso 4); learning and research technology manager (Meso 5); AV [audio visual] designers (Meso 5); eResearch specialists (Meso 5); media production team (Meso 5); technical developers (Meso 6); academic staff development (Meso 6, also Meso 3); library learning services (Meso 6, also Meso 3); LMS team (Meso 6); blended learning advisor (Meso 8); learning commons coordinator (Meso 10). Management titles included dean (Meso 1); dean of academic (Meso 3); head of school (Meso 3); VC [Vice Chancellor] (Meso 4); associate dean, teaching and learning (Meso 7). Descriptions applied to adopters of e-learning innovations included champions (Inno 5); subject coordinator (Meso 2); advisory group (Meso 9).

Inno 5 reported juggling additional multiple roles on top of her own job, while for Inno 3 a new position was created to deliver these roles as a result of the successful adoption of the e-learning innovation. Inno 5 also performed the management function of leadership and vision for the project in addition to providing evidence of effectiveness and dissemination. As well as developing the innovation, Inno 5 also responded to queries about the e-learning platform used in the innovation, from both staff and students, a responsibility generally associated with a central systems role. Inno 5 reported that it "provided quite a burden being the go-to person and it wasn't in my workload". By contrast, the new position of topic coordinator created in the case of Inno 3, was in recognition of the successful embedding of the e-learning innovation into mainstream teaching practice.

Resilience, passion, persistence as well as feeling alone were described as some of the personal attributes and experiences of being an innovator. Inno 3 described being “like a dog with a bone” when explaining how “we just carried on regardless in spite of some people saying, no we're not doing that”. Similarly, Inno 5 expressed that “all I knew was that we wanted it” and described having “a passion for getting it done” and adding that “if I didn't persist 100 percent with it, it wouldn't have gotten done”. Inno 5 described sometimes feeling “I was pushing my own agenda”, adding: “I felt I was quite alone in the project to some degree”. Meso 5 described such e-learning innovators in universities as being perceived as “lone rangers”.

Both negative and positive characteristics of actors in central support roles were discussed by participants in the study. The dominance of the LMS in universities provided a recurring theme in explaining the risk-averse nature of those in a central IT services support role. Meso 2 provided the following example:

> Technical support here, compared with other universities I've worked in, tend to be very risk-averse and they don't want to experiment. They are very anti trialling things that are not substantially supported. They don't want to deal with all the problems and the questions and the issues. So they work within their boundaries and that's why things tend to stick within the LMS.

The LMS provided an opportunity for some in central support (*meso*) roles to impose their control of innovations, which led to tensions between those managing the LMS and those involved in developing teaching practice innovations that were not dependant on the LMS platform. Inno 2 complained that “they [Central Systems] keep trying to want to centralise to create this control” and that “these are things I fight in my organization”. By contrast, two study participants who worked in central support professional development found they were able to play proactive roles in supporting bottom-up e-learning innovations, stating: “while we were putting some information out there, I think I was proactive in going to people and saying: ‘look, this is what we've done, do you want to be involved, I can see an opportunity’” (Meso 3) and “I've led it forward so I've got a role in disseminating it to new adopters” (Meso 8).

Management appeared to play a largely passive role throughout most of e-learning innovation development and adoption stages. In the case of Meso 1, these stages were “driven by the person implementing it and the person managing that behind the scenes [the innovators] … it wasn't coming from a *macro* level [management], it was coming from the *micro* level”. As reported in the Meso 4 case: “at the management level it was very much just, ‘yep, that sounds like a good idea, here's the money’ “. In one case, frustration was expressed as a characteristic of being an innovation adopter. Inno 3 remarked: “my participant academics were frustrated that they were getting the nuts and bolts but not the educational pedagogy of implementation and no time to experiment”. Lack of available time also resulted in “no time to share ideas and no one else to bounce ideas with because you're stuck with the daily grind” (Inno 3).

Personal characteristics of actors in e-learning innovation adoption, as revealed during interviews for this study, can be summed up as follows:

- Innovators tend to be passionate and persistent loners who are often required to multi-task.
- IT central support tend to be risk averse and focussed on control.
- Professional learning staff can provide a proactive central support role.
- Management largely appears passive
- Adopters can become frustrated particularly through lack of time and understanding of new pedagogies enabled by technologies.

5.2.3 Modelling inputs, results and participant insights

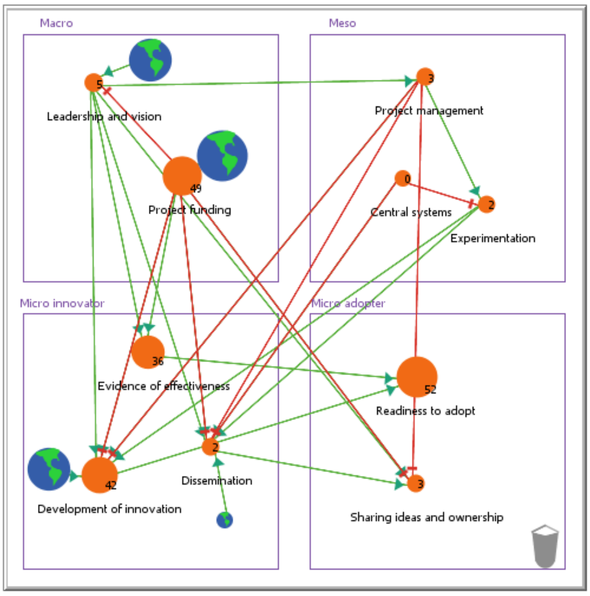
This section presents the models and a selection of participant insights when applying Interpretive Case-based Modelling to obtain primary data for this study. Each of the following 15 tables presents the data that was input (under the direction of each participant) by the researcher into the model, together with results produced after running the modelling software for *real* and *ideal* cases, and participant responses recorded after running both the *real* and *ideal* models.

The total number of inputs to the model provided by participants is listed beside each model. In the models, inputs are represented as enabling links (shown by the green arrows), inhibiting links (shown by the red barred lines), two-way enabling links (two-way green arrows) and influences (shown by globe icons), with each input connecting factors representing actor roles (shown as labelled orange dots).

Results are presented as percentages that reflect the size of the dots after running the NetLogo modelling software program, and represent the level of importance of each factor/actor role. Results in the *ideal* model were produced after the results in the *real* model were adjusted under the participant's direction and the model was run again. The 100% results, listed in orange font, highlight the most important factors in each model and represent the maximum value produced by the algorithm when running the computer modelling software. The 0% results indicate factors that had no importance. A plus sign beside a 100% result next to *ideal model*s indicates that this factor is additional to 100% results produced in the corresponding *real* model. Statistical comparisons of all results, shown in the following tables, are presented in the concluding section of this chapter.

Table 12. Inno 1 case study modelling and insights - Virtual case-based learning environment.

Real model



Inputs

Enabling links: 14
Inhibiting links: 9
Two-way enabling links: 0
Influential roles: 4

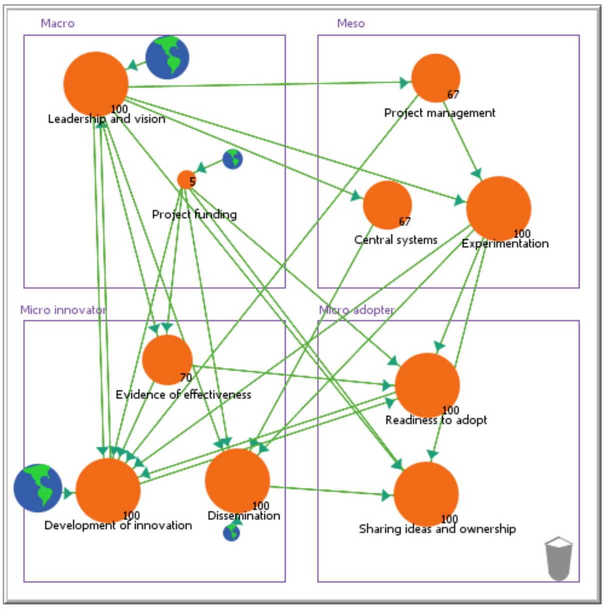
Results

Readiness to adopt 52%
Project funding 49%
Development of innovation 42%
Evidence of effectiveness 36%
Leadership and vision 5%
Project management 3%
Sharing ideas and ownership 3%
Experimentation 2%
Dissemination 2%
Central systems 0%

"It's been a project of extremes where sometimes the funding was good and then we got no funding and then we got funding again."

"There's no mechanisms from central support services to share anything."

Ideal model



Inputs

Enabling links: 24
Inhibiting links: 0
Two-way enabling links: 2
Influential roles: 4

Results

Leadership and vision 100%
Development of innovation 100%
Dissemination 100%
Experimentation 100%
Readiness to adopt 100%
Sharing ideas and ownership 100%

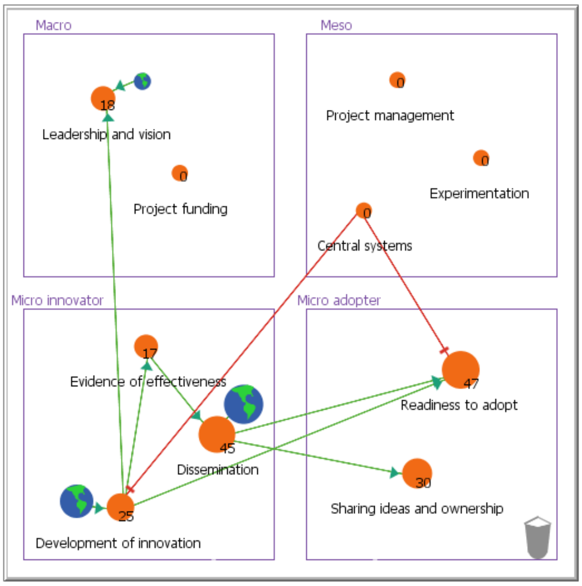
Evidence of effectiveness 70%
Project management 67%
Central systems 67%
Project funding 5%

"If you can get all these things to work in harmony with each other they can all help each other and are important."

"There's a lot more aligned in there so almost everything could be connected to everything else with a feedback mechanism."

Table 13. Inno 2 case study modelling and insights - Yammer discussion forums.

Real model



Inputs

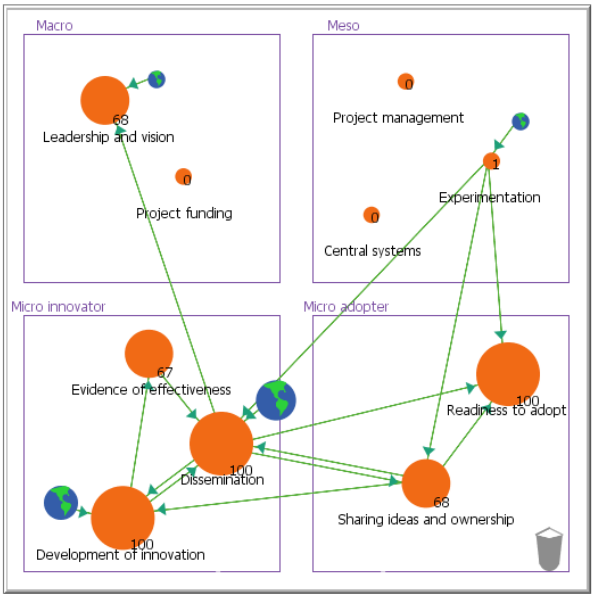
Enabling links: 6
Inhibiting links: 2
Two-way enabling links: 0
Influential roles: 3

Results

Readiness to adopt 47%
Dissemination 45%
Sharing ideas and ownership 30%
Development of innovation 25%
Leadership and vision 18%
Evidence of effectiveness 17%
Central systems 0%
Project funding 0%
Project management 0%
Experimentation 0%

"One of the things that I observe is that a lot of conversations in my organisation are about saying we need to get all these innovations in one place so we can see everything that's going on. It's to do with people's desire for control given that the span of things is so wide and they can't control this. They keep trying to want to centralise to create this control. These are things I fight in my organisation."

Ideal model



Inputs

Enabling links: 13
Inhibiting links: 0
Two-way enabling links: 2
Influential roles: 4

Results

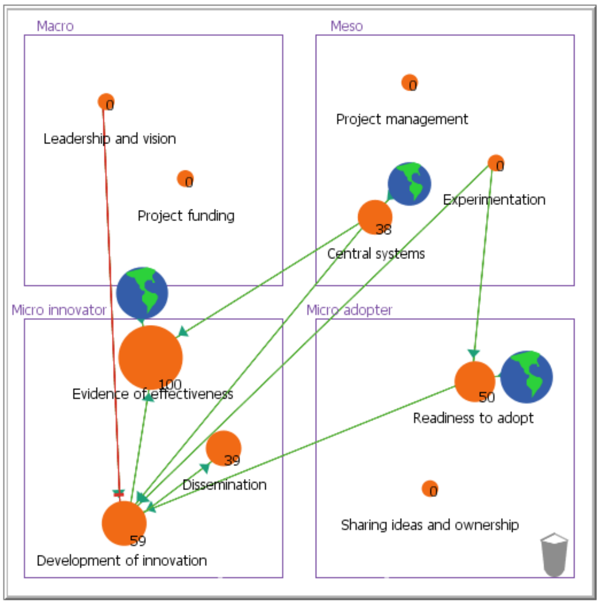
Readiness to adopt 100%
Dissemination 100%
Development of innovation 100%

Leadership and vision 68%
Sharing ideas and ownership 68%
Evidence of effectiveness 67%
Experimentation 1%
Project funding 0%
Project management 0%
Central systems 0%

"I think that one of the advantages I probably have in this story of change is I'm not another blended learning advisor telling them to use a tool. I'm somebody that does it and teaches a subject."

Table 14. Inno 3 case study modelling and insights - LMS gamification.

Real model



Inputs

Enabling links: 6
Inhibiting links: 1
Two-way enabling links: 0
Influential roles: 3

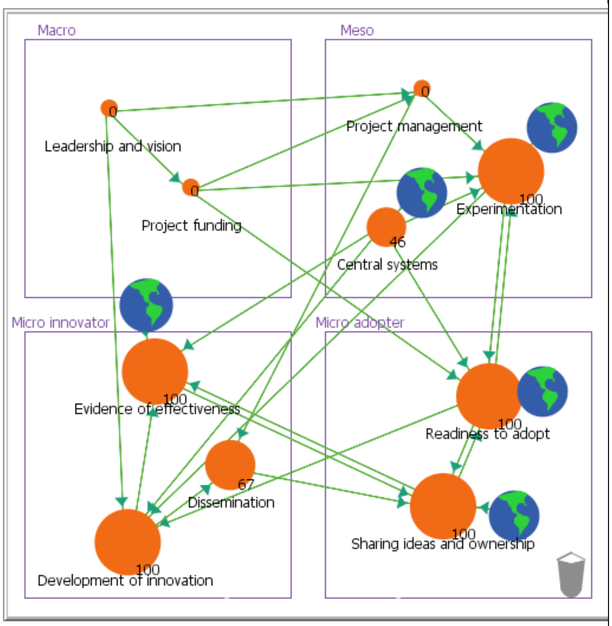
Results

Evidence of effectiveness 100%

Development of innovation 59%
Readiness to adopt 50%
Dissemination 39%
Central systems 38%
Leadership and vision 0%
Project funding 0%
Experimentation 0%
Project management 0%
Sharing ideas and ownership 0%

"Unless I can go to other topic coordinators and say, this is effective, this is what students want, and the same with my university school administration and say, we need to get out of these books, then they're really not helping student learning. So then I needed to have the evidence"

Ideal model



Inputs

Enabling links: 22
Inhibiting links: 0
Two-way enabling links: 3
Influential roles: 5

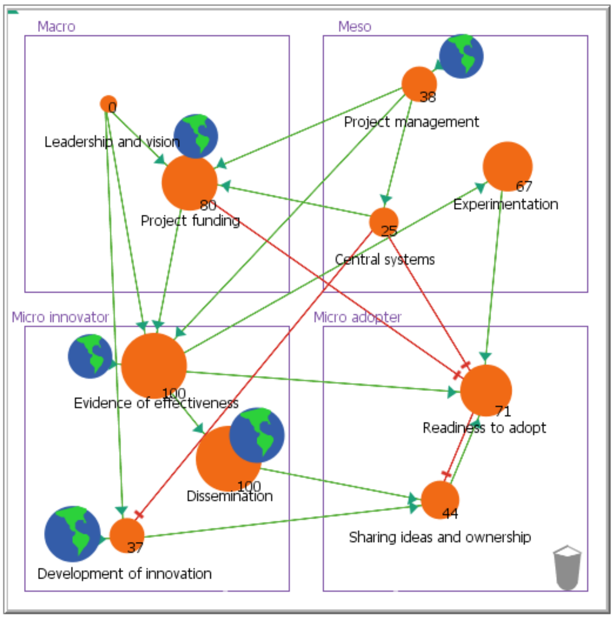
Results

Evidence of effectiveness 100%
+ Experimentation 100%
+ Development of innovation 100%
+ Readiness to adopt 100%
+ Sharing ideas and ownership 100%

Dissemination 57%
Central systems 46%
Leadership and vision 0%
Project management 0%
Project funding 0%

"It's getting the buy-in, with everybody on the bus."

Table 15. Inno 4 case study modelling and insights - ePortfolio choices in teacher education.

<table>
<tr><th colspan="2">Real model</th></tr>
<tr><td>


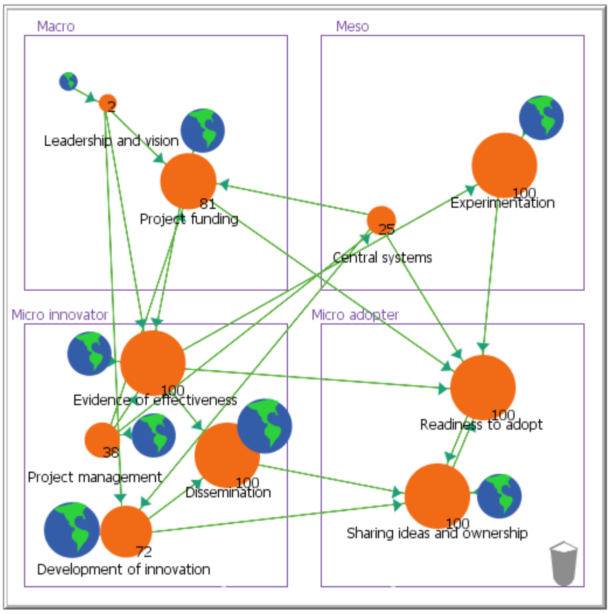
</td><td>

Inputs

Enabling links: 15
Inhibiting links: 4
Two-way enabling links: 0
Influential roles: 5

Results

Evidence of effectiveness 100%
Dissemination 100%

Project funding 80%
Readiness to adopt 71%
Experimentation 67%
Sharing ideas and ownership 44%
Project management 38%
Development of innovation 37%
Central systems 25%
Leadership and vision 0%
</td></tr>
<tr><td colspan="2">“It all happens down in the bottom left really. You can see that it's quite obvious.”</td></tr>
<tr><th colspan="2">Ideal model</th></tr>
<tr><td>


</td><td>

Inputs

Enabling links: 18
Inhibiting links: 0
Two-way enabling links: 1
Influential roles: 8

Results

Evidence of effectiveness 100%
Dissemination 100%
+ Readiness to adopt 100%
+ Sharing ideas and ownership 100%
+ Experimentation 100%

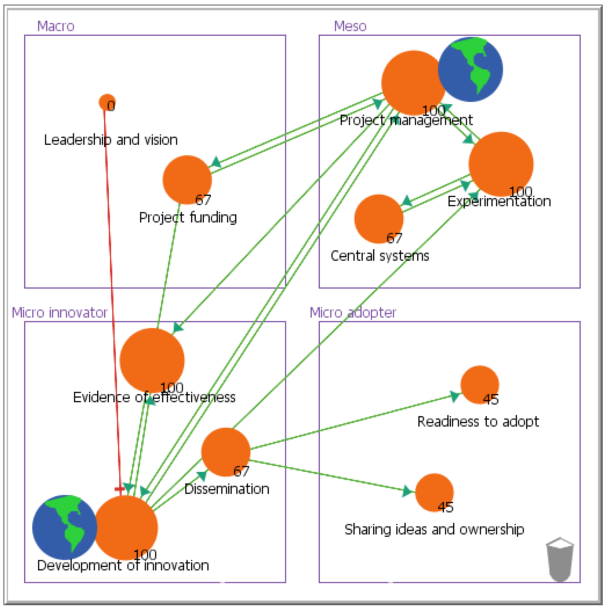
Project funding 81%
Development of innovation 72%
Project management 38% (*)
Central systems 25%
Leadership and vision 2%

(*) moved by study participant to *micro* innovator quadrant from *meso* quadrant
</td></tr>
<tr><td colspan="2">“I'm wondering, if they [Central systems] were more supportive, whether we'd have more people actually taking it up.”

"I really like your model. That was the most fun I have ever had in an interview."</td></tr>
</table>

Table 16. Inno 5 case study modelling and insights - Pathbrite ePortfolio.

Real model



Inputs

Enabling links: 14
Inhibiting links: 1
Two-way enabling links: 4
Influential roles: 2

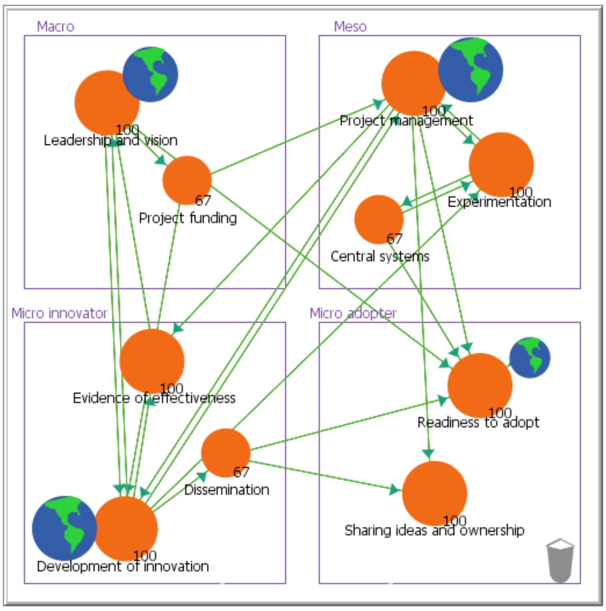
Results

Project management 100%
Experimentation 100%
Evidence of effectiveness 100%
Development of innovation 100%

Project funding 67%
Dissemination 67%
Central systems 67%
Readiness to adopt 45%
Sharing ideas and ownership 45%
Leadership and vision 0%

"It's reaffirming for me that the areas of strengths within the implementation that I thought were there, are there, and it also reaffirms for me that if I hadn't driven it and online learning had not come on board to drive it as well then it could have all fallen down."

Ideal model



Inputs

Enabling links: 19
Inhibiting links: 0
Two-way enabling links: 4
Influential roles: 4

Results

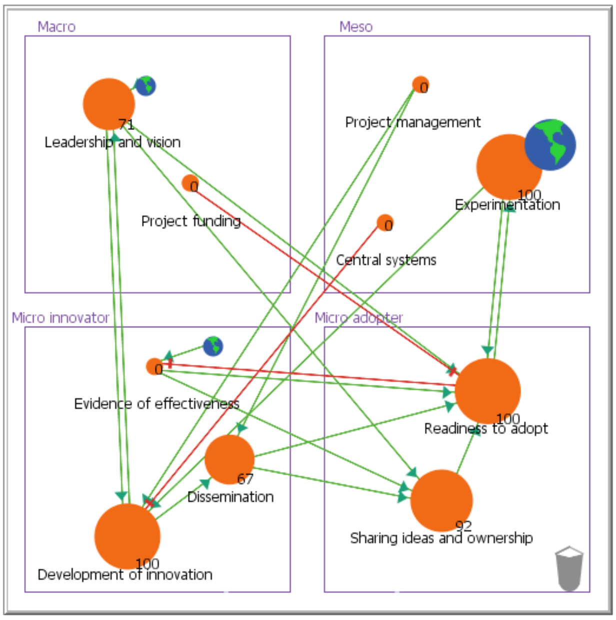
Project management 100%
Experimentation 100%
Evidence of effectiveness 100%
Development of innovation 100%
+ Leadership and vision 100%
+ Readiness to adopt 100%
+ Sharing ideas and ownership 100%

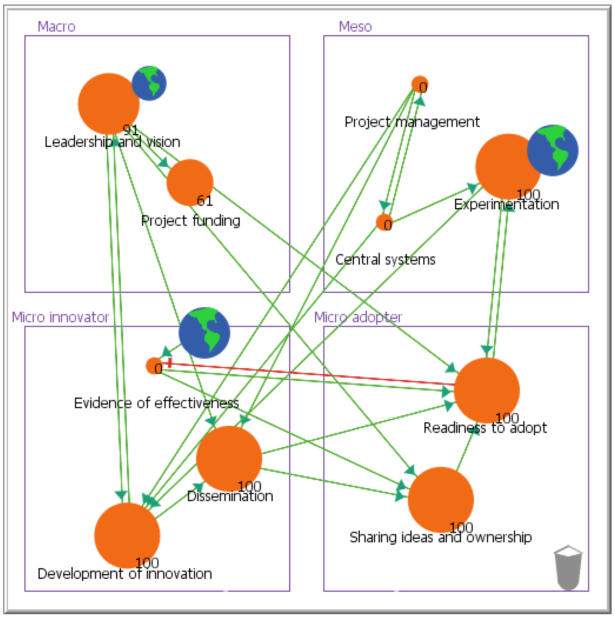
Project funding 67%
Central systems 67%
Dissemination 67%

"We worked in a silo as opposed to working more institution-wide"

"I like that it's relatively even between all four quadrants."

Table 17. Meso 1 case study modelling and insights - Wordpress ePortfolio.

<table>
<tr><th colspan="2">Real model</th></tr>
<tr><td>


</td><td>
Inputs
Enabling links: 14
Inhibiting links: 3
Two-way enabling links: 2
Influential roles: 3
Results
Experimentation 100%
Readiness to adopt 100%
Development of innovation 100%
Sharing ideas and ownership 92%
Leadership and vision 71%
Dissemination 67%
Project management 0%
Central systems 0%
Project funding 0%
Evidence of effectiveness 0%
</td></tr>
<tr><td colspan="2">“We are doing our own thing but I think that's not really the way it should be.”</td></tr>
<tr><th colspan="2">Ideal model</th></tr>
<tr><td>


</td><td>
Inputs
Enabling links: 20
Inhibiting links: 1
Two-way enabling links: 3
Influential roles: 3
Results
Experimentation 100%
Readiness to adopt 100%
Development of innovation 100%
+ Sharing ideas and ownership 100%
+ Dissemination 100%
Leadership and vision 91%
Project funding 61%
Project management 0%
Central systems 0%
Evidence of effectiveness 0%
</td></tr>
<tr><td colspan="2">“I think if you do this activity with an academic it would look different again. I think they're less exposed to some of the background work that people in my world are exposed to.”</td></tr>
</table>

Table 18. Meso 2 case study modelling and insights - Google Forms quiz polling in lectures.

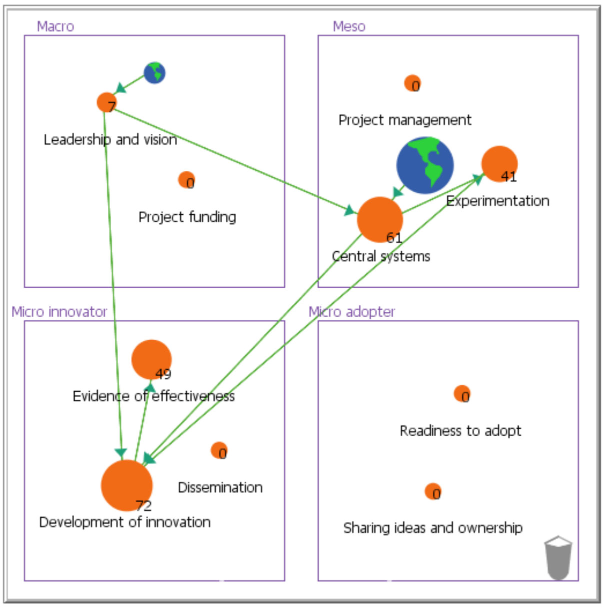
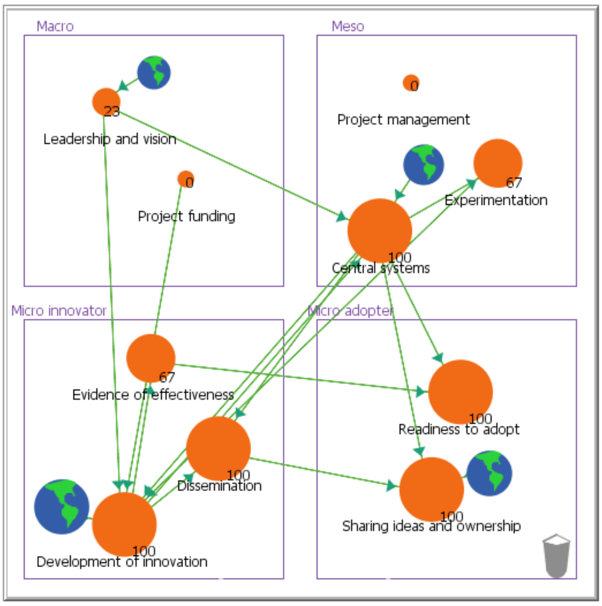
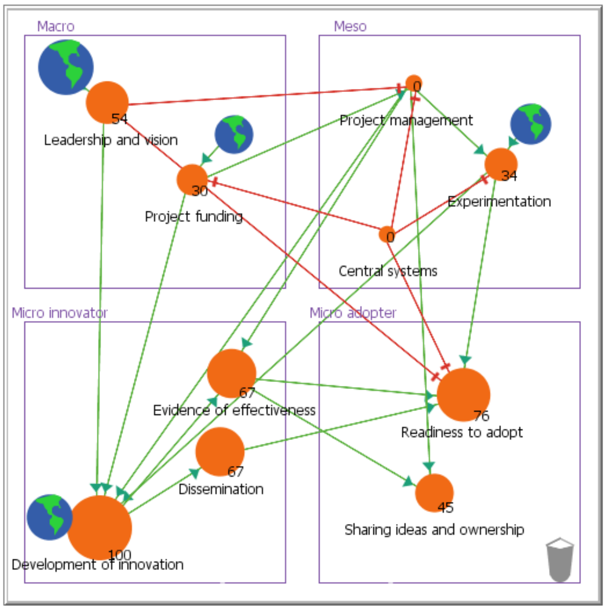
<table>
<tr><th colspan="2">Real model</th></tr>
<tr><td>
</td>
<td>Inputs
Enabling links: 6
Inhibiting links: 0
Two-way enabling links: 0
Influential roles: 1
Results
Development of innovation 72%
Central systems 61%
Evidence of effectiveness 49%
Experimentation 41%
Leadership and vision 0%
Project funding 0%
Project management 0%
Dissemination 0%
Readiness to adopt 0%
Sharing ideas and ownership 0%</td></tr>
<tr><td colspan="2">“In science you've got to be able to have proof to say where's the evidence that this is going to work, otherwise they'll say, why am I going to waste my time using it.”</td></tr>
<tr><th colspan="2">Ideal model</th></tr>
<tr><td>
</td>
<td>Inputs
Enabling links: 13
Inhibiting links: 0
Two-way enabling links: 1
Influential roles: 4
Results
Central systems 100%
Readiness to adopt 100%
Sharing ideas and ownership 100%
Dissemination 100%
Development of innovation 100%
Experimentation 67%
Evidence of effectiveness 67%
Leadership and vision 23%
Project management 0%
Project funding 0%</td></tr>
<tr><td colspan="2">“Obviously your adopters have a major stake in the process. It's talking about the roles and their importance.”
“I think [also] people tend to see what someone next door or in the corridor is doing.”</td></tr>
</table>

Table 19. Meso 3 case study modelling and insights - Location-based mobile learning games.

Real model



Inputs

Enabling links: 14
Inhibiting links: 5
Two-way enabling links: 0
Influential roles: 4

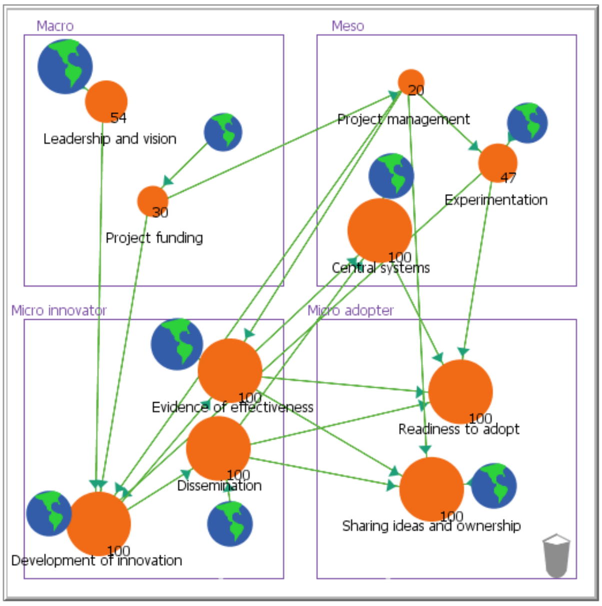
Results

Development of innovation 100%

Readiness to adopt 76%
Dissemination 67%
Evidence of effectiveness 67%
Leadership and vision 54%
Sharing ideas and ownership 45%
Experimentation 34%
Project funding 30%
Project management 0%
Central systems 0%

"I would like to have captured a bit more evidence of effectiveness. I didn't get a chance to do control groups and things like that. There was possibly more to achieve there that we didn't do."

Ideal model



Inputs

Enabling links: 16
Inhibiting links: 0
Two-way enabling links: 0
Influential roles: 8

Results

Development of innovation 100%
+ Evidence of effectiveness 100%
+ Dissemination 100%
+ Readiness to adopt 100%
+ Sharing ideas and ownership 100%
+ Central systems 100%

Leadership and vision 54%
Experimentation 47%
Project funding 30%
Project management 20%

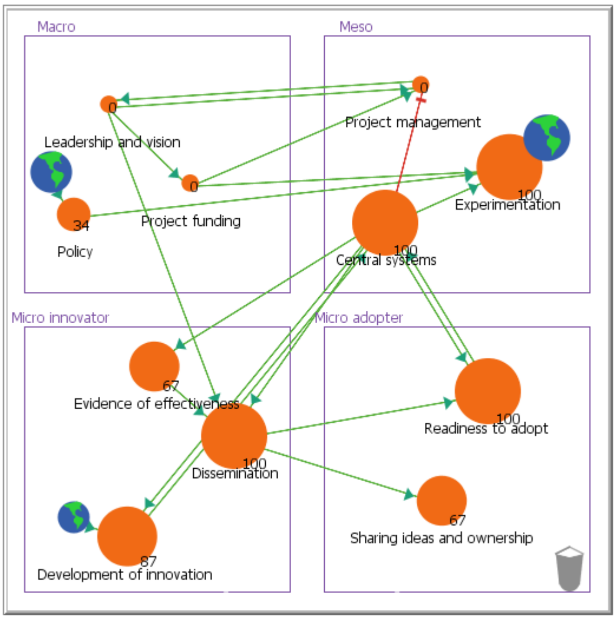
"In an ideal world the central systems functions of the library and professional learning for student engagement provide an opportunity for central systems to do more support than what they offered in the actual scenario."

"I think that's saying it's important to kick it off and then let the micro innovators influence the process from then on."

"That's capturing where it needs to go and what I would like it to move towards in a more perfect world."

Table 20. Meso 4 case study modelling and insights - Poll Everywhere lecture response tool.

Real model



Inputs

Enabling links: 17
Inhibiting links: 1
Two-way enabling links: 2
Influential roles: 3

Results

Dissemination 100%
Experimentation 100%
Central systems 100%
Readiness to adopt 100%

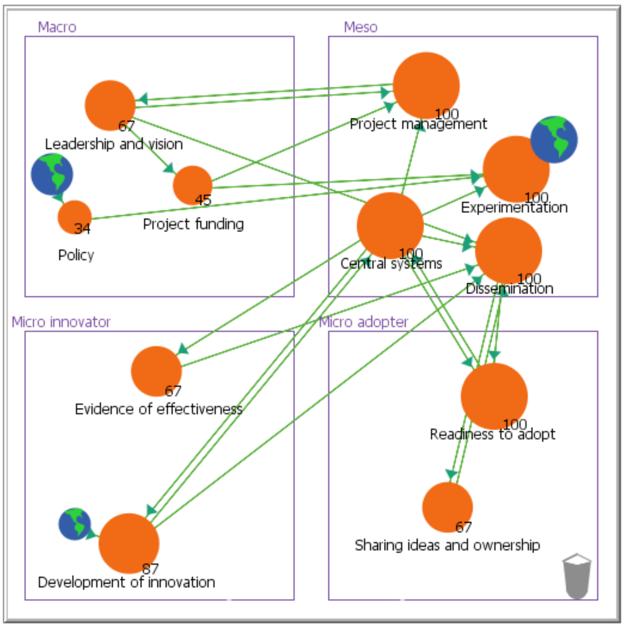
Development of innovation 87%
Sharing ideas and ownership 67%
Evidence of effectiveness 67%
Policy 34% (*)
Leadership and vision 0%
Project funding 0%
Project management 0%

(*) added by study participant in *macro* quadrant

"Policy played a fairly significant role in terms of what we were permitted to do. That's kind of a positive and a negative. It's prevented us from using particular tools but it didn't stop the implementation of this specific tool."

"We're meant to be helping to drive innovation. As a central point it's easier for us to talk to a lot of different areas. If you look at Third Space Theory in some ways we're at the juncture."

Ideal model



Inputs

Enabling links: 18
Inhibiting links: 0
Two-way enabling links: 4
Influential roles: 3

Results

Dissemination 100% (*)
Experimentation 100%
Central systems 100%
Readiness to adopt 100%
+ Project management 100%

Development of innovation 87%
Leadership and vision 67%
Sharing ideas and ownership 67%
Evidence of effectiveness 67%
Project funding 45%
Policy 34%

(*) moved by study participant to *meso* quadrant from *micro* innovator quadrant

"It would probably be worth having a chat to the lecturer who initiated the project. It would be quite interesting to compare her perception of this project to mine."

Table 21. Meso 5 case study modelling and insights - Touch screen TV group work.

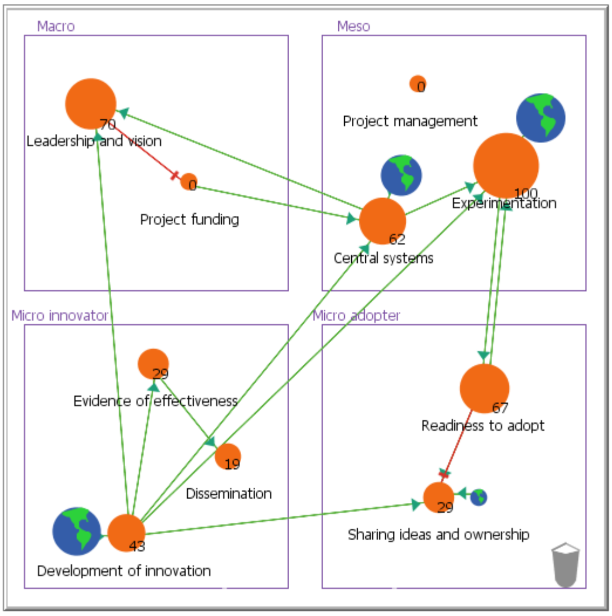
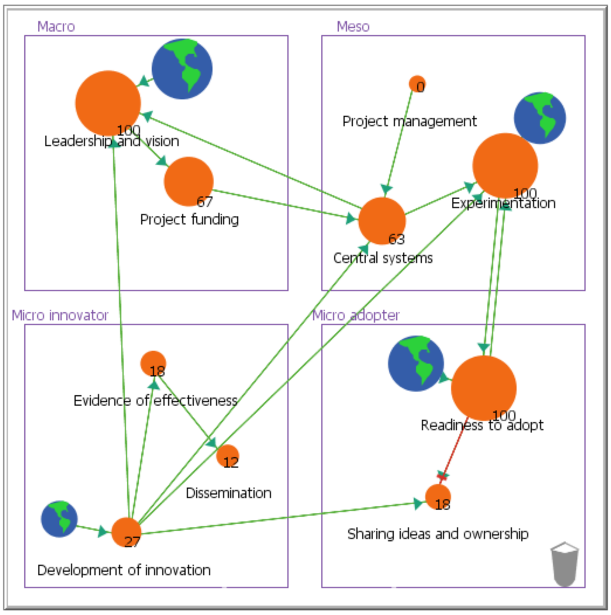
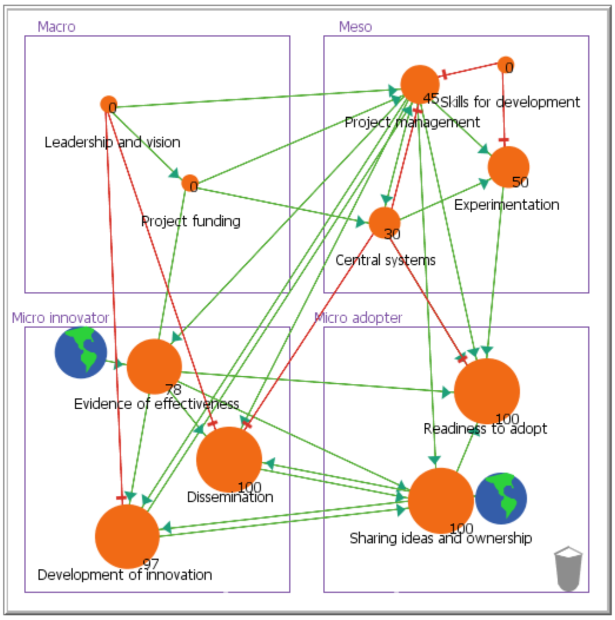
<table>
<tr><th colspan="2">Real model</th></tr>
<tr><td>
</td><td>Inputs
Enabling links: 12
Inhibiting links: 2
Two-way enabling links: 1
Influential roles: 4
Results
Experimentation 100%
Leadership and vision 70%
Readiness to adopt 67%
Central systems 62%
Development of innovation 43%
Evidence of effectiveness 29%
Sharing ideas and ownership 29%
Dissemination 19%
Project funding 0%
Project management 0%</td></tr>
<tr><td colspan="2">“I think from a model that's quite good. Project funding is still small so that's right. It shows people telling you, sorry we've got no money makes no difference on innovation.”</td></tr>
<tr><th colspan="2">Ideal model</th></tr>
<tr><td>
</td><td>Inputs
Enabling links: 14
Inhibiting links: 1
Two-way enabling links: 1
Influential roles: 4
Results
Experimentation 100%
+ Leadership and vision 100%
+ Readiness to adopt 100%
Project funding 67%
Central systems 63%
Development of innovation 27%
Evidence of effectiveness 18%
Sharing ideas and ownership 18%
Dissemination 12%
Project management 0%</td></tr>
<tr><td colspan="2">“That is nearly perfect because the leadership will say we want to be a digitally-enabled, technology-enabled organisation. They'll have something like a blended learning strategy or they'll have an e-learning strategy which will lead to funding which means people can play with tools that they have been told are important by their organisation and so you'll still have this group of people who want to push the edge, the bleeding edge.</td></tr>
</table>

Table 22. Meso 6 case study modelling and insights - Online course builder.

Real model



Inputs

Enabling links: 23
Inhibiting links: 6
Two-way enabling links: 3
Influential roles: 2

Results

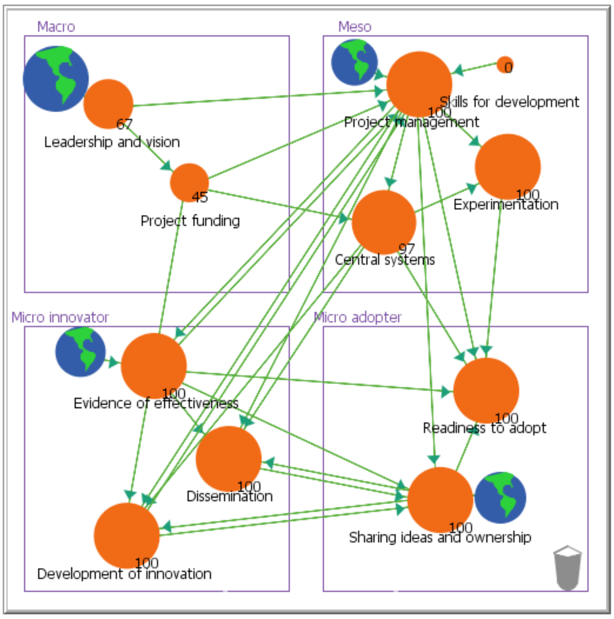
Dissemination 100%
Development of innovation 100%
Readiness to adopt 100%
Sharing ideas and ownership 100%

Evidence of effectiveness 78%
Experimentation 50%
Project management 45%
Central systems 30%
Leadership and vision 0%
Project funding 0%
Skills for development 0% (*)

(*) added by study participant in *meso* quadrant

"Luck is maybe part of it."

Ideal model



Inputs

Enabling links: 26
Inhibiting links: 0
Two-way enabling links: 4
Influential roles: 4

Results

Dissemination 100%
Development of innovation 100%
Readiness to adopt 100%
Sharing ideas and ownership 100%
+ Project management 100%
+ Experimentation 100%
+ Central systems 100%
+ Evidence of effectiveness 100%

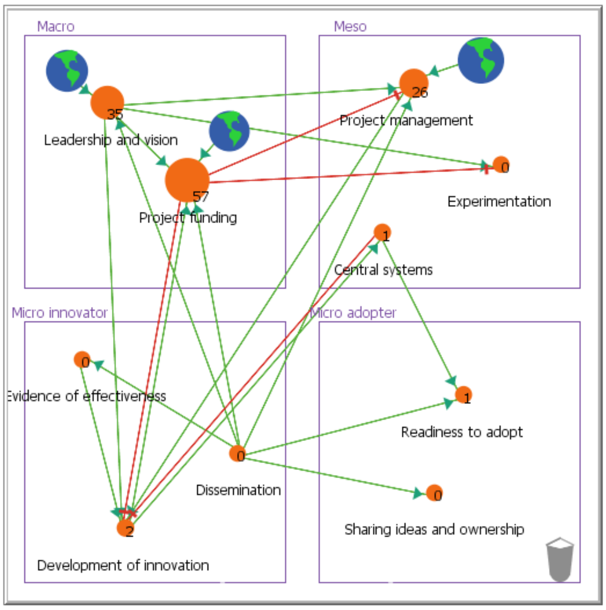
Leadership and vision 67%
Project funding 45%
Skills for development 0%

"We have a good mix in this situation."

"Innovation is a really hard thing to plan and manage."

Table 23. Meso 7 case study modelling and insights - Virtual case-based learning environment.

Real model



Inputs

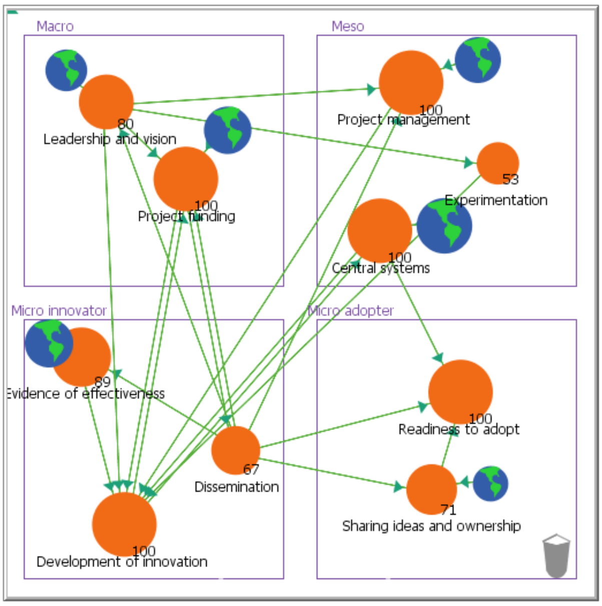
Enabling links: 14
Inhibiting links: 4
Two-way enabling links: 0
Influential roles: 3

Results

Project funding 57%
Leadership and vision 35%
Project management 26%
Development of innovation 2%
Readiness to adopt 1%
Central systems 1%
Evidence of effectiveness 0%
Dissemination 0%
Sharing ideas and ownership 0%
Experimentation 0%

"Maybe we're overestimating the impact we had."

Ideal model



Inputs

Enabling links: 17
Inhibiting links: 0
Two-way enabling links: 3
Influential roles: 6

Results

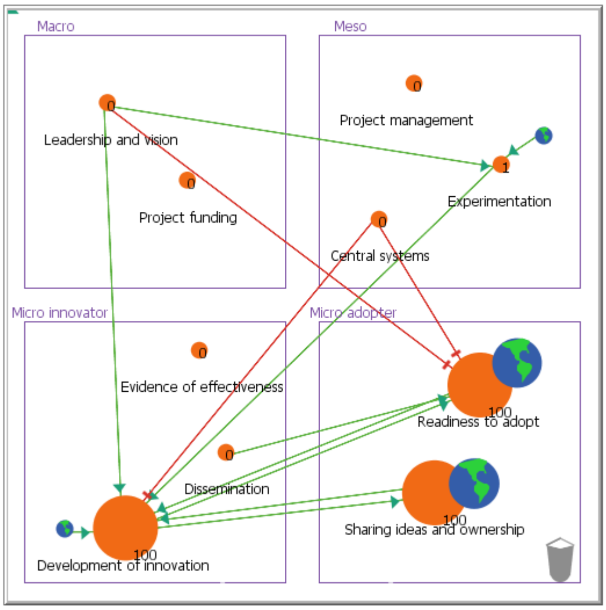
Project funding 100%
Development of innovation 100%
Readiness to adopt 100%
Central systems 100%
Project management 100%

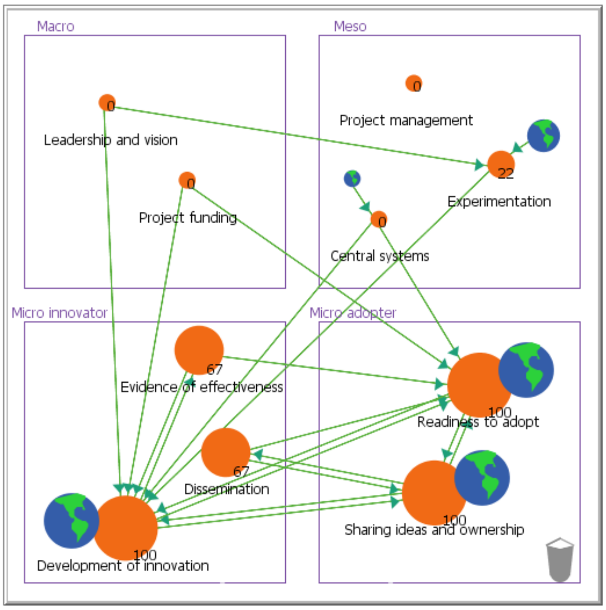
Evidence of effectiveness 89%
Leadership and vision 80%
Sharing ideas and ownership 71%
Dissemination 67%
Experimentation 53%

"It shows that a holistic approach is going to be more effective."

"You can't have innovation without all those other things which is what we're often asked to do, innovate, innovate, but no funding, no resources."

Table 24. Meso 8 case study modelling and insights - Course map infographic.

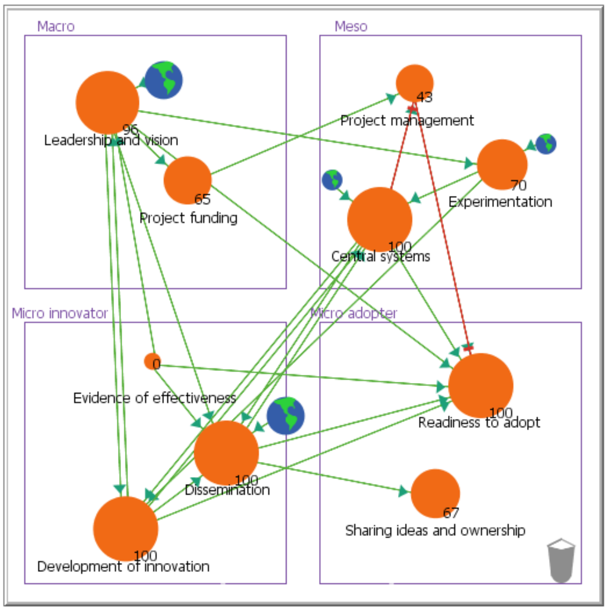
<table>
<tr><th colspan="2">Real model</th></tr>
<tr><td>


</td><td>
Inputs
Enabling links: 8
Inhibiting links: 3
Two-way enabling links: 2
Influential roles: 4
Results
Readiness to adopt 100%
Sharing ideas and ownership 100%
Development of innovation 100%
Experimentation 1%
Leadership and vision 0%
Project funding 0%
Evidence of effectiveness 0%
Dissemination 0%
Project management 0%
Central systems 0%
</td></tr>
<tr><td colspan="2">“In terms of impacts, that says Development of innovation, the Readiness to adopt and Sharing ideas and ownership of that innovation underpin each other.”</td></tr>
<tr><th colspan="2">Ideal model</th></tr>
<tr><td>


</td><td>
Inputs
Enabling links: 17
Inhibiting links: 0
Two-way enabling links: 3
Influential roles: 5
Results
Readiness to adopt 100%
Sharing ideas and ownership 100%
Development of innovation 100%
Evidence of effectiveness 67%
Dissemination 67%
Experimentation 22%
Leadership and vision 0%
Project funding 0%
Project management 0%
Central systems 0%
</td></tr>
<tr><td colspan="2">“In a perfect world, I'd be happy with that. I know I have a role which is unique in a lot of university structures and the way that I conduct this role is unique because it is to enable the academics to do it for themselves and not rely on central support and to become agile in their own skills and professional learning.”</td></tr>
</table>

Table 25. Meso 9 case study modelling and insights - Yammer discussion forums.

Real model



Inputs

Enabling links: 22
Inhibiting links: 2
Two-way enabling links: 3
Influential roles: 4

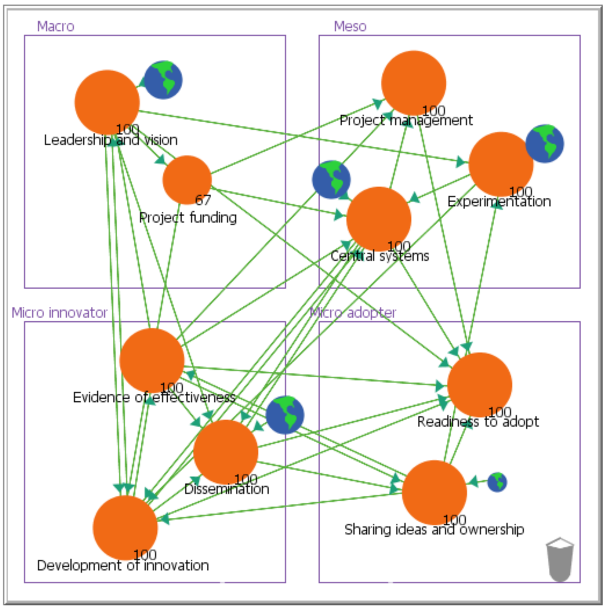
Results

Central systems 100%
Readiness to adopt 100%
Dissemination 100%
Development of innovation 100%

Leadership and vision 96%
Experimentation 70%
Sharing ideas and ownership 67%
Project funding 65%
Project management 43%
Evidence of effectiveness 0%

“To be able to legitimately use staff time to be involved was also critical.”

Ideal model



Inputs

Enabling links: 28
Inhibiting links: 0
Two-way enabling links: 4
Influential roles: 5

Results

Central systems 100%
Readiness to adopt 100%
Dissemination 100%
Development of innovation 100%
+ Leadership and vision 100%
+ Experimentation 100%
+ Sharing ideas and ownership 100%
+ Project management 100%
+ Evidence of effectiveness 100%

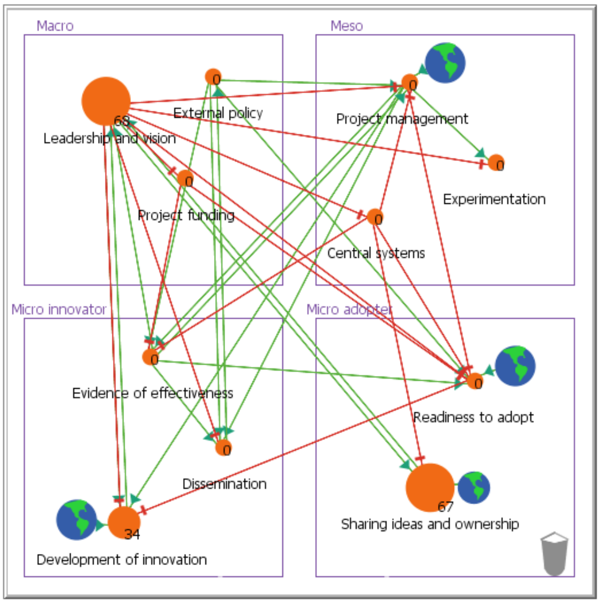
Project funding 67%

“I think those concepts within the quadrants are useful to think about along with this kind of networked thinking about innovation, yes, it's good. All those concepts have a place.”

“Maybe not just one person but a team of early adopters or champions.”

Table 26. Meso 10 case study modelling and insights - Student as producer.

Real model



Inputs

Enabling links: 16
Inhibiting links: 12
Two-way enabling links: 3
Influential roles: 4

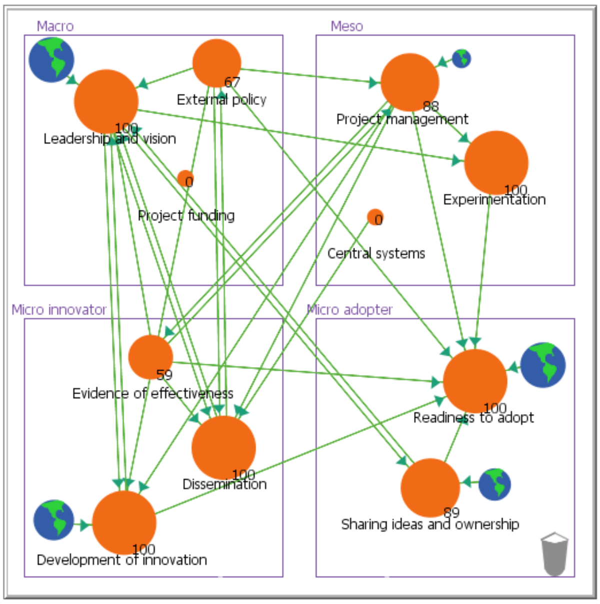
Results

Leadership and vision 68%
Sharing ideas and ownership 67%
Development of innovation 34%
Evidence of effectiveness 0%
Readiness to adopt 0%
Dissemination 0%
Central systems 0%
Project funding 0%
Experimentation 0%
Project management 0%
External policy 0% (*)

(*) added by study participant in *macro* quadrant

“In our story, the inhibitors provided by *Leadership and vision* far outweigh the enablers. Seeing the model run, because their [Management’s] resources and influences are so huge, a small thing that they do can have a big impact and sometimes that impact may not be as bad as it seems.”

Ideal model



Inputs

Enabling links: 24
Inhibiting links: 0
Two-way enabling links: 4
Influential roles: 5

Results

Leadership and vision 100%
Development of innovation 100%
Dissemination 100%
Experimentation 100%
Readiness to adopt 100%

Sharing ideas and ownership 89%
Project management 88%
External policy 67%
Evidence of effectiveness 59%
Project funding 0%
Central systems 0%

“The outside policy was a bypass [to internal institutional policy] by saying this is a federal government approach generally … and so provided endorsement”

“The ideal model reinforces my pre-existing assumptions that mainly *Central systems* and *Project funding* are not necessary and the others will flourish despite these.”

5.2.4 Insights about capacity building

Interview transcripts, recorded throughout the modelling process, reveal insights into how e-learning innovation adoption can be achieved and who should be involved. The following sections in this thesis provide a representative selection of these insights as they relate to each of the factors, depicted as roles in the model. The insights, quoted from the transcripts, are identified by the case study code, for example, Inno 3, Meso 6, etc, to represent both the case studies and the voices of the participants.

The following sections correspond to the themes identified in Section 5.1.1:

- Evidence of effectiveness in teaching and learning.
- Readiness to adopt expressed through skills, knowledge and attitudes.
- Project funding for innovation development and implementation.
- Leadership and vision for driving and inspiring innovation.
- Central systems support through learning management system, professional learning and library services.
- Project management of innovation development and implementation.
- Experimentation opportunities and support for testing and trialling innovations.
- Development of innovation through individual and team effort.
- Sharing ideas and ownership of an innovation with potential adopters.
- Dissemination about innovations with potential adopters.
- Policy for guiding innovation adoption.

Evidence of effectiveness in teaching and learning

Both quantitative and qualitative data gathering were recognised by study participants as useful strategies for providing evidence of the effectiveness of e-learning innovations adoptions in improving higher education teaching and learning practices. Inno 2 provided the following example of quantifying and analysing data:

> We're starting to quantify and analyse the conversations using a tool that represents how many posts people make and that's making me think about quantifying conversations to link these to students' grades and that being another driver to create adoption as opposed to experiential evidence of I've used it, I like it, I can see that it works.

Three other cases used a mix of formal and informal feedback and survey results over different periods to drive adoption, for example, Inno 3 stated: "we've been doing the pre- and post-tests and collecting data now for four years", while in the case of Meso 3, online surveys were conducted "of students who had been playing the games and a group of students who were designing games" plus holding "follow-up focus groups" with these students. In the case of Meso 3 a project officer was also engaged to create the surveys. In the Meso 4 case, surveys were conducted with a pilot group in the first semester of implementing the innovation which provided positive feedback. Similarly, Meso 7 received “feedback from people saying this is a really good idea, this is exactly what we need”.

The need for collecting and maintaining the results of evidence gathering was noted by Meso 9 who recommended “building of a repository of evidence and knowledge”. This could include evidence from outside the university, as suggested by Meso 10 who reported that a “teacher felt more confident to adopt this practice because it was trending outside of the university”.

Readiness to adopt expressed through skills, knowledge and attitudes

Support for building confidence and the value of experimentation were regarded by study participants as useful for creating conditions for readiness to adopt. Inno 4 noted that, for adopters, “building their confidence would help them feel that they were ready to start using digital portfolios as well because they've tried it out”. Similarly, Meso 1 observed that adopters needed to do “their own testing and work out their own way to make it work and that's still ongoing for us as well … we still keep experimenting”. Meso 8 reported that “one of the things that really drove this was the academics themselves” and “whether they're given support by their school to engage in the process”. Another key consideration was overcoming a perceived threat to an academic’s job promotion, as reported by Meso 8:

> Academics need to feel safe about their own promotion possibilities. If they implement a new teaching innovation some are scared to do it because it will affect their student satisfaction scores which effects their ability to get promotions.

Barriers to adoption were described by Inno 4 as caused by academic staff having a “low level of digital capability”, “low self-efficacy in using digital tools” and they “didn’t have enough equipment”. Meso 5 viewed academic resistance and fears as a two-sided problem in describing this experience:

> There was some real resistance at the start. You had some people with positive interactions. It was a two-sided argument. You did have a lot of people saying, “get those out of my lab, what are you doing, you're ruining science”. I think as an innovator if you're trying to not enforce change but communicate change in a very, very traditional environment you will get some people who want to come along on your journey and some people will want to severely restrict it. I think that does cause a little bit of conflict especially within a small academic unit. That does shrink the ability to be able to really push and show the value of the ideas that you are trying to achieve.

Overcoming resistance was reported by Meso 10 as possible when an innovation was “trending outside the university” in contrast to resistance to innovations that were being promoted solely by the innovator within an academic’s own university.

Project funding for innovation development and implementation

In several cases there was only limited funding (or none) available or viewed as necessary for supporting innovation adoption. Inno 1 reported that funding for the innovation was sporadic, describing it as “a project of extremes where sometimes the funding was good and then we got no funding and then we got funding again”. Inno 2 was less dependent on funding and proposed that “you probably don’t need much money because there’s probably a free tool out there that does it”.

In the case of Inno 4, the university “research office was where the funding came from”. Inno 4 added that “other funding for the use of digital portfolios in teaching comes from outside the organisation” and that this funding, as in most universities, is also dependant on the number of student enrolments. In the case of Inno 5, the funding for implementation came from “the IT people”, with support from management, which was used to pay for software licences. In the Meso 3 case the funding, to maintain subscription fees for an internet service that was needed to implement the innovation, was paid from personal funds provided by Meso 3, who suggested “it's probably not project funding but it's just general funding that's needed”. When making funding decisions, Meso 4 recalled: “when I was evaluating tools, I asked, ‘is this going to be insanely expensive and is there a per-student charge’ and, if so, obviously that made that system less attractive”. Applications of funds for furthering the adoption of e-learning innovations varied and included using a “second grant” for project management (Meso 3), in the Meso 6 case “users got funding” and in the case of Meso 8 project funding was “based on in-kind funding”. An example of in-kind funding was provided in the Meso 5 case where “the IT people” … “were allocated time to do it so that's funding and time is money”. Like the Meso 6 example where funding for users was provided through “teaching improvement grants”, Inno 1 reported seeing “a lot of projects work well when there are incentives for adopters.”

The need to fund resources was viewed positively in the case of Meso 6 where “the library got funding to develop tutorials”, while a lack of funding for resources was lamented by Inno 3, as follows:

> We're wanting people to go to online but we won't give them a second screen, we haven't got webcams, we haven't got effective microphones or headsets and things like that. So all of that infrastructure has to happen too and that's where the project funding comes in.

Meso 1 concluded that “I don't think project funding has stopped us or stops anyone from experimenting and coming up with an idea but it does stop you from implementing it”. For Meso 7 a lack of funding “reduced the capacity to manage the project well” while for Meso 10 it limited the capacity to generate evidence of the innovation’s effectiveness and therefore gain wider recognition that could lead to further adoption.

Leadership and vision for driving and inspiring innovation

Having a university strategic plan aimed at driving and inspiring innovation was viewed in several cases as management performing a leadership and vision role in furthering adoption. In the Inno 3 case, leadership and vision was expressed as “part of the university strategic plan for inspiring and supporting innovation” and in the Inno 4 case, as providing “strategic direction and vision for blended and flexible learning and developing digital capability". Similarly, it was reported in the Meso 6 case that "there was an institutional vision and a strategic plan that said we support innovation in teaching". The need for support from management was illustrated in the Meso 1 case as seeking endorsement from a Dean, with Meso 1 noting that this "had a big impact even though it [support] wasn't there at every step of the process".

Not all experiences of leadership were positive. Inconsistencies in leadership support created a range of problems at different stages of innovation adoption for seven participants (Inno 3, Inno 5, Meso 3, Meso 5, Meso 6, Meso 8, Meso 10). Inno 5 noted "there was a lack of leadership and vision from the beginning and then once the online learning designers came on board … that's when things started to happen". Meso 3 expressed anger about the effects a change of leadership had on slowing down what had been a steady rate of adoption of the e-learning innovation, stating:

> I can't do any location-based mobile learning Monday to Wednesday. I'm not allowed to anymore so there's a complete stop to what I've been doing. There's a different leader. If an academic came to me now and said: "could you help, I've really got this cool idea, we can really do this", I'd have to say: "no, I can't help you, I'm not permitted, I'm on another task". So I'm angry because I think it is affecting readiness to adopt and it's affecting sharing to some extent.

Leadership's restriction of funding was highlighted by Meso 5 who noted: "as best as we have tried to push forward with the innovation, they [leadership] are saying 'oh that's a bit expensive'". Tensions experienced by project team members were attributed by Meso 6 directly to a lack of support from institutional leadership and vision for "what we were actually doing". Meso 10 lamented that, except for one manager, "the wider group of people in management who considered themselves leaders and visionaries had a negative impact on almost everything" associated with furthering adoption of the innovation. "One person was supporting it in management but then his direct peers and seniors would contradict that", added Meso 10.

Meso 3 described leadership as becoming "more a powerful force for evil than it was for good [because] it was there initially but then it disappeared" when it was particularly needed during the implementation stage. In the Meso 10 case the single source of support in the university was a person from senior management, who was viewed as being "against the grain of the rest of the management" in contrast to "the wider group of people in management, who considered themselves leaders and visionaries, [and] had a negative impact on almost everything". Such negative experiences contrast with the positive support given in the Inno 2 and Meso 9 cases in which the mandating by management of adoption of the innovation across the university was viewed positively. Inno 2 described also being part of a university leadership team and thus having sufficient influence to mandate adoption of the innovation, stating: "I mandated Yammer in all online courses in Christmas 2015 and now a year and a half later the DVC uses Yammer for leadership team meetings because I report in to the Deputy Vice Chancellor Academic". Rather than a focus on individual leadership and vision, Meso 7 viewed this being provided by "a number of people, not just one".

Central systems support through learning management system, professional learning and library services

A lack of central systems support was considered by many to be a major barrier in achieving wider adoption of e-learning innovations. Inno 1 reported that there were “no mechanisms from central support services to share anything”, unlike the Meso 4 case in which showcase videos of the innovation were created and distributed by a central support unit. A method used to overcome a lack of central support in the Inno 2 case was to bypass IT services by advising adopters “if you need support you Google it”. Inno 2 described the ambivalent role of IT as follows:

> It was like they’re [IT] saying, we’re not going to support this but we’re not stopping you either and some people [adopters] interpreted that lack of support as an inhibitor and some people didn’t care because they’d had a poor level of service from central services anyway.

Meso 6 suggested a potential benefit of having a supportive central IT role was that “people knew that they could call the help desk which they did for everything else” and could therefore also get assistance with e-learning adoption related issues such as “contracts for licensing”.

Inno 4 viewed opportunities for service provision by central systems as supporting testing and trialling, particularly through giving “advice on using some of the different tools” and assisting “home-grown ideas” and use of “other platforms” in addition to the university LMS. Inno 4 viewed the problem as “IT weren’t willing to support any of these other platforms”. The negative experience of Inno 4 in dealing with central systems support led to the conclusion that “sometimes it is better if they are hands-off and just let you get on with it” which was followed by the statement: “I'm wondering, if they were more supportive, whether we'd have more people actually taking it up”.

Difficulties in working with the people who ran the LMS were expressed by both Meso 4 and Meso 6. Meso 4 described “I was in a different central team to the central team that runs the LMS and they are hard to work with … because it was outside the LMS, they didn't have anything to do with the project” and “we had to work with their time frames and that took longer than necessary”. In the case of Meso 6 the “LMS team weren't initially very receptive but eventually, when they saw enough evidence or what people were doing, they realised that we weren't trying to reinvent their system and take over their universe”. The initial frustration experienced in the Meso 6 case was a difficulty in getting more server space to expand take-up of the innovation. Meso 6 found it initially difficult to overcome “technical constraints”, stating that “we needed more server space and it was quite a difficult thing to get that from central systems”. In the Meso 1 case, similar frustrations led to the use of a platform from outside the university’s own system. Overcoming an early barrier to adoption due to lack of IT support, resulted in Meso 1 using “an external provider” for hosting the ePortfolio innovation, rather than the university LMS managed by central systems. Meso 9 claimed a lack of integration with the LMS led “to another chore for teaching staff to make that connection” which inhibited further adoption of the innovation. Like Meso 1, Meso 10 also managed to bypass central systems. Utilisation of existing software licences was an option suggested by Inno 2 for working with rather than against central system control of resources, noting “the university has already got an agreement with Microsoft and this product is sitting there now”.

Central system roles that were viewed as necessary for furthering innovation adoption included the provision of professional learning, library and educational design services. Professional learning provision included “bringing in casual tutors and paying for them to have specific staff development for online teaching“ and going beyond the technical “nuts and bolts” to include “educational pedagogy” (Inno 3), as well as providing “some of the training and more involvement in letting people be more innovative with the tools they use” as well as stopping the “cut back on doing digital training” (Inno 4). For adoption of an innovation to occur it was also seen as necessary by Meso 8 to “provide the pedagogical expertise in technology enabled learning” for “having the true educational purpose fully realised”. In the Meso 3 case the library was also viewed as assisting readiness to adopt but did not elaborate on how this could be achieved. Inno 3 viewed the central support role of educational design technologist as providing “access to features in the LMS that were not yet open to the rest of the university” and thus educational technologists were able to support innovation development. Meso 5 described this role as “the innovation translator”. Meso 3 initially viewed problems as emanating from the role of central systems but after the *real* model was run acknowledged that “central systems didn’t play a big factor” in enabling the innovation to be adopted, once project funding and project management became available.

Project management of innovation development and implementation

In several cases it was recognised that project management of the development and implementation of e-learning innovations was desirable, but this also differed from traditional methods used in large scale IT projects. Inno 4 acknowledged that “project management for the research was definitely influential in getting more people on board with trying out different tools for digital portfolios”. A difference to traditional IT related project management noted by Meso 5 was that “what we do isn't things like implementing a learning management system [so] it's not a large long-term technology grind”. In the Meso 8 case this difference was also raised in the comment: “we don't work to a project management cycle”.

The suggestion was put forward in the Meso 1 case that “there should be a centralised way to manage these types of projects”. This was proposed as a solution for overcoming the disadvantage of using personal documentation such as *Excel* spread sheets and communication via email inboxes, resulting in the statement by Meso 1 that “nobody else really knows what we're working on at any time”. The role of academics was not seen in the Meso 1 case as requiring involvement in managing projects. Meso 1 noted: “academics I work with don't really have to get involved in any of that because they have professional staff to worry about that side of it”. In the case of Inno 1 the project management role was regarded as best suited to “online designers”. This was supported in the case of Meso 3, where the appointment of a project officer was made possible through the availability of second grant which allowed the online designer "to have a part-time commitment to managing a wider project" that led to further adoption of the e-learning innovation.

Comparisons were made between an ad hoc approach to implementation of innovations versus the need for more systematic planning of strategies for dissemination. Inno 4 noted that in sharing the e-learning innovation with potential adopters "you almost had to sit alongside them and talk them through", with the lack of implementation planning described as "more of a home-grown exercise" versus one in which formal project management methods could have been more useful. Meso 6 described how "the implementation wasn't done all that systematically" but instead "had a very organic growth" that did not appear to hinder adoption rates. One barrier to applying a more systematic approach was a lack of time, as noted by Inno 5 in stating: "I think it could have been implemented better if I had had more dedicated time to do this".

Experimentation opportunities and support for testing and trialling innovations

Benefits of experimentation were described as the opportunity to play with trialling innovations. Inno 2 described becoming "a much more emergent thinker" through letting "that notion of play inform where I think things can move to" while Inno 3 felt "being involved one-to-one and playing with it" brought similar benefits.

Experimentation that was ongoing, beyond the development stage into further adoption of the e-learning innovation, was described by Meso 1 as follows:

> They [the adopters] had to do their own testing and work out their own way to make it work and that's still ongoing for us as well. Even though we're keen to keep putting these things in place we [central support also] still keep experimenting.

In the cases of both Meso 1 and Meso 3, experimentation was not restricted to using internal university systems, with Meso 3 reporting that not relying on the LMS for use of the innovation had enabled experimentation that led to wider adoption by teaching academics.

Both individuals and groups played a role in driving experimentation. In the case of Inno 3, the experimentation that led to wider adoption was achieved by piloting the e-learning innovation with an experienced academic, "using a topic coordinator who was experienced in the topic as opposed to a brand-new person". In the Inno 4 case, a group rather than an individual played a supportive role: "testing and trialling came from when we had an online group who were there to give advice on using some of the different tools", but this relied on having "time to experiment and trial – properly". The focus on experimentation in the Meso 1 case was on the role played by the central support person. Meso 1 advised that "you need to have time to try these things out on your own before you bring anyone else along" and added, "I think there's probably not enough of that." The need for technical competence was noted by Meso 2 who also highlighted the pivotal role of the central support person in encouraging experimentation, stating: “if you've got a support person who is not particularly technology savvy, they're not going to recommend you to do the experimentation”. This was further illustrated by Meso 4 who reported that the “experimentation stage was largely just me … in response to the discussions that we'd had about identifying the platforms and systems based on the academic's needs”. Inno 5 also described how the online learning team “were on board with experimentation”.

Development of innovation through individual and team effort

The timing of decision-making appeared to play a role in the development stage of an e-learning innovation and involved both individual and team efforts and how tools were obtained. Inno 2 noted that “you think out the solution before you buy the tool” whereas the availability of existing tools within the university drove the timing and types of decisions made in other cases. Meso 6 described “the fact that we have the suite of Google tools available as a university supported system” enabled the innovation from the beginning, while in the case of Meso 7 “as the development process took place it became obvious that we needed to change towards using it in the LMS”. This eventual decision for Meso 7 came late in the project (before the innovation could be adopted) and was considered a contributing factor when “the development team received a Vice Chancellor's award”. Meso 7 wondered if commitment from leadership, throughout the development of the innovation, may also have had an impact on this success, noting:

> The thing that I found to be most interesting was the leadership team of the school, the Dean and myself, who were so committed to this happening, but maybe we're overestimating the impact we had. It was almost like we didn't have to persuade anyone all that much to get it going.

“Making the system easy to use” was suggested by Meso 6 as a key consideration for developing an e-learning innovation that had potential for further adoption. According to Meso 6, achieving ease of use required the development team or individual to have “all the necessary skills and expertise” but, as noted by Meso 5, limitations could arise if there was no capability available to undertake documentation in accordance with “industry standard software development”.

Inno 2 saw benefits in following an iterative approach for innovation development:

> Friction and messiness, if you like, actually helps create space for innovation because we’re trying to work out where we’re going and then, when we work at it a little bit, we see a problem and that problem generates the questions that we ask which generates the innovation.

In the case of Inno 3, successful development and implementation was viewed as being aided by “time release from the central support for their educational designer”, “starting with a proof of concept” and “looking for trends from a curriculum design point of view”. In the case of Meso 6 “the really important thing was the user driven design” and emphasising that “it's what they're [teachers are] trying to do that informs what we [educational designers] do”.

In the cases of both Meso 7 and Meso 8, team effort was regarded as having played a key role in successful development and implementation of the innovation. Meso 7 needed “to employ casual staff to be part of a team” which resulted in having “a really good team in place” but could have been enhanced by adding “some technical programming support”. The team in the case of Meso 8 were able to “come up with a solution together”. Meso 2 viewed the addition of a research assistant as extending development capacity, beyond producing “just in one subject for one week but perhaps every week or in all of the subjects”. By contrast, Meso 5 saw the development and implementation of e-learning innovations as driven by “the academic who was looking to push a fundamental change and shift to active learning” described as “the kind of people we called the lone rangers”.

Sharing ideas and ownership of an innovation with potential adopters

Achieving a sense of shared ideas and ownership by adopters of an innovation was described by Inno 2 as “when you've got people like the DVC [Deputy Vice Chancellor] saying ‘well I'm going to use it for my meetings and then we're going to use it on senior leadership conferences’ that means that people can't turn their backs on the tool”. This achievement was further described by Inno 2 as an innovation becoming “part of the wallpaper”: “no longer edgy, it's no longer out there” and having “entered mainstream thought in the organisation as a valid tool to use” resulting in a “power of the crowd that you can harness”. For Inno 3, sharing ideas about an innovation with potential adopters was viewed as “whetting peoples' appetites about what's possible”, which was enhanced when they [the potential adopters] asked “how many students did you have”. Inno 4 viewed opportunities to establish communities of practice as the best way for “sharing with each other so they're seeing what others are doing”. It was suggested that this method of sharing was further enhanced “when you [as the innovator] are teaching teachers [as] they are also your colleagues” and the innovator “was using it as a teaching strategy” rather than trialling it as a research project. Meso 3 suggested innovators could be proactive in promoting the innovation by providing statements, such as, “look, this is what we've done, do you want to be involved, I can see an opportunity”. Meso 5 saw benefits in the promotion of the innovation being led by academics as well as students.

In the case of Meso 10, students took on an ownership role with some becoming professional development tutors. Meso 6 also supported using “professional development strategies” through a process of “people showing what they could do and others buying into that idea and realizing they could do it themselves”. This was similarly expressed by Meso 8 in stating: “way beyond just meeting with us, they [the adopters] took up that concept of, I've got these ideas that I want to implement and I'm going to learn how to do it for myself” which turned adoption of the innovation “from being a hand-holding exercise”. Meso 2 reported that “we started by being the disciples of these tools but then we just found that nobody really had any issues or problems” so the adopters became the new disciples. Similarly, Meso 6 found that “once we had a few champions who were happy to show and tell and share, they did so through their departments" and this "sharing with their colleagues was even more powerful" than dissemination in any other form.

Dissemination about innovations with potential adopters

Inno 1 recalled the successful role of the former Australian Government-funded Office for Learning and Teaching (OLT), preceded by the Australian Learning and Teaching Council (ALTC). The OLT promoted dissemination of e-learning innovations across Australia and New Zealand, noting that "the old ALTC and OLT tried very strongly to promote dissemination across universities". In the case of Inno 2, dissemination was described as "creating a noise" about the innovation by writing and sending out an online update "every few weeks" and "continual spruiking [Australian slang for extensively elaborate promotion] of the tool". In the case of Inno 3, dissemination was achieved through "a number of conference poster presentations" and, at the time the study was conducted, "an article that's being reviewed about who's motivated to use digital badges" which "has been more external than internal". Inno 4 found that "using the portfolios in a teaching qualification, which is worth 120 credits and involves a significant amount of study, is a good way to disseminate an innovation like that because you're modelling how it can be used" thus providing "an exemplar ". Meso 3 described how dissemination to potential individual adopters was achieved by proactively engaging with them, as follows:

> I went to the geology people at the university who I didn't know and said to them: "look guys, this is what we've been doing in business and society [however] my background is geology. I know this will help the pedagogy of what you're trying to do with geology field excursions", and they leapt up and said: "yes, we can see what you've done, we'd like to apply too". But unless I went to them, they would not necessarily have found out about it as quickly, perhaps.

Enabled by a grant, Meso 3 also gained "opportunities to speak at conferences" about the innovation thus gaining an even wider audience for the innovation outside the university. At the time of conducting the study, Meso 4 was planning to make "showcase videos where the academics talk about projects they've been involved in". Meso 4, who viewed central support as providing the key advocacy role, noted "it was always handy being able to say, 'here's what your colleagues have been doing'". By contrast, Meso 6 reported: "we disseminated out but people sharing with their colleagues was even more powerful than that". Meso 7 viewed dissemination as a shared activity that occurred across the university, stating "the more it was talked about in the school and presented to people it generated excitement" and "that helped the vision and to keep it going along". Meso 9 "hosted quarterly forums", provided "guides for students and instructors" and presented "to the advisory group" which supported the development and implementation of the innovation.

Policy for guiding innovation adoption

In the cases of Meso 4 and Meso 10, the role of policy was added to the other 10 factors in the model as playing a role in e-learning innovation adoption. In Meso 4, policy "was more about compliance and legislation and it was more about institutional policy and just dealing with that" and was seen to have "played a fairly significant role in terms of what we were permitted to do". In the case of Meso 4, internal university policies were also viewed as playing an ambiguous role, reported as both "a positive and a negative" which, although it hindered the use of the innovation did not prevent its implementation. In the case of Meso 10 "the outside policy was a bypass [to internal institutional policy] by saying this is a federal government approach generally … and so provided endorsement" of the value of the innovation.

5.2.5 Summary of modelling results

A comparison of the values of means of all results (from modelling the 15 cases in the study) is shown in Figure 23. This comparison indicates development of the innovation (labelled *Develop*) as slightly ahead of readiness to adopt (*Readiness*) in indicating levels of importance across all Inno and Meso *real* cases, while readiness to adopt (*Readiness)* is clearly the most important role in all Inno and Meso *ideal* scenarios.

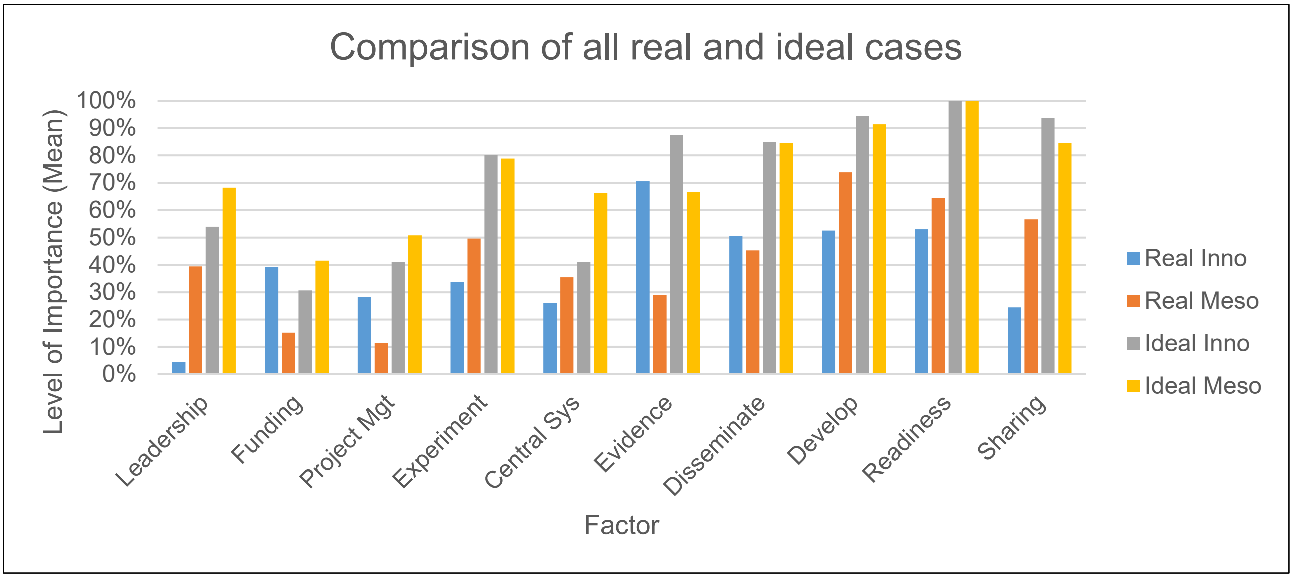


Figure 23. Comparison of importance of all Inno and Meso roles in *real* and *ideal* cases.

Readiness appears in Figure 23 as the most important role in *ideal* models for both Inno and Meso cases in the study. A comparison of means indicating levels of importance of roles in interactions in all *ideal* models shows *Readiness* at 100%, closely followed by *Develop* (Development) at above 90% and then *Sharing*, *Dissemination*, *Evidence* and Experiment (Experimentation). The least important role in all Inno *real* models is *Leadership* while in all Meso *real* models the least important role is *Project Mgt* (Management). In the Inno *ideal* models the least important role is *Project Mgt* while in the Meso *ideal* models it is (Project) *Funding*. The overall results in Figure 23 are noticeably lower for the importance of leadership, funding, project management, experimentation and central systems, which are associated with the management (*macro*) and central support (*meso*) quadrants in the model, compared with the innovator and adopter (*micro*) quadrant roles of readiness, development, dissemination and evidence and sharing which appear as the most important.

Table 27 shows the number of links for *real* and *ideal* models: enabling, inhibiting, two-way enabling and influencing.

Table 27. Frequency of enabling/inhibiting, two-way enabling links, influences.

Cases	Real enabling	Ideal enabling	Real inhibiting	Ideal inhibiting	Real two-way enabling	Ideal two-way enabling	Real influencing	Ideal influencing
Inno 1	14	24	9	0	0	2	4	4
Inno 2	6	13	2	0	0	2	3	4
Inno 3	6	22	1	0	0	3	3	5
Inno 4	15	18	4	0	0	1	5	8
Inno 5	14	19	1	0	4	4	2	4
Meso 1	14	20	3	1	2	3	3	3
Meso 2	6	13	0	0	0	1	1	4
Meso 3	14	16	5	0	0	0	4	8
Meso 4	17	18	1	0	2	4	3	3
Meso 5	12	14	2	1	1	1	4	4
Meso 6	23	26	6	0	3	4	2	4
Meso 7	14	17	4	0	0	3	3	6
Meso 8	8	17	3	0	2	3	4	5
Meso 9	22	28	2	0	3	4	4	5
Meso 10	16	24	12	0	3	4	4	5
Mean	**13.4**	**19.3**	**3.7**	**0.1**	**1.3**	**2.6**	**3.3**	**4.8**

In Table 27, single-direction enabling links dominate in models with far fewer roles indicated as influences, followed by frequency of two-way enabling links between roles.

Figure 24 was developed from the mean data shown in Table 27 and shows the change (labelled “Frequency change”) in mean values from *real* to *ideal* models and have implications for strategy development as they represent potential “base case” scenarios. The negative result for inhibiting links in the figure reflects the large number of inhibiting links that were removed in *ideal* models when compared with *real* models.

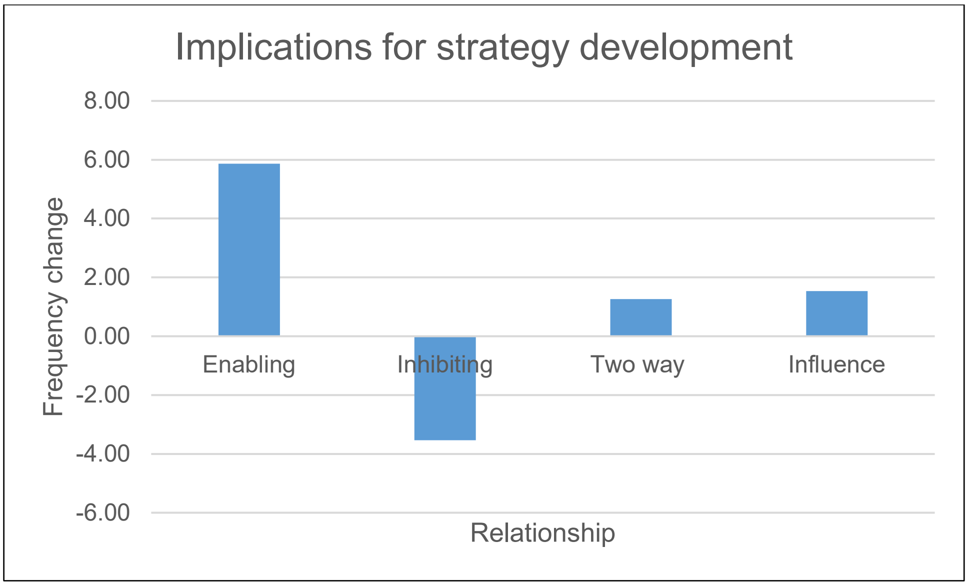


Figure 24. Frequency of all enabling, inhibiting, two-way enabling links and influences.

Implications for strategy development arising from Figure 24 along with the modelling results in Figure 23 are discussed in the next chapter and presented in the conclusion of this thesis.

5.3 Benefits of the modelling process

Participants in the study provided the following comments about the benefits of the modelling process in eliciting their insights for strategy development.

> One of the things that I'm intrigued by in the model is that it reflects how I think about things which is to tell people about it, they play with it so they tell you more about it, you tell more people about what they played with and you create these cycles of playing, trying, etc. (Inno 2)
>
> I really like your model. That was the most fun I have ever had in an interview. (Inno 4)
>
> Whenever you try to map things like this, you realise it's much more complicated than it looks. It's not top down. (Meso 1)
>
> I like the way this [model] gets you to think about the wider picture of what you're doing. It's very easy day-to-day to go meet with people to suggest they innovate, in some particular way, and help them do that and then walk away. You might write a paper about it, you might not. It's nice to have the time to sit and think it through. It's a nice visual way to think through what's happening and what's going on in the bigger picture as well as just at the coalface, so it's good. (Meso 2)
>
> To make it happen, and make it continue to happen, central support has to play a wider role and that's only going to probably come when you can gain that evidence of effectiveness and show that you are disseminating and you are sharing and you've got readiness to adopt. (Meso 3)
>
> It shows innovators working within an organisation where the leadership is giving them the vision for change. (Meso 5)
>
> It's been awesome fun. I know people have probably said it that the model's one thing and visualising it is the other thing. I think having someone else involved in this conversation is the most important thing. It's where models and technology like this actually enable an open conversation about change and reflection of change. So, I think it's been brilliant. (Meso 5)
>
> That's actually a good process. I'm into mind mapping and I like the visualising of something like that. I find it very helpful. You understand it a lot better seeing it. Brilliant! (Meso 7)
>
> I think those concepts within the quadrants are useful to think about along with this kind of networked thinking about innovation, yes, it's good. (Meso 9)
>
> I think the model for me was most useful in the depiction of reality in stimulating that new idea from the scenario. The ideal model reinforces my pre-existing assumptions that mainly Central systems and Project funding are not necessary, and the others will flourish despite these. (Meso 10)

These comments suggest that participants in the study found the process of Interpretive Case-based Modelling useful in confirming assumptions and eliciting new insights about their lived experiences along with suggesting what was needed to improve institutional capacity building for mainstreaming e-learning innovations in their universities.

5.4 Suggestions for improvement

Several suggestions for improving the modelling process used in this study were made by participants. These suggestions were mostly concerned with how to emphasise the different levels of importance between the roles depicted in the model and how to depict innovations occurring over time. Inno 1 offered the suggestion that the connecting “lines could really have different weightings on them” to show levels of importance, while also noting “there may be many more connections particularly when we're talking about actual reporting over the long-time line of the project.” Meso 6 provided a similar suggestion about depicting different time frames, stating during the modelling process:

> I almost want to put a timeline on some of these relationships because this was not in the initial stage. It was after many years of struggle, after we’d gotten to the top end of our user numbers, that the first line support for the course builder was handed over to the IT help desk but that didn't come early in the piece.

Both Meso 1 and Meso 4 suggested re-running the modelling process with input from others, with Meso 1 stating “I think if you do this activity with an academic it would look different again”. Meso 4 suggested “it would probably be worth having a chat to the lecturer who initiated the project” and “it would be quite interesting to compare her perception of this project to mine”.

These insights about the benefits of the modelling process and how it could be improved are discussed in the next chapter.

CHAPTER 6. DISCUSSION

> Obtaining and presenting personal experience stories and self-stories that embody, in full detail, the essential features of the phenomenon as constituted in the bracketing and construction phases of interpretation [and] presenting contrasting stories that will illuminate variations on the stages and forms of the process. (Denzin, 2001, p. 79)

This chapter draws on the findings from this study (Chapter 5) to compare data and to interpret the essential features of the phenomenon of mainstreaming e-learning innovations in higher education teaching practice. Within this discussion, similarities and differences are drawn that have implications for building institutional capacity in universities for mainstreaming e-learning innovations which is the focus of this study. As the final *contextualising* phase of the Interpretative Case-based Modelling methodology applied in conducting this study, this chapter leads to identifying implications arising from the impact of institutional role interactions in innovation adoption, which are presented in the conclusion of this thesis.

This chapter is guided by the sixth phase of the Denzin (2001) research design in which the phenomenon investigated by the study is relocated “back in the natural social world” (Denzin, 2001, p. 70). The social world modelled in this study represents *macro* (management), *meso* (central support) and *micro* (*innovator* and *adopter*) institutional stakeholder groups in Australian and New Zealand universities through the lived experiences captured in the recording and modelling of 15 participant case studies, as reported in the Findings chapter. Ten study participants identified themselves as working in central support and five identified as innovators of e-learning innovations. The inclusion of a larger number of central support (*meso*) participants in this study enabled previous studies (reported in secondary data analysis) to be extended by including greater representation of university staff with an IT focus, as recommended by Gunn and Herrick (2012).

In this discussion, actionable insights from the primary data recorded during the modelling of participants’ lived experiences are compared and examined with reference to the secondary data and literature review. Responses to the research challenges raised in Section 2.5 are discussed with reference to findings from primary participant data (Section 5.2) and the deconstruction and analysis of secondary data sources (Section 5.1) in this study. Participant insights are included to reveal the “wicked” challenges of mainstreaming e-learning innovation adoption. The effectiveness of Interpretive Case-based Modelling, as a new research methodology developed for conducting this study in addressing the challenges of wicked problems, provides a conclusion to this discussion.

This chapter examines the wicked questions presented in Section 2.5.2, in light of the findings of this research, as follows:

- How the problem in each university is unique
- How the problem can be defined
- How the problem is multi-faceted
- How multi-stakeholders are motivated
- How organisational boundaries in universities are straddled
- How the problem is connected to other problems in universities
- How solutions have system ramifications
- How better/worse solutions compare with right/wrong solutions
- How time needed for evaluation impacts on solving the problem
- How the problem is never completely solved.

6.1 How the problem in each university is unique

> Despite seeming similarities among wicked problems, one can never be certain that the particulars of a problem do not override its commonalities. (Rittel & Webber, 1973, p. 165)

The Interpretive Case-based Modelling process developed for this study started with each participant telling their personal story of a lived experience of the adoption of an e-learning innovation as it had occurred in their own university during the past three years. The transcript of the interview with Meso 3 is provided in Appendix 4 as a sample of a participant's story and further edited transcriptions are available on request. Making the baseline model visible to participants from the start of recording each interview proved to be an effective aid in eliciting these rich stories of lived experiences. The participant stories highlight a range of problems that had occurred within university settings. During the generation of the models from these stories, many variations associated with these problems became apparent along with some notable similarities. In the modelling stage of the study, problems identified by participants from their own experiences in achieving mainstream adoption of an e-learning innovation were indicated by the red inhibiting links between university stakeholder roles shown in the *real* models provided in Tables 12 through 26. These tables describe the 15 cases provided by study participants which are correspondingly referred to as Inno 1 to Inno 5 and Meso 1 to Meso 10 throughout this discussion.

In the *real* models, a wide range of variations between inhibiting links appear to suggest that problems are unique to each case, with only a few similarities that can be drawn from these problematic relationships. *Central Systems* was the most common source for problematic relationships identified by 11 of the 15 participants (Inno 1, Inno 2, Inno 4, Meso 1, Meso 3, Meso 4, Meso 6, Meso 7, Meso 8, Meso 9, Meso 10). The shaded areas in Table 28 show where *real* models in the 15 case studies contain inhibiting links emanating from *Central Systems*. A small

South Australian university (indicted in the table by a single asterisk * was the setting for the two cases of VCLE adoption described by Inno 1* and Meso 7*. The three other cases all occurred within the same large Queensland university (indicted in Table 28 by a double asterisk **): Inno 2**, Meso 8** and Meso 9**. The three ** cases involved the adoption of Yammer Discussion Forums (Inno 2, Meso 9) and a Course Map Infographic (Meso 8). The similarities between the connections from *Central System*s to *Development* and *Readiness* in the Inno 2 and Meso 8 cases are further highlighted by the darkest shading within the table.

Table 28. Roles in *real* models with inhibiting links from central systems.

Cases	Development	Dissemination	Evidence	Experimentation	Leadership	Project Funding	Project Mgt	Readiness	Sharing
Inno 1*									
Inno 2**	**							**	
Inno 3									
Inno 4									
Inno 5									
Meso 1									
Meso 2									
Meso 3									
Meso 4									
Meso 5									
Meso 6									
Meso 7*									
Meso 8**	**							**	
Meso 9**									
Meso 10									
Totals	**5**	**2**	**1**	**2**	**0**	**1**	**5**	**6**	**1**

Legend
* Small South Australian University
** Large Queensland University

As shown in Table 28, the inhibiting links from *Central Systems* in the *real* models for the five asterisked cases connected to *Dissemination* and Experimentation (Inno 1); *Development of the Innovation* (*Development*) and *Readiness to Adopt* (*Readiness*) (Inno 2, Meso 7, Meso 8); and *Project Management* (*Project Mgt*) (Meso 9). Similarities between Inno 2 and Meso 8, evident in the *Development* and *Readiness* columns, suggest these two cases may have had similar problematic experiences with restrictions imposed by central systems functions within the same university, even though the type of innovations, Yammer Discussion Forums and Course Map Infographic, and how they were adopted differed widely in both cases.

A comparison with other cases shows that inhibiting links from *Central Systems* to both *Development* and *Readiness* also occur in Inno 4. In other *real* models, inhibiting links from *Central Systems* connect to *Development* (Meso 1); *Readiness*, *Experimentation*, *Project Mgt* and *Project Funding* (Meso 3); *Project Mgt* (Meso 4); *Dissemination*, *Readiness* and *Project Mgt* (Meso 6); and *Readiness*, *Sharing Ideas and Ownership* (*Sharing*), *Evidence of Effectiveness* (*Evidence*) and *Project Mgt* (Meso 10). In the remaining four *real* models selected for comparison in Table 28 (Inno 3, Inno 5, Meso 2, Meso 5), no inhibiting links originated from *Central Systems*, although Inno 3, Inno 5 and Meso 5 all showed one inhibiting link originating from *Leadership and Vision* (*Leadership*). In summary, the most common inhibiting links from *Central Systems* in *real* cases connected to *Development* (five links); *Project Mgt* (five links) and *Readiness* (six links) with

Leadership also providing inhibiting links to these roles in three cases.

These comparisons suggest that while problems in each university at first appear to be unique, there are similarities in problems emanating from the role of central systems affecting readiness to adopt, and to a slightly lesser extent the development of innovations and project management. These similarities suggest an opportunity for building institutional capacity for mainstreaming e-learning innovation adoption by developing further capacity in the role of university central systems to support both the readiness to adopt innovations and the development of innovations that originate from within the university. It appears readiness to adopt and development of innovations could be further supported by strengthening project management as a centralised function within universities. It is also notable that in the secondary data analysed for this study, no references were found to supporting adopters nor developing innovations through centrally located support roles in universities. In the secondary data sources, primary functions of central support roles were largely described as related to software infrastructure and technical support (Davis & Fill, 2007; Gunn & Herrick, 2012; Csete & Evans, 2013; Salmon & Angood, 2013; Smigiel, 2013; Gregory et al., 2015; Robertson, 2015; Selwyn et al., 2016b; Pomerantz & Brooks, 2017) and compliance and risk management (Robertson, 2015; Selwyn et al., 2016b).

This study demonstrates that a richer view of both unique and common features of the problem of mainstreaming e-learning innovation adoption in each university can be gained from modelling connections between actors and factors to represent relationships between institutional stakeholder roles. As revealed by Interpretive Case-based Modelling, the most problematic relationships in mainstreaming e-learning innovation adoption in universities appear to involve stakeholder roles emanating mostly from central systems with regards to project funding, readiness to adopt and project management and to a lesser extent from leadership and vision.

6.2 How the problem is defined

The process of solving the problem is identical with the process of understanding its nature.
(Rittel & Webber, 1973, p. 162)

As discussed previously, the role of *Central Systems* was identified by 11 of the 15 participants as representing the most common inhibitor with the largest number of links to other roles in depicting the *real* models (see Table 28). The other sources of inhibiting links identified by participants in populating the *real* models with stories of their lived experiences were *Leadership*, identified by eight participants (Inno 1, Inno 3, Inno 5, Meso 3, Meso 5, Meso 6, Meso 8, Meso 10); *Project Funding*, identified by four participants (Inno 1, Meso 1, Meso 7, Meso 10); *Readiness*, identified by four participants (Inno 4, Meso 1, Meso 5, Meso 10); *Project Mgt*, identified by three participants (Inno 1, Meso 1, Meso 9); and *Skills for Development*, which was added by Meso 6 as an inhibiting role.

The *real* models created in the study show *Readiness* as the sole source of inhibiting links at the *micro* stakeholder level (which comprises the Innovator and Adopter quadrants). From *Readiness*, inhibiting links in *real* models connect to *Sharing* (Inno 4, Meso 5), Evidence (Meso 1) and *Development* (Meso 10). By contrast, across the *Management* and *meso* quadrants in the *real* models, all roles except *Experimentation* are identified as a source for problematic role relationships. The contexts provided by study participants contained both similarities and differences in describing the five most problematic roles: *Central Systems*, *Leadership*, *Project Funding*, *Readiness* and *Project Mgt* in the models. A discussion of each of these five problematic roles follows, supported by contexts provided in participants' own stories, secondary data and references to the research literature, with a view to revealing how an understanding of these problematic roles also offers potential solutions.

6.2.1 Central systems

A lack of communication, inconsistencies with communication, and technical and training support were variously described as sources of problems associated with the role of central systems by nine of the 15 study participants (Inno 1, Inno 2, Inno 4, Meso 1, Meso 3, Meso 4, Meso 6, Meso 9, Meso 10). In this study, the role of central systems represented support functions associated with the implementation and management of an LMS and professional learning and library services provided centrally in a university. Inno 1 described the cause of the main problem with central systems as a lack of an information sharing mechanism. Inno 4 viewed the problem as both a lack of IT support for software and platforms that were not part of the university LMS coupled with cutbacks in training. Meso 6 found it difficult to overcome a lack of server space. Lack of internal university IT support resulted in Meso 1 going outside the university to host an ePortfolio innovation. Meso 3 initially experienced similar problems with the university LMS but was able to bypass these once project funding and project management were available. Difficulties in working with central systems' management of the LMS were also raised by Meso 4 who also found working with uncooperative staff members and the constraints of unrealistic time frames were problematic. Inno 2 viewed central systems as playing an ambivalent role, which at times supported but at other times frustrated efforts of academics to develop and promote adoption of their e-learning innovations.

Limitations of central systems in supporting the updating of content that resided on the LMS was seen by Meso 8 as a major inhibitor to realising the educational purpose of the innovation and thus furthering adoption of the innovation. Frustration with central systems was experienced by Meso 9 due to a continuing lack of integration of the innovation with the LMS. This created more work for academics in updating content and inhibited further adoption, although Meso 9 was optimistic about overcoming this. Like Meso 1, Meso 10 managed to bypass central systems by selecting a platform from outside the university, but this decision then impeded gaining central support for project management and evaluation. As reported in the deconstruction and analysis of secondary data in Section 5.1, Selwyn et al. (2016b) suggested that central systems support for the integration of non-enterprise software and online services would be beneficial for overcoming the need to bypass a university LMS and thus maintaining vital institutional support for furthering the adoption of an e-learning innovation.

6.2.2 Leadership and vision

Problems with inconsistencies in leadership and vision from management were reported by seven participants (Inno 3, Inno 5, Meso 3, Meso 5, Meso 6, Meso 8, Meso 10). In interview transcripts, a lack of leadership at the start of developing an e-learning innovation from within a teaching practice environment was noted by Inno 5, while Meso 3 expressed anger about changes in leadership within the university throughout the innovation development stage that ultimately slowed down adoption of the innovation. Restrictions on funding imposed by university management, who seemingly felt the e-learning innovation was too costly, was reported as hampering opportunities for further adoption in the case of Meso 5. A lack of support from institutional leadership was reported by Meso 6 as leading to tensions amongst university staff and the academics who were committed to e-learning innovation and this was attributed (by Meso 6) to management in the university not fully understanding how e-learning worked and its potential benefits in transforming teaching practice, beyond administrative functions. In the case of Meso 10, only one manager contributed to furthering adoption of the innovation and this manager was also hampered by lack of support from peers and more senior management. Inconsistencies in leadership and vision led Meso 3 to describe management in universities as a "more a powerful force for evil than it was for good" in lamenting that while there was leadership and vision from university management at the beginning of development of the e-learning innovation, this disappeared when it was most needed during adoption.

These negative experiences contrast with mostly positive views of university leadership and vision reported in the findings by the other eight participants (Inno 1, Inno 2, Inno 4, Meso 1, Meso 2, Meso 4, Meso 7, Meso 9) and in the secondary data. University management's leadership and vision was viewed by seven of the 22 sources of secondary data used in this study (see Table 2) as driving innovation adoption by providing strategic planning, decision-making, direction and governance (Czerniewicz & Brown, 2009; Gunn & Herrick, 2012; Salmon & Angood, 2013; Dennison, 2014; Singh & Hardaker, 2014; King & Boyatt, 2015; Robertson, 2015). Both Salmon and Angood (2013) and Robertson (2015) regarded university leadership as an essential role in dismantling institutional barriers, described by Inno 5 as "surrounding institutional silos". Other barriers reported by participants, particularly to funding and those caused by inconsistencies in decision-making, contrast with a more optimistic view of leadership in universities as fostering a harmonious climate for development and adoption of e-learning innovations suggested by Snyder et al. (2007) and Singh and Hardaker (2014). Salmon and Angood (2013) recommended establishing partnerships and direct lines of communication among management, information technology specialists and teachers. This was to be followed by establishment, recruitment and promotion of the "pivotal role [of] learning technologists" (Salmon and Angood, 2013, p. 922) in universities as leaders and change agents, thus locating leadership roles for innovation adoption in the central support (*meso*) quadrant rather than the management (*macro*) quadrant of the model.

6.2.3 Project funding

Fluctuations in funding availability - in some cases a complete lack of funding - created problems for four study participants (Inno 1, Meso 1, Meso 7, Meso 10). Extreme fluctuations were described by Inno 1 as ranging from having no funding to good funding then back to no funding. The impact of a lack of funding was felt most by Meso 1 once the innovation reached readiness for adoption. For Meso 7, a lack of funding reduced capacity for project management while, in the case of Meso 10, it limited opportunities for generation of evidence of the innovation's effectiveness and wider recognition.

As reported in the Findings chapter, around half of the studies examined for secondary data analysis viewed the provision of adequate funding as a key factor for ensuring successful mainstreaming of both e-learning innovation development and adoption. This was a view supported by Davis and Fill (2007) and Gunn and Herrick (2012) who recognised the need for ongoing funding beyond the initial development stage of an e-learning innovation, but also acknowledged such funds were rarely available or ran out before they were needed for supporting adoption of innovations in universities. In some cases, as Selwyn et al. (2016b) noted, limitations in funding could be overcome if a university provided free software and technologies. However, such central control contrasted with the need for decentralised academic financial autonomy recommended by Snyder et al. (2007), as being particularly necessary for e-learning innovation adoption that was driven bottom-up.

Unlike top-down driven innovation adoption, Selwyn et al. (2016a) recommended funding bottom-up, e-learning innovations on a "fail fast and fail often" (p. 28) basis, rather than scoping projects over a longer term. Such a recommendation would place project funding in the innovator (*micro*) quadrant of the model. While potentially attractive to innovators with a role in teaching practice, particularly for those keen on experimentation, such iterative funding strategies could be problematic by presenting a challenging proposition for largely conservative funding decision-makers who remain represented in the management (*macro*) quadrant of the model. Similarly, in the research literature, Ellis and Goodyear (2019) viewed reliance on external funding as potentially problematic if it bypassed university management decision-making.

6.2.4 Readiness to adopt

As mentioned previously, *Readiness* was the only role identified by study participants from the Innovator and Adopter (*micro*) level in the model as a source for inhibiting links to other roles. A lack of physical resources, computer skills and adopter resistance to change were variously described by three study participants (Inno 4, Meso 5, Meso 10) as generating problems. Lack of the right equipment in a university and an academic's low level of computer skills were both regarded by Inno 4 as barriers for adoption of e-learning innovations. Academic resistance to change was seen by Meso 5 as a barrier that could be viewed from two sides: those wanting to cling to traditional teaching environments and practices versus those willing to change these. Further resistance was noted by Meso 10 when innovations were promoted solely by the innovator from within an originating university, rather than from outside through publications and conferences.

In the secondary data, resistance to change found in professional staff and academics towards e-learning was described as based in suspicion and scepticism (Laurillard et al., 2009; Anderson, 2012; Smigiel, 2013; Singh & Hardaker, 2014) as well as driven by negative attitudes and ignorance about digital technologies in general (Selwyn et al., 2016a). More recently, similar views were expressed in the research literature by Keehn et al. (2018) suggesting that many negative attitudes continued to prevail in universities. Selwyn et al. (2016b) noted that providing training and support to overcome resistance remained a challenge for universities while academic staff clung to traditional beliefs and values, while even those who were ready to adopt sometimes remained hesitant. Such a two-sided view of resistance to the adoption of e-learning innovations was described by Pomerantz and Brooks (2017) as representing “a love-hate relationship with online teaching and learning” (p. 7).

6.2.5 Project management

Three study participants described a lack of both availability of centralised project management systems and support for non-traditional methods as inhibiting the planning deemed as necessary for managing bottom-up e-learning innovation adoption. A lack of a centralised university system for managing projects was a concern expressed by Meso 1, whose use of personal digital spread sheets and emails meant sharing of information was limited. In several cases it was recognised that project management of e-learning innovation adoption differed from traditional methods used in large scale IT projects. Four study participants (Inno 4, Meso 5, Meso 6, Meso 8) noted that planning for e-learning innovation adoption was not conducted in the same way as traditional IT-related project management because bottom-up adoption was an ad hoc and organic process rather than being systematic. Inno 4 described how the ad hoc approach involved sitting alongside adopters. In the Meso 6 case, applying an organic approach to project management did not hinder adoption rates. By contrast, a lack of dedicated time for implementing a more formal project management approach was seen by Inno 5 as hindering innovation adoption rates.

From the secondary data it is apparent that there are differing views about how adoption of e-learning innovations should be managed, both up to (Salmon & Angood, 2013) and beyond (Gunn

& Herrick, 2012) the proof-of concept stage of developing an e-learning innovation. Methods proposed ranged from traditional top-down, structured project management to iterative and incremental approaches, with the latter viewed as more suited to bottom-up initiatives (Selwyn et al. (2016b). In the literature reviewed for this study, Bates and Sangrà (2011) described bottom-up adoption of e-learning innovations as driven by just a few enthusiastic innovators and early adopters they called the "lone rangers". Stepanyan et al. (2013) noted that such lone rangers mostly lacked institutional support for managing large-scale adoption of e-learning innovations at the scale typically associated with management-driven, top-down, university-wide implementation of an LMS. There was also a view expressed that mandated, top-down-driven LMS implementation stifled the kind of creativity associated with bottom-up e-learning innovation and its adoption (Fullan, 2015; Gunn & Herrick, 2012). Quinn and Fullan (2018) proposed that project management aimed at bridging this top-down, bottom-up divide in universities required strategies that were non-linear, agile and better suited to solving the multi-dimensional problems of complexity found in cases of educational change.

6.3 How the problem is multi-faceted

> There are no ends to the causal chains that link interacting open systems. (Rittel & Webber, 1973, p. 162)

The discussion in the two previous sections (6.1 and 6.2) of this chapter demonstrates how stakeholder relationships associated with problem of achieving mainstream adoption of e-learning innovations are multi-faceted. These relationships span the ten stakeholder roles in the baseline model used in this study and are evident as factors in the innovation adoption process and in the boundaries between institutional stakeholders, as the actors in university systems. From these multi-faceted relationships, mainstreaming e-learning innovation adoption in higher education practice presents as a complex problem, with multiple factors and actors, in a complex system. The multi-faceted characteristics of this complex problem in a complex system are most apparent in the many variations between the *real* and *ideal* models elicited from participants' stories in this study. No two models were the same and each contained a wide range of different inputs (see for example Table 27, Figure 23 and Figure 24).

In the models, ten distinct stakeholder roles (factors) were distributed across the four stakeholder quadrants (actors) to provide the baseline model used in this study, reflecting the multi-faceted characteristics of university systems. In modelling the cases, multiple links and dependencies between stakeholder roles were best illustrated in the following reflection by Meso 3, after running the *ideal* model:

> To make it happen, and make it continue to happen, central support has to play a wider role and that's only going to probably come when you can gain that evidence of effectiveness and show that you are disseminating and you are sharing and you've got readiness to adopt. (Meso 3)

Unlike Meso 3, Meso 8 viewed reliance on central support as unnecessary for innovation adoption as long as academics had the agility and skills to “do it for themselves” (Meso 8) when adopting e-learning innovations. Such variations continued to be evident in further comparisons of the models and different contexts reported in this study.

A multiplicity of job titles represented in university systems added further to the portrayal of a multi-faceted problem, with the job of some innovators requiring juggling of multiple tasks, as described by Inno 5. In Section 5.2.2, 35 separate job titles obtained from participant interviews are listed. Of these, 16 different job titles were associated with the central support function in universities compared with 12 associated with innovators, 4 in management and 3 for adopters. With only a few exceptions, central support functions reflected traditional university job titles, such as, academic director (Inno 2); topic coordinator (Inno 3); project manager (Inno 3, Inno 4), project officer (Meso 3), academic staff development (Meso 3, Meso 6) and learning designer (Meso 2, Meso 5, Meso 6). The exceptions were hybrid job titles that were described as a combination of teacher and educational designer (Inno 4), education innovation officer (Meso 4) and learning and research technology manager (Meso 5). As noted in the literature review, Daly (2018) viewed this hybridisation as representing part of a transition from “specialists to cross-trained generalists” (p. 158). Ellis and Goodyear (2019) preferred the title “educational technologists” for such roles, while Salmon and Angood (2013) strongly favoured “learning technologists”, as previously reported in Section 2.4.3.

The 32 different job titles identified in the secondary data sources closely approximate a similar number (35) found in primary data gathered from participant interviews. The secondary data identified 11 different management titles, representing both academic and professional job functions, 14 for central support, 4 for innovators and 3 for adopters. This multiplicity of job titles, particularly for describing functions in central support, provides further examples of inconsistent terminology to support views presented in the literature review by McAleese et al. (2014), Bates (2018) and Adams Becker et al. (2018) which together suggest that both e-learning innovation and its adoption in universities are still evolving.

As Levin and Jacobson (2016) noted, such inconsistencies provide ongoing challenges for shaping new workplace environments in building capacity to adopt complex technology integration in teaching practice which they describe as located within a complex education system (Jacobson, 2015; Levin & Jacobson, 2016). Added to this challenge, this system continues to operate within “a continually changing technological and pedagogical context” (Nichols, 2008, p. 608).

6.4 How multi-stakeholders are motivated

> The higher the level of a problem's formulation, the broader and more general it becomes: and the more difficult it becomes to do something about it. (Rittel & Webber, 1973, p. 165)

Findings from primary data revealed a range of motivational attributes and conflicting agendas associated with stakeholder groups. While innovators tended to be passionate and persistent loners, central support staff, who had a primarily IT-focussed role, tended to be risk averse and focussed on control. Professional learning staff members were proactive in providing support, while management appeared largely passive. Adopters became frustrated by lack of time and understanding of new pedagogies enabled by technologies.

Inno 3 and Inno 5 both described themselves as persistent and having a passion for developing and achieving further adoption of their e-learning innovations, although frustrated by lack of time to share innovations (Inno 3) and feeling alone (Inno 5). Meso 2 described those with a technical central support function as not motivated to experiment with teacher-led innovations because they were focussed primarily on the LMS and centralising control of e-learning. By contrast both Meso 3 and Meso 8 described being motivated to proactively promote dissemination of e-learning innovations. Management was presented by Meso 4 as passive and only interested in funding decisions. Meso 4 also noted that adopters expressed frustration with lack of time to experiment with the new pedagogies enabled by e-learning innovations. In several cases, as reported by Meso 1 and Meso 4, innovators and central support took on the leadership and vision role that was an expectation of management.

In the literature review of DoI theories, Arkorful and Abaidoo (2015) recommended that academics who adopt e-learning innovations need to have strong motivation to overcome traditional preferences for face-to-face delivery, coupled with skills in time management and technology-enabled pedagogies. In a case study, Smigiel (2013) described potential adopters of e-learning innovations as maintaining a “veiled suspicion” (p. 85) of the university’s motivation for introducing online teaching and learning. Singh and Hardaker (2014) associated similar suspicions with perceived negative impacts of e-learning on an individual teacher’s academic role and autonomy. Selwyn et al. (2016a, 2016b) and Pomerantz and Brooks (2017) attributed resistance to change by academics to negative attitudes towards e-learning, even when their beliefs supported teaching improvements with e-learning were possible. This further reflects the ambivalent and conflicted “love-hate relationship” (Pomerantz & Brooks, 2017, p. 7) noted in Section 6.2.4.

6.5 How organisational boundaries are straddled

> System boundaries get stretched, and as we become more sophisticated about the complex workings of open societal systems. (Rittel & Webber, 1973, p. 159)

As introduced in Section 1.2, organisational boundaries in this study are depicted in each case-based model as bordering four quadrants that represent the groups of institutional stakeholders who are the key actors in e-learning innovation adoption in universities. The four stakeholder quadrants represent: university management, university support services, innovators working in faculties and adopters of innovations originating in faculties. These groupings also represent three activity systems, viewed as levels from an Activity Theory perspective. These levels were identified by Robertson (2008) as “organisational” (p. 821) management roles at a *macro* level, “technological” (p. 822) information and training support roles at a *meso* level and two “pedagogic” (p. 822) *micro* level roles representing e-learning *innovators* and *adopters* who teach students.

The boundaries between the four quadrants in the case-based models are straddled by connecting lines between roles in each group, with the function of each group role associated with a critical success factor in achieving mainstreaming of e-learning innovation adoption. By applying Interpretive Case-based Modelling in interview methods used in this study, connections between roles in the models were made that straddle the four stakeholder group quadrant boundaries by drawing enabling and inhibiting links between the stakeholder roles represented within each quadrant.

Representation of the quadrants in the models confirmed suggestions in primary data, secondary data and the literature review that universities are made up of institutional *silos*. Inno 5 reported feeling “like we worked in a silo as opposed to working more institution-wide”. In framing the research question for this study, it was noted that themes from the literature described universities as silo-based institutional systems (Robertson, 2015; Salmon & Angood, 2013) in which roles and relationships between university academic and professional staff were continually being impacted by introduction of new technologies.

The study presented a vision of how boundaries between institutional silos could be successfully straddled by generating models of *ideal* scenarios that were derived from *real* models of mainstreaming the adoption of e-learning innovations. In *ideal* models, single and two-way enabling links between stakeholder roles dominated compared to fewer enabling links and many more inhibiting links in the *real* models (see Table 27).

Table 29 shows roles in ideal models that included enabling links from leadership. The largest number of enabling links were evident from *Leadership* in the *ideal* models, particularly one way* and two-way** enabling links from *Leadership* to *Development*, as highlighted within the shading in Table 29.

Table 29. Roles in *ideal* models with enabling links from leadership.

Cases	Central Systems	Development	Dissemination	Evidence	Experimentation	Project Funding	Project Mgt	Readiness	Sharing
Inno 1	*	**	*	*	*		*	*	*
Inno 2									
Inno 3		*				*	*		
Inno 4		*		*		*			
Inno 5		**				*		*	
Meso 1		**	*			*		*	*
Meso 2	*	*							
Meso 3		*							
Meso 4			*			*	**		
Meso 5						*			
Meso 6						*	*		
Meso 7		*	*		*	*	*		
Meso 8		*			*				
Meso 9		**			*	*		*	
Meso 10		**	**		*				**
Totals all	**2**	**11**	**5**	**2**	**5**	**9**	**5**	**4**	**3**
Total **		**5**	**1**				**1**		**1**

Legend
* one way from Leadership
** two way from to Leadership

The distribution of enabling links from *Leadership* to all other roles in *ideal* models, as shown in Table 29*,* confirms the need for leadership in facilitating collaboration across the university. This leadership role was also identified by Salmon and Angood (2013), Robertson (2015) and Fullan and Quinn (2016) as pivotal for dismantling institutional barriers around organisational boundaries. Salmon and Angood (2013) viewed "learning technologists" (p. 922) in universities to be well suited to the role of leaders and change agents which, in this study, would place the role of leadership in the *meso* central support quadrant rather than in the *macro* management quadrant in the models.

Fullan and Quinn (2016) depicted leadership as a centralised function, explained as radiating from the centre into each of the four quadrants of their Coherence Framework. By contrast, Robertson (2015) viewed breaking down institutional silos as a *micro* teaching level role, where faculty acted as "gatekeepers to changes in teaching practices" (p. 148). Bates (2017) held a similar view of educators as the ones who should control and manage "the use of computing for teaching and learning" (p. 308). The term "organisational glue" (Czerniewicz & Brown, 2009, p. 114) was applied in describing the strategic role of institutional leadership as an intermediary in straddling organisational boundaries. Two study participants, Meso 4 and Meso 10, indicated a role for e-learning policy, added to the *macro* (Management) quadrant in straddling boundaries. It is worth noting that Conole et al. (2007) warn that policy effects on practice can be unpredictable and erratic.

Daly (2018) argued for a distributed rather than a centralised leadership role in educational change that was not guided by "rigid policy and procedure but facilitated through simple, shared and flexible parameters that honor professionalism and the influence of context" (p. 158). The lack of certainty and ambiguity these different views represent appear to support the visualisation of Bolden et al. (2015) of a "'sinking ship' model of academic leadership" (p. 11) in which "professional identity and purpose does not map neatly onto organisational boundaries" (p. 9). A blurring of leadership roles between management, professional staff and academics is viewed by Bolden et al. (2015) as creating "[a] 'third space' in which professional staff engage in leadership activity based on their expertise, particularly in learning and teaching support areas" (p. 10). Meso 4 locates this blending of leadership roles in the centre of the model, stating “if you look at Third Space Theory, in some ways we're at the juncture.” The blurring of these different leadership identities becomes a challenge for defining organisational boundaries and how they can be straddled in universities.

Interpretive Case-based Modelling in this study demonstrates the importance of considering the unique contexts for mainstreaming e-learning innovations in universities. Many differences in the relationships between roles, together with some similarities, became apparent when participants compared and interpreted the models. Inno 5 liked how the results of enabling links, that connected the roles in the quadrants, were “relatively even between all four quadrants” in their *ideal* model compared to results from the uneven distribution of both enabling and inhibiting links in the *real* model. Similarly, Inno 1 speculated that “if you can get all these things to work in harmony with each other they can all help each other and are important” by observing “there's a lot more aligned in there so almost everything could be connected to everything else with a feedback mechanism”. The need for a harmonious climate for development and adoption of e-learning innovations was also noted in the secondary data provided by Snyder et al., (2007) and Singh and Hardaker (2014). Meso 1’s *real* model reflection suggested that working in silos was not *ideal*, noting that “we are doing our own thing, but I think that's not really the way it should be”. Meso 9’s *ideal* model reflection provided the following insight: “I think those concepts within the quadrants are useful to think about along with this kind of networked thinking about innovation”. Meso 2 remarked: “I like the way this [*ideal* model] gets you to think about the wider picture of what you're doing … it's a nice visual way to think through what's happening and what’s going on in the bigger picture as well as just at the coalface, so it's good”. This big picture view of how organisational boundaries can be straddled allowed participants to draw interpretations, from the patterns created in the models. Numerous theories about the existence of these patterns have been proposed in the research literature but not previously observed in conducting studies of the diffusion of innovations.

The suggestion by Inno 1 to include a “feedback mechanism” in the model supports the inclusion of a feedback feature of the Bass Model (Section 2.2.4), which itself is an adaptation of the original Rogers (1962) DoI theory. In the Bass Model, aggregated feedback loops define diffusion effects rather than the interactions between non-linear and dynamic real-world behaviours depicted by the ABM method used in this study. Kiesling et al. (2012), a proponent of ABM for studies of the diffusion of innovations in complex systems, argued for the depiction of interactions to “reproduce the complexity of real-world diffusion patterns” (p. 6). Interpreting these patterns of interaction in the *ideal* models from this study has enabled identification of new channels and directional flows for communication, as is recommended by Gunn (2014). These communication channels and flows represent opportunities for collaboration across institutional silos in straddling the complex organisational ecosystem in universities (Pacansky-Brock, 2015) and for resolving the tensions described by Fullan and Quinn (2016) between technical and social forces in education systems. The establishment of professional communities of practice, proposed by Gunn (2010) and raised by Gunn and Herrick (2012) in their studies, could be an effective way of building cross-functional collaborative environments (Gunn, 2010; Gunn & Herrick, 2012) for straddling boundaries in universities.

6.6 How the problem is connected to other problems

Every wicked problem can be considered to be a symptom of another problem. (Rittel & Webber, 1973, p. 165)

This study revealed that problems with achieving mainstream adoption of e-learning innovations were connected to other problems in universities, such as lack of funding reliability; policies and guidelines not being appropriate for encouraging innovation; insufficient allocation of time and resources; and inadequate workplace systems to accommodate 24/7 online learning. The first three of these are discussed in the following paragraphs, while the latter is discussed in more detail in the following section.

Experiences with funding problems varied across the cases modelled in this study. Nine of the 15 participants reported problems within their universities directly related to funding, policies and guidelines and workplace provision of time and resources. Of these, six participants reported periods of poor funding provision for a variety of needs associated with furthering the adoption of e-learning innovations. For Inno 1 the unreliability of funding was a problem, particularly when a university-wide freeze occurred that stopped further funding, despite this funding (for innovation development and further implementation) having already received approval. Inno 3 found university funding was limited for equipment purchases, such as microphones, headsets, webcams and second computer screens, and this restricted availability of essential infrastructure needed for furthering adoption of the innovation. Initially Meso 3 was forced to use personal funds to maintain subscription services, as this type of funding was not provided by the university at the time. Meso 7, from the same university as Inno 1, found that general funding restrictions within the university reduced capacity for project management, while Meso 8 relied on in-kind funding for this, exchanging hours worked in this role in lieu of receiving further funding. A lack of funding limited opportunities for Meso 10 to generate evidence of the effectiveness of the innovation.

Meso 9 found that policy for licencing of externally provided software fell outside university guidelines leading to access issues before an internal university enterprise licence could be established. Policies affecting academic promotion impacted on the ability of Meso 8 to encourage further adoption of the innovation because of concerns amongst teaching academics that experimentation with new technology-enabled teaching practices could lead to lower scores from student experience surveys.

A lack of provision by the university for adequate time, resources and workplace systems to accommodate 24/7 online learning, was raised as an inhibitor of e-learning innovation adoption by Meso 2 and Meso 9. Problems with lack of time were raised by Inno 5 as impacting on the ability to implement more formal project management. Inno 3 found there was poor time provision for sharing innovations and Meso 4 noted that adopters expressed frustration with lack of time to experiment with the new pedagogies enabled by e-learning innovations.

Problems with university funding raised by participants also appeared as themes in the secondary data and research literature reviewed for this study. The provision of adequate funding was identified in 13 of the 22 secondary data sources as a key factor in ensuring successful mainstreaming of e-learning innovations. In the secondary data, availability of funding was reported as generally unreliable beyond the initial “seed funding” (Selwyn et al., 2016a, p. 35) stage for e-learning innovation prototype development (Gunn & Herrick, 2012) and, even when available, was often insufficient for enabling mainstream adoption of innovations (Davis & Fill, 2007; Gunn & Herrick, 2012). As noted in the introduction to this thesis, problems with funding in universities comes at a time when academics and professional staff are increasingly under pressure from university management to maximise past investments in e-learning (Stepanyan et al., 2013) and while universities around the world continue to experience increasing budgetary constraints (Ellis & Goodyear, 2019). The high level of decision-making by management in universities about the allocation of funding described a dilemma noted by Rittel and Webber (1973) in which "the higher the level of a problem's formulation, the broader and more general it becomes: and the more difficult it becomes to do something about it" (p. 165).

At an even higher level, stagnation of government initiatives and incentives for e-learning innovation collaboration, infrastructure development and research, previously driven by national agencies, are, as Ellis and Goodyear (2019) lamented, now “long gone” (p. vii). This type of government support can be traced back to US federal funding behind the origins of the Internet in 1973 (Cerf, 2019) and the development of the web at CERN. Australian and New Zealand universities were beneficiaries of proactive government-driven initiatives, aimed at building Internet capacity over two decades (1996 to 2016) that tapered off with the gradual dismantling from 2011 of the Australia’s national education and training technology agency (Education.au Limited) and Office of Learning and Teaching (OLT). This stagnation in government action continues to leave a void in funding, policymaking and re-thinking of the workplace systems and practices needed for harnessing transformative educational benefits of e-learning innovation adoption in higher education.

6.7 How solutions have system ramifications

The aim is not to find the truth, but to improve some characteristics of the world where people live. (Rittel & Webber, 1973, p. 165)

Ramifications of multi-faceted relationships between stakeholder roles in e-learning innovation adoption in university systems can be seen in Tables 12 through 26, by comparing impacts (shown by size of orange dots) created from the input of enabling and inhibiting links in *real* and *ideal* models. Comparative results shown in Tables 27 through 29 demonstrate “waves of consequences” (Rittel & Webber, 1973, p, 163) found in wicked problems.

Some examples of ramifications in systems to emerge from this study included: restrictions in using a university LMS that hindered adoption of bottom-up e-learning innovations (Inno 4, Meso 1, Meso 3, Meso 4, Meso 10); lack of IT infrastructure, for example in the need for more server space for scaling up adoption (Meso 1, Meso 6); perceived threats to academic promotional opportunities from potential negative student satisfaction survey results associated with lecturers trialling new teaching practices (Meso 8); ambiguous role of university policies in gaining and guiding support for mainstreaming e-learning innovation adoption (Meso 4); and on continued dependency on student enrolments for funding (Inno 4). As shown in models from this study, ramifications become even more apparent when they make an impact on each other, for example, as observed by Inno 3 and Inno 4 when highlighting the impact of limited funding availability on the capacity of universities to meet infrastructure requests.

The secondary data and literature review contain numerous supporting references to the ramifications reported by study participants resulting from: university LMS restrictions, demands on IT infrastructure, perceived threats to academic promotion opportunities, challenges of policy ambiguity and difficulties in securing ongoing funding. These ramifications are discussed in the following sections.

6.7.1 University LMS restrictions

Administrative restrictions and management-driven policies associated with the dominate role of LMSs in universities have been blamed for over a decade for stifling deeper application of e-learning beyond a template-driven model, development of more teacher driven e-learning innovations and subsequent wider adoption (Cross, 2004, Elgort, 2005; Alexander, 2006; Gunn & Herrick, 2012; Gunn, 2014; King & Boyatt, 2015; Selwyn et al., 2016a, 2016b). This view is supported by the findings reported in Section 5.2.4, with six participants in the study (Inno 2, Inno 4, Meso 2, Meso 4, Meso 6, Meso 9) all noting tensions between LMS adminstrators and developers of e-learning innovations, which some associated with a risk averse nature demonstrated by university staff in central IT services support roles.

6.7.2 Demands on IT infrastructure

The need for overcoming demands for more flexible IT infrastructure and LMS usage was supported by Selwyn et al. (2016b) who suggested that university central system support for the integration of non-enterprise software and online services would be beneficial in furthering both e-learning innovation development and adoption. This, however, presents challenges for the maintenance of university IT infrastructure (Gunn & Herrick, 2012) which, along with the provision of software and technical support, has been viewed for over a decade as a primary function of the central support role in universities by Davis and Fill (2007), Gunn and Herrick (2012), Csete and Evans (2013), Salmon and Angood (2013), Smigiel (2013), Gregory et al. (2015), Robertson (2015), Selwyn et al. (2016b) and Pomerantz and Brooks (2017). The modelling of the negative experiences of six study participants (Inno 4, Meso 1, Meso 3, Meso 4, Meso 6, Meso 10) suggests when central systems do not meet IT infrastructure demands, there are ramifications across the university for innovation adoption. This was particularly the case for Meso 3, Meso 6 and Meso 10 who indicated inhibiting links (Table 28) from *Central Systems* to *Dissemination* (Meso 6), *Experimentation* and *Project funding* (Meso 3), *Evidence* and *Sharing* (Meso 10), *Project Mgt* (Meso 3, Meso 6, Meso 10) and *Readiness* (Meso 3, Meso 6, Meso 10).

6.7.3 Perceived threats to academic promotion

Failure of e-learning innovation adoption as a perceived threat to academic promotion was raised by Meso 8 and centred on negative responses in a student experience survey which could directly and drastically affect teacher promotional opportunities and even their ongoing employment. There is a lack of rigorous research that investigates such perceptions amongst teachers. As Anderson (2012) noted in a PhD thesis about a single case study of barriers and enablers to teachers' adoption of online teaching, “there does not appear to be any convincing research into the effect of promotion policies ... but the literature indicates there is a perception by teachers that this is the case" (p. 43). This is a concern that appears to warrant further investigation to establish how widespread this perception may be.

6.7.4 Policy ambiguity

Conole et al. (2007) reported a warning about the unpredictable and erratic effects of policy on practice. Czerniewicz and Brown (2009) and Laurillard et al. (2009) added to this view by acknowledging an ambiguous role of university policy in influencing e-learning innovation adoption. Czerniewicz and Brown (2009) attributed this ambiguity to rigid e-learning policies and LMS management practices in universities that, while supporting top-down adoption of central systems, also might also end up stifling bottom-up innovation development and mainstreaming of e-learning innovation adoption.

Such ambiguity is illustrated in the case of Meso 4, where the experience of institutional policy had both “a positive and a negative” effect on the tools selected for developing the e-learning innovation, but still did not hinder further adoption of the innovation once the effectiveness of the innovation had been evaluated. In another example, an external federal government policy was used deliberately by Meso 10 to gain endorsement, for bypassing restrictive internal institutional policies that would have otherwise hindered the development and adoption of the e-learning innovation. The case of Meso 10 appears to support the effectiveness of having national policy drivers (White, 2010; Gannaway et al., 2011; Ellis and Goodyear, 2019). A further example of the ambivalent role of policy was found by Anderson (2012) who reported that internal university policy in one university had “little direct effect” (p. 41) in driving innovation adoption, contrary to perceptions amongst faculty, who believed it did. The explanation by Laurillard et al. (2009) of such apparent contradictions was that university policy was generally viewed by faculty as disconnected from their own experience and further reinforced scepticism about changes supported by these policies. Laurillard et al. (2009) attributed these contradictions to a "contrast between the policy ‘hype’ and the challenges that characterise their own use of TEL [e-learning]" (p. 292).

Solutions proposed in the Transformative Framework for Learning Innovation by Salmon (2015) link *macro*-level capabilities of both policy and collaboration as overcoming resistance to transformational change in higher education. This contrasts with recommendations for collective rather than collaborative policy decision-making by Gunn (2010) and Gunn and Herrick (2012), a contrast that has implications for the how the role of leadership is perceived and executed in university policymaking. Daly (2018) was reported as arguing against rigid policy and procedure (see Section 6.5), recommending instead a distributed, rather than a centralised, leadership role in educational change “facilitated through simple, shared and flexible parameters that honor professionalism and the influence of context” (p. 158). Conole (2017) added that research was also necessary for understanding the impact of leadership “on policy and practice” (p. 18) in digital learning.

It is not clear from these recommendations if policy should be viewed as either an outcome of or input into facilitated, multi-faceted, strategic processes for driving the adoption of e-learning innovations. The ambiguous nature of policy in universities and its impact on mainstreaming of e-learning innovation adoption suggests that both policy-as-input and policy-as-outcome are needed.

6.7.5 Difficulties in securing ongoing funding

Typically, funding is viewed as a necessary input for e-learning innovation development and adoption. Davis and Fill (2007) reported that such funding was allocated mostly to software and online resource development (Davis & Fill, 2007), with surplus funding being rarely available for implementing an innovation, as funds either ran out (Davis & Fill, 2007; Gunn & Herrick, 2012) or were redeployed (Gunn & Herrick, 2012). Suggested institutional solutions included providing free software and technologies (Selwyn et al., 2016b), financial management expertise for sourcing and managing ongoing funding (Gunn & Herrick, 2012; Robertson, 2015), incentives in the form of stipends and release time for potential adopters to attend training (Pomerantz & Brooks, 2017; Davis & Fill, 2007), payment for extra staff and teaching preparation time (Davis & Fill, 2007) and assistance with obtaining funding through sources external to a university (Nascimbeni, 2013; Ellis & Goodyear, 2019). Each of these solutions has potential ramifications when funding runs out or becomes more difficult to obtain (Davis & Fill, 2007; Gunn & Herrick, 2012; Ellis & Goodyear, 2019).

Ellis and Goodyear (2019) warned that reliance on external sources of funding was likely to lead to failure in furthering adoption of an e-learning innovation when that funding ran out. Gunn and Herrick (2012) suggested such a threat may be averted by gaining “commitment from a consortium” (p. 9) made up of private sector investment (Nascimbeni, 2013) and institutional funding (Kind & Boyatt, 2015).

Centralised (rather than distributed) financial management in universities had ramifications for academic financial autonomy (Davis & Fill, 2007; Snyder et al., 2007) as such systems hindered autonomy and therefore decision-making. A simple example given was associated with local capacity to purchase needed software licences (Davis & Fill, 2007; Snyder et al., 2007). A recommendation by Selwyn et al. (2016a) for funding based on “fail fast and fail often” (p. 28) iterative project scoping over a long term presented a threat to traditional conservative accounting practices in universities that operated on shorter terms. As Jansen et al. (2011) warned, "bottom-up emergence can lead to chaos" (p. 68) which could further threaten to undermine local administrative funding practices.

Funding pressures may increase the attractiveness of open and free software. The emergence of e-learning innovations that use external, open, free- and subscription-based software appeared as a growing global concern (Pomerantz & Brooks, 2017; World Bank Group, 2018) with ramifications for managing data privacy, intellectual property, copyright and cyber security threats. Not one of these issues was raised by any study participant.

6.8 How better/worse solutions compare with right/wrong solutions

> Problems can be described as discrepancies between the state of affairs as it is and the state as it ought to be. (Rittel & Webber, 1973, p. 165)

A visual comparison of the models in Tables 12 through 26 reveals a wide range of better solutions in the *ideal* models suggested by study participants, compared with the *real* models for each case. Comparing *ideal* models with each other further suggests that no model offers either a right or wrong solution in how relationships between stakeholder roles are configured. The models in this study, together with participant insights, reveal a range of problems and suggested solutions based on interpreting stakeholder relationships. As discussed in Section 6.2, common problems are focussed on central systems, leadership and vision, project funding, readiness to adopt and project management. In eight cases (Inno 1, Inno 4, Meso 1, Meso 3, Meso 4, Meso 6, Meso 8, Meso 10) these problems are variously associated with university LMS restrictions, demands on IT infrastructure, perceived threats to academic promotion, policy ambiguity and difficulties in securing ongoing funding. In other cases, these problems are either bypassed or do not appear.

Quantifying of case-based modelling in this study allowed a full comparison (Figure 23) of better and worse results (*ideal* versus *real*) based on the inputs of enabling and inhibiting links and identification of influential roles (Table 27). From a comparison of results in Figure 23, the *innovator* and *adopter (micro*) quadrant roles of readiness to adopt, development of the innovation, sharing ideas and ownership, dissemination and evidence of effectiveness appear the most important in building institutional capacity for innovation adoption. This suggests that while no role interactions are the same in any of the models produced by this study, it is still possible to identify where in a university the effort for mainstreaming e-learning innovation needs to occur, which is at the frontline ("coalface") of higher education teaching practice at the *micro* organisational level.

The models in this study provide a far richer picture for informing capacity building than lists of enablers/critical success factors and inhibitors/barriers (presented respectively as right and wrong solutions) in previous studies, such as, Anderson, 2012, Gunn and Herrick (2012, Csete and Evans (2013), Singh and Hardaker (2014), Selwyn et al. (2016a, 2016b), Gregory et al. (2015). While an analysis of these right/wrong solutions provided a useful starting point for conducting this study, they were limited in informing how capacity building in universities could be achieved. As this study demonstrates, addressing this problem requires an understanding of how two-way enabling relationships in particular can be encouraged to develop between all roles played by institutional stakeholders in universities. While there appear to be no "right" or "wrong" ways to achieve mainstream e-learning innovation adoption, more enabling links (especially two-way links) between roles in the models resulted in more roles appearing important in the process of mainstreaming e-learning innovations in higher education teaching practice. In particular, as shown by the tallest graphs in Figure 23, these enabling links result in boosting institutional capacity for readiness to adopt, development of the innovation, sharing of ideas and ownership at the *micro* level of a university system.

6.9 How time needed for evaluation impacts on solving the problem

There is no immediate and no ultimate test of a solution to a wicked problem. (Rittel & Webber, 1973, p. 163)

Recurring themes throughout this study include conflicts over: valuing the importance of evaluation, gathering evidence of e-learning innovation effectiveness, and a lack of adequate funding and time for conducting evaluation. Meso 2 noted, "in science you've got to be able to have proof to say 'where's the evidence that this is going to work', otherwise they'll say, 'why am I going to waste my time using it'". Similarly, in the review of research literature, Rosenberg (2005) noted the need for an evidence-based approach, claiming “advocates of elearning [sic] have squandered opportunities to demonstrate real value” (p. 15). Rosenberg (2005) added that decisions to adopt an e-learning innovation should be based on proof emerging from rigorous research about what works in practice.

In the case of Meso 10, there was evidence available from outside the university that influenced a teacher towards feeling “more confident to adopt this practice because it was trending outside of the university”. Evidence of effectiveness of an e-learning innovation was also viewed as necessary for overcoming resistance to e-learning innovations amongst other university stakeholders, such as the case of Meso 6, where the “LMS team weren't initially very receptive but eventually, when they saw enough evidence or what people were doing, they realised that we weren't trying to reinvent their system and take over their universe”.

Meso 9 found that “to be able to legitimately use staff time to be involved was also critical”, which Meso 5 suggested could be achieved through in-kind funding, with Inno 5 equating time with money. Other participants in the study highlighted the need for time for experimentation. Inno 4 emphasised the need for “time to experiment and trial – properly”. Meso 1 expressed concern that there was not enough time for this, explaining “you need to have time to try these things out on your own before you bring anyone else along”, while Meso 2 similarly noted that “it's nice to have the time to sit and think it through”. Capturing time elements was also reflected in the suggestion by Inno 1 for future enhancements to the models used in this study. The suggestion was to demonstrate changing levels of importance in relationships between roles based on different stages within the timeline of innovation adoption and the impact of applying change processes.

A lack of funding was reported by Meso 10 as limiting the capacity for finding time to generate internal evidence of an innovation’s effectiveness and consequently in gaining wider recognition leading to further adoption. Evidence-based research about change processes in universities was viewed as increasingly necessary (Salmon, 2005; Bichsel, 2013) as the adoption of e-learning evolved, increased and matured, even while time pressures on academics (in particular) continued to mount. Conducting research in universities was noted by Birch and Burnett (2009) as an incentive for gaining academic promotion while observing that "adopting and integrating educational technology may leave academics with less time to devote to research and other activities that lead to promotion and tenure" (p. 122). Inno 2 was able to overcome time limitations by combining both academic research and faculty-based evaluation of the innovation’s effectiveness by “quantifying conversations to link these to students' grades”. According to Alexander (2006), Dennison (2014), Gunn and Herrick (2012) and Pomerantz and Brooks (2017), evidence of effectiveness needed to demonstrate improvement in student learning outcomes as well as enhancement of teaching practice. The need for “building of a repository of evidence and knowledge” from such evidence gathering was recommended by Meso 9 as a long-term strategy for universities. Gunn and Herrick (2012) also highlighted the need for “uniform sets of data to present a coherent picture” (p. 16). The challenge in setting up such data repositories is in keeping them up-to-date given rapid changes in technologies and educational practices that arise from their application.

Anderson (2012) recommended providing strong evidence of the effectiveness of an e-learning innovation for overcoming faculty suspicion and scepticism about potential impacts on existing teaching, learning, administration workloads and academic autonomy. This recommendation was also supported by Gunn and Herrick (2012), Selwyn et al. (2016b), and Pomerantz and Brooks (2017) who viewed collection of evaluation data about the quality of e-learning as important in motivating faculty adoption of e-learning innovations, for dissemination by providing “insights into practices” (Selwyn et al., 2016b, p. 58) and in building institutional business cases (Gunn & Herrick, 2012). Over the past two decades, the practice of providing business cases in universities (particularly for investments in centralised LMS services, maintenance and support) has been based on evidence from national and global drivers for change (Massy & Zemsky, 1995; White, 2004; White, 2010; Stepanyan et al., 2013; Ellis & Goodyear, 2019), augmented by traditional evidence-gathering practices described by Rittel and Webber (1973) as a “modern-classical model” (p. 159).

The practice of modern-classical evidence gathering was viewed by Rittel and Webber (1973) as addressing tame rather than wicked problems (see Section 2.4.4). These tame practices can be found in traditional auditing methods that continue to be widely used in conducting evaluation studies of top-down university management-driven e-learning initiatives, such as LMS implementations and MOOCs. The typical practice of applying these methods was described by Gregory et al. (2015) as including conduct of audits, such as IT and IS maturity model asset audits of institutional rates of take-up of e-learning innovations, recommended by Salmon and Angood (2013). Collyer and Campbell (2015) noted that the focus in evaluating implementations of top-down-driven innovations emphasised gathering evidence of administrative cost and time savings while reducing impacts on university systems and services, rather than concerns about teaching and learning. This contrasts with studies of bottom-up e-learning innovation adoption in which the focus, as recommended by Alexander (2006), needs to be on providing evidence of the value of innovations to students in improving the quality of their learning outcomes and on teaching effectiveness.

A shift in focus towards evidence gathering concerned with teaching and learning outcomes supports the proposition by Gunn (2010), as a condition for achieving sustainability and thereby mainstreaming e-learning innovation adoption, that an e-learning innovation "has been through a proof-of-concept stage and has been judged, on the basis of evidence produced, to be beneficial to teaching and learning" (p. 90). In defining critical mass as the point beyond which an innovation becomes self-sustaining, Rabin et al. (2008) located this point as reached when “an evidence-based intervention can deliver its intended benefits over an extended period of time after external support is terminated” (p. 3).

For the purpose of this study, a period of three years was considered a sufficiently extended time span for participants to “capture” evidence of sustainable adoption of e-learning innovations that originated in higher education teaching practice. Such a time period is illustrated in the interview transcript of Meso 3 in Appendix 4, which covered Meso 3’s experiences in the period 2014 to 2017. The recruitment selection criteria, as outlined in Appendix 5, targeted study participants with direct recent experience, which was defined as occurring within the previous three years during which an e-learning innovation had originated and been adopted in higher education teaching practice within the participant’s own institution.

Gunn and Herrick (2012) and Pomerantz and Brooks (2017) concluded that there were, as yet, no universally agreed methodologies or measures for rating ease and effectiveness of technologies used in e-learning in order to provide a coherent picture for suggesting improvements and increasing take-up of innovations (Gunn & Herrick, 2012), or to demonstrate the originality of a teaching and learning innovation and how well that innovation integrated with the functions of a university’s LMS (Pomerantz & Brooks, 2017). Giersch and McMartin (2014) noted in universities a lack of the decision-making and project management processes commonly found in entrepreneurial-business environments. Salmon and Angood (2013) suggested linking project management processes with the practice of evidence gathering in universities and engaging groups of institutional stakeholders in “joint research and development activities” (p. 922).

There is potential for developing such group-based strategies by using Interpretive Case-based Modelling, to more efficiently and possibly effectively collaborate through groups. While there is no immediate or ultimate test for solving the wicked problem of building institutional capacity for mainstreaming e-learning innovation adoption in universities, the application of Interpretive Case-based Modelling offers a strategic approach that realistically considers time limitations for conducting research and collaboration while recognising that there can never be proof of a complete solution or, according to the meme, “no magic bullet”.

6.10 How the problem is never completely solved

> There are no criteria which enable one to prove that all solutions to a wicked problem have been identified and considered. (Rittel & Webber, 1973, p. 163)

Dede (2009) described the capturing of collective wisdom gained from past experience as necessary for attempting wicked problems. In this study, results generated by inputs from participants’ experiences were captured in *real* and *ideal* models. Differences between the *real* and the *ideal* help to connect relationships between stakeholder roles and enable formation of strategies for building institutional capacity for mainstreaming e-learning innovations, while requiring the recognition of multiple possibilities as characteristic of wicked problems. Variations in results from the collective wisdom gathered in this study are evident from the widely different lived experiences, models and insights elicited from participants, yet there are also some similarities that suggest useful strategies for consideration.

The outcomes of this study, as shown in Figure 23, have wide variations between the importance of the original ten stakeholder roles in *real* versus *ideal* models and across all *ideal* models. In Figure 23, the top 20% of the bar chart reveals the five most important roles resulting from enabling relationships between stakeholders as *Dissemination, Development of innovation*, *Readiness to adopt*, *Sharing ideas and ownership* and *Evidence of effectiveness* (Section 5.2.5). As previously discussed in Section 5.2.5, all five important roles are found in the lower quadrants of the model and represent the *micro* organisational activity level, which consists of *innovators* and *adopters* of e-learning innovations. The results shown in Figure 23 appear to confirm observations made by participants about the importance of engaging all stakeholders in empowering originators and adopters of e-learning innovations, including: “if you can get all these things to work in harmony with each other they can all help each other and are important” (Inno 1); “it's getting the buy-in, with everybody on the bus” (Inno 3); “you can't have innovation without all those other things" (Meso 7); and “I think those concepts within the quadrants are useful to think about along with this kind of networked thinking about innovation” (Meso 9). Yet the mapping in the models, depicting the engagement of stakeholders by showing enabling relationships connecting to the roles of innovators and adopters, is different in each case.

The *real* models in this study each depicted widely varying relationships and contexts, even when cases of adoption of the same innovation occurred within a university (illustrated when comparing Inno 1 with Meso 7 and Inno 2 with Meso 9). In *ideal* models, relationships still varied but were mostly enabling between the stakeholder roles, with more two-way connections and evenly spread. As Inno 5 noted in the *ideal* model: “I like that it's relatively even between all four quadrants” suggesting that all roles in the quadrants representing stakeholders needed to play an equal part in capacity building for mainstreaming e-learning innovations that originated and were subsequently adopted in higher education teaching practice. Validation by this study of the relevance of the original roles in the baseline model did not preclude other roles – such as *policy*, from being added by two participants Meso 4 and Meso 10, and the addition of *Skills for Development* by Meso 6 – in the *real* models. Other exceptions, based on the widely different contexts represented in cases, can be found in the relocations of *Project management* (from the *meso* to *micro* i*nnovator* quadrant by Inno 4) and *Dissemination* (from the *micro* to *meso* quadrant by Meso 6) when making adjustments from *real* to *ideal* models.

Both the erratic nature and ambiguity of the role of policy were raised by Conole et al. (2007), Czerniewicz and Brown (2009) and Laurillard et al. (2009) as being problematic for e-learning strategy development in universities. Policy that is internal (created within a university) and external to a university (created by agencies and organisations outside university jurisdictions), may be viewed as both an input and an output of strategy development, which becomes even more challenging because of the ambivalence created, when applied for the purposes of informing and guiding the mainstreaming e-learning innovation adoption. As Meso 6 observed "innovation is a really hard thing to plan and manage", a view supported by Gunn and Herrick (2012) in proposing that "a clear roadmap for the future" (p. 8) may never be achievable in universities for e-learning innovation adoption.

The duality in using models for strategy development and research (simultaneously providing both outcomes [findings] and strategy tools [methods]) reflects the proposition by Rittel and Webber (1973) that in addressing a wicked problem "the process of solving the problem is identical with the process of understanding its nature" (p. 162). This process was demonstrated by Levin and Datnow (2012) in their application of case-based modelling by revealing, through the use of MMM, the continuous interaction between actors in a complex system, while isolating the actions of individual actors. To this extent, Levin and Datnow (2012) anticipated the argument put forward by Singh and Hardaker (2014) that "future research studies should not model the adoption and diffusion of eLearning based primarily on either an individualist [defined as] (Micro) or structuralist [defined as] (Macro) perspective, but by using a more interactive approach to examine the complexity and multiple levels and dimensions of social reality" (p. 105).

6.11 Summary of interpretative case-based modelling

While perhaps never leading to a complete solution, there is clearly a role for case-based modelling using MMM for informing capacity building in education systems through harnessing co-construction and sense-making enabled by case-based modelling. What has been missing is a research design framework for *in situ* co-construction and sense-making through conversations between a researcher and those with recent lived experiences. This missing framework is offered by the new methodology of Interpretative Case-based Modelling, developed for and applied in this study. Interpretative Case-based Modelling builds and extends on previous theories and methods to address complex problems in complex systems by bringing conversations into modelling and modelling into conversations. In the ever-evolving context of mainstreaming the adoption of e-learning innovations in higher education teaching practice, these conversations will continue to evolve and thus may never be completely solved.

In Chapter 7, conclusions are drawn from the discussions in this chapter to demonstrate the effectiveness of Interpretative Case-based Modelling as a new research methodology for capturing and analysing evolving conversations about wicked problems. The new methodology enables revelation of implications for capacity building in mainstreaming e-learning innovation adoption in universities. A synthesis of key findings together with recommended strategies for institutional capacity building are also presented in this following chapter.

By combining an interpretive research design framework with case-based modelling, Interpretative Case-based Modelling is presented as a methodology for extending the combination of DoI and CAS theories proposed by Rogers et al. (2005) and furthering the application of MMM of case studies, pioneered by Levin and Datnow (2012), which inspired this study. Further applications of this new methodology are proposed at the end Chapter 7, along with recommendations for further research.

A workshop to test a group facilitated application of Interpretive Case-based Modelling was accepted for presentation at the American Education Research Association (AERA) meeting in April 2020 in San Francisco (see aera.2020-conference.org) but was postponed due to the COVID-19 pandemic. This workshop was planned to follow an initial trial of a group process at Flinders University in March 2020 that used enhancements to the model suggested by participants in this study together with application of the Conklin (2006) facilitated group dialogue mapping process, designed for investigating wicked problems.

CHAPTER 7. CONCLUSION

Contextualizing the phenomenon. (Denzin, 2001)

Comparing and synthesizing the main themes of these stories so that their differences may be brought together into a reformulated statement of the process. (Denzin, 2001, p. 79)

This PhD research study reveals many challenges faced by universities in building institutional capacity for mainstreaming e-learning innovation adoption. The main research question investigated by this study asked how the building of institutional capacity could be achieved. The study produced both recommendations from the study findings in answering this question and a new methodology, Interpretive Case-based Modelling, developed for addressing the wicked problem presented by the challenge of mainstreaming e-learning innovation adoption in higher education teaching practice. The study successfully applied Interpretive Case-based Modelling as a new methodology for generative co-creation of research and, as an additional benefit, appears to have potential for wider applications in addressing the challenges of wicked problems beyond the scope of this study. Developed as a bricolage methodology, Interpretive Case-based Modelling extends existing theories, methods and research design concepts by combining DoI and CAS theories with case studies and ABM, implemented with the use of MMM software guided by an Interpretive Interactionism research design.

The interpretive research design guided the creation of the following secondary questions and the development of the methodology used in this study:

- What are the critical success factors in the process of innovation adoption?
- Who are the key actors as institutional stakeholders in innovation adoption?
- What roles are played by the key actors in innovation adoption?
- How do the roles of key actors interact in an institutional setting?
- What are the impacts of real and ideal interactions between institutional roles in innovation adoption?
- What implications arise from the impact of institutional role interactions in innovation adoption?

Each of these questions is addressed in the following sections, with conclusions being drawn from discussion in Chapter 6, a chapter that validated the identification and suitability of critical success factors and institutional stakeholders as actors in defining roles investigated by this study. The first three sections (Sections 7.1 through 7.3) draw conclusions related to the first three secondary questions. Conclusions related to the last three questions (Sections 7.4 through 7.6) validate the efficacy of Interpretive Case-based Modelling in eliciting and visualising interactions from lived experiences as models of *real* cases from which *ideal* scenarios were modelled and insights drawn.

The chapter concludes with a brief review of Interpretive Case-based Modelling (Section 7.7), limitations of this study (Section 7.8), areas for further research (Section 7.9), and final remarks (Section 7.10).

7.1 Critical success factors

The study commenced with a review and analysis of research literature from which case study data was sourced for the purpose of identifying common critical success factors that play a causal role in the process of mainstreaming e-learning innovation adoption in higher education teaching practice. A baseline model was developed for conducting interviews with study participants, and included the following factors (Section 5.1.1) that also represented roles played by higher education institutional (university) actors in e-learning innovation adoption:

- Evidence of effectiveness
- Readiness to adopt
- Project funding
- Leadership and vision
- Central systems
- Project management
- Experimentation
- Development of innovation
- Sharing ideas and ownership
- Dissemination

Policy, as a factor in guiding innovation adoption, was also identified but was omitted from the baseline model because it was perceived in the literature as ambiguous and could not be allocated to any specific actor role. It was however added to the case-based model by two participants while another participant added *Skills for Development*. Results from modelling show neither *Policy* nor *Skills for Development* played a significant role as an input in either enabling or inhibiting innovation adoption, despite both being perceived as necessary additions in the specific case-based models in which they appeared.

In comparing all models, the most common inhibiting factors (as inputs) were identified in the *real* case-based models as *Central Systems,* followed by *Leadership* and then *Project Funding*, *Readiness* and *Project Management.* Across all *real* models it is worth noting that all baseline factors appeared at least once as a problematic source, except for *Experimentation*, which only appeared in both *real* and *ideal* models as an enabling factor.

In *ideal* models, the most common factor identified as a source in enabling e-learning adoption was *Leadership.* In acting as both an enabler in *ideal* models and an inhibitor in *real* models, *Leadership* capacity appears to be the most important consideration for mainstreaming e-learning innovation adoption, particularly in influencing the *Development of innovations* through supporting individual and team efforts, in decision-making and in obtaining *Project funding* for innovation development and implementation. The need for *Leadership and vision* is the most critical factor in supporting development and implementation and in making funding decisions.

In addition to having an impact on *Development of innovations*, there are other resulting benefits from maximising harnessing of all critical success factors for building institutional capacity. These results are most apparent in achieving *Readiness to adopt* skills, knowledge and attitudes; *Sharing ideas and ownership* with potential adopters; *Dissemination* about innovations; providing *Evidence of effectiveness* in teaching and learning; and *Experimentation* opportunities and support for testing and trialling innovations. The study provides both a synthesis and validation of common critical success factors in institutional capacity building not previously identified in other studies, such as those listed in Section 6.8.

7.2 Key actors

Identification and categorisation of actors provides a multi-faceted view of institutional stakeholder activity levels and their motivations towards mainstreaming e-learning innovation adoption in universities. Four groups were identified as playing key institutional roles in mainstreaming e-learning innovation adoption (Section 5.1.2):

- Management
- Support services
- Innovators
- Adopters.

Applied to a university setting, *management* was categorised as active at a *macro* upper level, (central) *support services* represented a *meso* middle level and *innovators* and *adopters* a *micro* (teaching practice) level.

The study identified a multiplicity of job titles within each of the four actor groups, with the most diverse range of role descriptions associated with support services. The job titles revealed in this study appear to adhere to traditional higher education job descriptions. This is in spite of evidence in cases of a growing hybridisation of roles (transitioning from specialists to cross-trained generalists) and recognition of an emerging *third space* that is resulting in a blurring of leadership roles across all three institutional levels.

Resistance to change is evident as a common de-motivator across all four actor groups. Resistance appears to be driven by suspicions about management motivations for driving the adoption of e-learning innovations, coupled with perceived threats to job promotion opportunities, and an ambivalent and sometimes conflicted *love-hate* relationship towards technology use in education. There is also evidence that affirms a positive role for leadership by university management and central support stakeholder groups in motivating and supporting both innovators and adopters to persist with driving changes at the frontline of teaching and learning in universities. Excluded from investigation in this study was the role of students in both adopting and motivating the development of e-learning innovations. The study results confirm that students did not appear to play a significant role in the process of mainstreaming the adoption of e-learning innovations although they were portrayed as contributing to the development of some of the innovations examined in the study and as active participants in experimentation and evaluation. While the role of students was featured as the subject of numerous studies of e-learning adoption in higher education, there were comparatively fewer studies that examined the specific roles of institutional actors in universities, comprising management, professional staff and academics in a teaching role, as indicated in the literature review of this thesis.

7.3 Roles and environment

In the study the four actor categories (listed in Section 7.2) were grouped with critical success factors (listed in Section 7.1) to represent university stakeholder roles and institutional boundaries that operated in mainstreaming e-learning innovations. This grouping provided the baseline model to which the stories of the lived experiences of participants were applied in conducting the case-based modelling for this study.

The value of grouping factors with actors in creating the baseline model was validated by the findings from the case-based modelling interviews. The findings demonstrate both the reliability of the modelling framework and its flexibility in accommodating the unique contexts of participants' often widely different, lived experiences. Evidence from this study appears to confirm growing speculation about the emergence of a "third space", represented in the model by a blurring of leadership roles in management with roles of professional staff engaged in learning and teaching support. Merging and hybridisation of roles, evident in many of the cases, highlights the need to dismantle boundaries around traditional institutional silos and create new, flexible organisational models and ways of working collaboratively in order to respond to the complex organisational ecosystems that exist in universities today. Such ecosystems are characterised by an ongoing lack of funding reliability, inappropriateness of policies and guidelines for encouraging innovation, insufficient allocation of time and resources and inadequate workplace systems to accommodate 24/7 online learning. Re-thinking of workplace systems requires institutional capacity building for spanning boundaries between policies and practices needed to harness the transformative educational benefits of e-learning innovation adoption in higher education. The study is the first to present this view of university system actors and factors that enables exploration of different roles and workplace environments through the new methodology of Interpretive Case-based Modelling.

7.4 Interactions

The modelling process applies the lived experiences of participants, as institutional actor representatives, by presenting a view of enabling, inhibiting and influencing links between roles and eliciting an exploration of the impact of subsequent interactions. The process allows an understanding, through visualisation and interpretation, of the impact of the interactions within university workplace systems and what is important for re-thinking institutional capacity building in solving a complex problem in a complex environment. A diversity of interactions in the models depicted in this study supports the characterisation of the process of mainstreaming the adoption of e-learning innovations as presenting a wicked problem, put simply as a complex problem within a complex system. A comparison of the diverse interactions in the models suggests that while the experiences of individual stakeholders are unique, there are some notable similarities in the results of the interactions depicted by their experiences, thus it may be argued, revealing the simplicity behind the complexity.

From an analysis of inhibiting links in the models, central systems (technical and training) support appears the main source for creating barriers to mainstreaming e-learning innovation adoption. The restrictive practices of university central system administration of the LMS (as well as limited training support) were shown to have the greatest negative impact on the development of skills, knowledge and attitudes necessary for readiness to adopt. Other negative impacts were hindrances to both team and individual efforts in the development of innovations and in a lack of project management support for both development and implementation of innovations. These negative impacts appear to confirm claims that LMS mainstreaming stifles development of technology-enhanced teaching innovation and hinders the mainstreaming of these innovations.

Positive interactions indicated by enabling links between roles in models pointed to leadership and vision as having the greatest potential for impact on development of innovations, especially when associated with decision-making and securing reliability for project funding. A suggestion was made by some participants that in an ideal world almost everything in the models would be positively connected to everything else, with “everyone on the bus” even though the “bus” in each case might look quite different. The more enabling (in particular, two-way enabling) links between roles in a models, together with the more influences attached to roles, the larger the roles appeared and thus became more important. Although it might appear that in an ideal university workplace environment all roles would achieve importance through the strength of the relationships between them, this would be unlikely given the many variables and different contexts associated with innovation. However, strengthening of these relationships appears to remain a worthy goal.

Modelling of interactions in this study enabled identification of channels and directional flows for communication, coupled with opportunities for collaboration across institutional silos in straddling the complex organisational ecosystem of a university. There were clearly benefits in engaging stakeholders at *macro* (management) and *meso* (central systems support) levels in order to empower innovators and adopters (at the *micro* level) who are identified by participants and in literature as at the challenging *coalface* (or frontline) of e-learning innovation development and adoption. The location of interactions in some models even argued for devolving leadership roles to roles at the coalface. It was unclear from results of the multiple different interactions modelled in this study if experiences of mainstreaming bottom-up adoption of e-learning innovations, originating in higher education teaching practice, might be similar to or different from top-down driven LMS implementations that are more commonly found in universities around-the-world.

The interactions recorded in this study addressed recommendations by researchers in the field of e-learning innovation adoption that highlighted the need to make these enabling and inhibiting interactions visible for informing system change in universities.

7.5 Real versus ideal

In revealing both real and ideal perspectives, the models and participant insights from this study provide contrasting views about what *is* and what *might be* possible in achieving institutional capacity for change. Gaps between *real* and *ideal* models in this study suggest there is still much to do (and that can be achieved) in building capacity for mainstreaming e-learning innovation adoption in universities. The study demonstrates many system ramifications of better and worse scenarios related directly to the roles played by central systems and leadership. A comparison of results in *real* versus *ideal* models shows these ramifications as directly impacting institutional capacity for readiness, closely followed by development and sharing and then dissemination, evidence and experimentation. Restrictions imposed by university administrators, such as those commonly imposed through systems and policies associated with an LMS, generate waves of repercussion that stifle creativity and motivation for both development and adoption of bottom-up e-learning innovations. Such restrictions would not exist in an ideal world.

The role of leadership provides the starkest contrast, as an *inhibitor* in *real* models and an *enabler* in *ideal* models. Leadership is viewed as particularly necessary for strengthening central systems functions by providing an *organisational glue* through support for the LMS and for professional learning. In many of the lived experiences reported in this study, a leadership role was provided by innovators who were able to collaborate with individuals with roles designated as *central systems* or *management*. These individuals shared a common vision of the transformational potential of an e-learning innovation, often because they had already experienced this benefit for themselves or had witnessed it in others.

Results of comparisons between *real* and *ideal* models, coupled with participant experiences and insights, indicate that university effort for supporting mainstream adoption of e-learning innovations would be best applied at the frontline of higher education teaching practice through strategies that empower the roles of *innovators* and *adopters* at the *micro* organisational level. such *real* versus *ideal* views of simultaneously enabling and inhibiting interactions across the organisational landscape of universities, while also providing the opportunity for an interpretation of the results of these interactions.

7.6 Implications and recommendations

Interpreting the case-based models and insights generated by this study leads to a number of recommendations for universities in informing policies and practices for building institutional capacity for change. Overall, the study demonstrates benefits for universities in harnessing the experiences of their institutional stakeholders by valuing their insights and using them to create a collective vision for shaping an ideal adaptive workplace environment: turning their ideals into reality. Through this vision, mainstreaming of bottom-up e-learning innovation and its adoption in higher education teaching practice can occur, unhindered by LMS restrictions, demands on IT Infrastructure, perceived threats to academic promotional opportunities, policy ambiguities and difficulties in securing ongoing funding.

The following recommendations are presented for consideration in building institutional capacity aimed at mainstreaming the adoption of e-learning innovation adoption:

- Transforming the role of central systems to support change.
- Devolving leadership while working towards a shared vision.
- Securing funding and resources through informed decision-making.
- Establishing effective policies and guidelines.
- Providing centralised project management support.
- Opening channels of communication for collaboration and sharing best practice.

These recommendations require rethinking how each university works as a complex system and allocating adequate time to evaluate and formulate strategies. In considering these strategies, there is a need to recognise how all stakeholders interact and support each other, while also recognising the constantly changing environments in which universities deliver learning experiences for the benefit of their students within local, national and global communities. The recommendations are described in more detail in the following sections.

7.6.1 Transforming central systems

To meet the challenges of building institutional capacity to support adoption of e-learning innovations, central systems can assist by adopting the following suggestions arising from this study by providing:

- Centralised information sharing mechanism.
- IT support for software and platforms that are not part of the university LMS.
- Additional server space, as required.
- More flexible IT infrastructure and LMS integration of non-enterprise software and online services.
- Secure funding for training.
- Cooperative staff members who support development and promote adoption.
- Realistic time frames.
- Updating and enhancement of digital content.
- New job titles, such as, educational/learning technologists, to reflect hybrid job descriptions based on skills and understanding in both pedagogy and technology.
- More access to opportunities for experimentation by both developers and adopters of e-learning innovations.

7.6.2 Devolving leadership and creating shared vision

In the study leadership in universities was portrayed in *ideal* models as fostering a harmonious climate for development and adoption of e-learning innovations. This was viewed as achievable through consistency in leadership and vision across all activity levels within a university by facilitating and presenting evidence-based business cases for:

- Adequate funding, including removal of funding barriers and supporting the value of project management, evidence gathering, enabling localised software and technology acquisitions, iterative funding of bottom-up e-learning innovations on a *fail fast and fail often* basis, rather than scoping projects over a longer term.
- Decentralising academic financial autonomy throughout all development and adoption stages.
- Educating management in how e-learning works and its potential benefits in transforming teaching practice, beyond a focus on administrative function.
- Strategic planning, decision-making, direction and governance based on consultation with all stakeholders.
- Dismantling of traditional institutional barriers by establishing partnerships and direct lines of communication between management, information technology specialists and teachers
- Creating, recruiting and promoting the pivotal role of educational/learning technologists.

- Distributed rather than centralised role for leadership in educational change, guided by unambiguous yet flexible policies and procedures that honour professionalism and the influence of context and recognise an emerging *third space* for leadership activity in providing learning and teaching support.

7.6.3 Securing funding and resources

Adequate and reliable funding needs to be available in universities to ensure mainstreaming of bottom-up adoption of e-learning innovation, which is particularly vulnerable to the effects of high-level management decisions that can jeopardise ongoing funding. The study findings recognise there is a need to balance localised allocation of funding with the need for conservative, funding-decision-making in universities. This need for a balanced approach also applies to securing external funding which was viewed in this study as potentially problematic if this bypassed financial due diligence of university management.

Institutional capacity for making effective funding and resourcing decisions, in supporting ongoing mainstreaming of e-learning innovation adoption, is needed for:

- Maintaining software subscription services beyond initial *seed* funding.
- Generating ongoing evidence of the effectiveness of e-learning innovations.
- Securing project management support.
- Developing local capacity to purchase needed software licences by authorising central systems and individual innovators and teams.
- Equipment purchases, such as, microphones, headsets, webcams and additional computer screens.
- Exploring options that remove dependency on student enrolments for funding, which may include developing external partnerships with software providers and/or providing free software and technologies, while ensuring risk is managed and data and intellectual property are not compromised.
- Securing financial management expertise for obtaining funding through sources external to a university and managing funds and assets.
- Providing incentives in the form of stipends, release time for potential adopters to attend training, payments for extra staff and teaching preparation time.
- Ensuring availability of risk management assessment and alternative strategies for when funding runs out and/or becomes more difficult to obtain, such as, commitment from a consortium made up of a mix of private sector and institutional funders.
- Developing iterative project scoping over both short and long term.
- Providing enough time for innovators and adopters to experiment with and apply new pedagogies enabled by digital education technologies.

- Establishing adequate workplace systems and resources to accommodate 24/7 online learning.
- Allocating sufficient time to achieve mainstreaming: the study demonstrated that three years is needed to establish mainstream adoption of an e-learning innovation.

7.6.4 Establishing effective policies and guidelines

A major challenge for universities identified by this study is how to remove perceived ambiguities in policies and guidelines that impact on achieving mainstreaming of e-learning innovations in higher education teaching practice. Results of the study suggest that policy making is both an input and an output in decision-making and planning for mainstreaming of e-learning innovations.

Building institutional capacity for informing effective policy and guidelines for decision-making and planning requires consideration of the following challenges and opportunities:

- Overcoming problematic licencing of externally provided software while ensuring data integrity and risk management.
- Presenting a case for re-establishing political support for government funding, national collaborative policymaking and research about re-thinking workplace systems and practices needed for harnessing the transformative educational benefits of e-learning innovation adoption in higher education.
- Providing physical and human resources for training, especially in computer skills, beyond templates, technical infrastructure and administrative rules.
- Overcoming staff and academic resistance to change, acknowledging those wanting to cling to traditional environments and practices, their fears of technology and suspicions of management motivations, while engaging those willing to change.
- Revising academic promotion policies to reward innovations in teaching and learning and to negate perceptions that lower scores from student experience surveys result from experimentation with new technology-enabled teaching practices.
- Recognising when collective and/or collaborative policy decision-making will be effective.
- Differentiating the duality in policy making as both an input and an output of strategy development.

7.6.5 Providing project management

The need for project management in previous recommendations (see Sections 7.6.2 and 7.6.3) adds a further consideration in institutional capacity building. The results of the study suggest that the role of project management can be pivotal in:

- Linking project management processes with the practice of evidence gathering.
- Centralising support for managing and sharing digital spread sheets and emails, specific to a project.
- Acknowledging the ad hoc and organic nature of project management of adoption of e-learning innovations that originate bottom-up in higher education practice, and further that these innovations require more agile, iterative, incremental and devolved methods than traditional systemic methods used in large scale IT projects (such as LMS implementations) that are driven top-down by university management and central systems.
- Sitting alongside adopters and engaging them as active project partners.
- Alleviating time pressures on academics by revising workloads and allocating adequate time for exploration, including time to think and experiment.
- Accommodating a balance of top-down *direction* and bottom-up *emergence*.
- Evidence gathering, beyond the use of audits, that focusses on teaching and learning effectiveness and benefits.
- Establishing universally agreed methodologies and measures for rating ease and effectiveness of technologies used in e-learning.

7.6.6 Opening channels of communication

The study reveals that building collaboration across institutional silos is needed to straddle the complex organisational ecosystems of universities, in order to resolve tensions between administrative, technical, pedagogical and social forces. Although not raised by study participants in gathering primary data, establishment of communities of practice is proposed in secondary data and literature review as an effective way of building cross-functional, collaborative environments.

Other ways of opening and maintaining collaborative communication in universities also appear worthy of consideration and include:

- Promoting achievements of e-learning innovators from both within an originating university and outside through external publications and conferences.
- Sharing information inside a university about what is trending in successful application of educational technologies outside of the university through newsletters and forums.
- Building and disseminating a repository of evidence and knowledge, drawing on uniform sets of data to present a coherent picture of evaluated e-learning innovations and insights into effective teaching practices, with opportunities for networking.

7.6.7 Conclusions

The implications for building institutional capacity summarised in these recommendations have not been previously published in any other research study. This study is the first to provide evidence from research findings in support of the recommendations along with a new methodology for the generative co-creation of this evidence, Interpretive Case-based Modelling, that has potential for further application in decision-making and planning in universities and beyond.

7.7 Interpretive Case-based Modelling

Findings from this research confirm the effectiveness of Interpretive Case-based Modelling as a methodology to bring together the multifaceted roles of researcher and participant to address a wicked problem. The new methodology, developed for this study, provides a researcher with a dual role: as an observer of an evolving, complex environment in which transformational change is occurring and as an active participant in unravelling its complexity through modelling this environment through lived experiences of study participants.

Applying the role of researcher as designer and observer, proposed in the *La Méthode* complexity paradigm (Morin, 1982), an elusive goal until now, has been made possible through an array of technologies described in this study (Section 4.9). This was a study about technologies that utilised technologies, using a research design framework for *in situ* co-construction and sense-making that enabled conversations between the researcher and those with recent lived experiences. These conversations were applied to a computer model as a focus for collaborative evidence-gathering that provided a common language for both participant and researcher along with a platform for visualisation. In this way, Interpretative Case-based Modelling was able to build on and extend previous theories and methods to address complex problems in complex systems by bringing conversations into modelling and modelling into conversations.

7.8 Limitations in this study

In the ever-evolving context of mainstreaming e-learning innovations in higher education teaching practice, the experiences of the people involved in it will continue to change. Conversations between those people in whatever role they operate, *macro*, *meso*, *micro* or some combination, will also continue to evolve. Thus the problem of how to build institutional capacity for mainstreaming e-learning innovations appears unlikely to be completely solved in the foreseeable future, although in studies that view this as a wicked problem this does not present a limitation (see Section 6.10).

The study excluded the role of students as actors in e-learning innovation adoption.

Factors from previous studies with a primary focus on organisational culture rather than organisational systems were also excluded.

7.9 Further research

The addition of students as potential actors in mainstreaming e-learning innovations may be worth exploring in further research, along with factors associated with organisational cultures in universities. This study noted potential for student participation in the early development and evaluation stages of e-learning innovations and this may be worth investigating in expanding applications of interpretative case-based modelling.

Modifications to the modelling software were suggested by some participants and included the addition of capturing and comparing different scenarios over time and indicating the levels of importance in relationships between roles with thicker or thinner lines in the models. The addition of aggregated feedback loops in the model, as depicted in the Bass Model, may also be possible and worth exploring in future research. Recent releases of newer versions of the COMPLEX-IT software (discussed in Section 4.9) have potential in further applications for modelling and analysis of results and appear worthy of testing in future studies.

Replicating the methods used in this study in groups made up of representatives of all stakeholder groups, including management and adopters, was also recommended by some participants in the study. “Third space” theory offers a further lens for future studies, using Interpretive Case-based Modelling, in examining the organisational consequences of interactions between stakeholders in building institutional capacity in universities and informing what needs to change.

7.10 Final remarks

In this thesis, the opening words came from David Ward, former Chancellor of the University of Wisconsin-Madison, in stating “we must find ways to stimulate and scale change across institutions - as well as to sustain those changes - if we are to create models that can serve the expanding needs of our learners” (Ward, 2013, p. 22). Achieving this challenge requires a commitment to capacity building based on establishing enabling connections between actors and factors within a complex university ecosystem. In universities, and indeed across the world, effective leadership is required to drive and sustain change. Just as we see today, in a world under threat from climate change and a global pandemic, leadership at many levels, coupled with support systems for innovation and its adoption, is needed for driving and sustaining change in social systems. So it is, in our universities. The COVID-19 pandemic has provided an unprecedented opportunity for stimulating teacher-led e-learning innovations around the world. Once the pandemic has passed, institutions have the opportunity to evaluate and harness the transformative benefits of these innovations through creating collaborative models for mainstreaming and thus sustaining their adoption.

This study has developed Interpretive Case-based Modelling as a new methodology for revealing conditions necessary in universities for sustaining change, by mainstreaming e-learning innovations that originate in higher education teaching practice. The new methodology builds on and extends applications of previous theories (DoI and CAS) by incorporating principles of the Denzin (2001) Interpretative Interactionism research design as a guiding framework for conducting case-based modelling. In this study, Interpretive Case-based Modelling was successfully demonstrated as a new methodology for investigating complexity, defined as a wicked problem, in educational systems. Interpretive Case-based Modelling enabled participants to visualise the impact of institutional roles during the adoption of e-learning innovations and provided a process for conversation, visualisation, reflection and elicitation of insights not previously possible with other research methods. The study also demonstrated that an array of technologies available to researchers today can be applied together successfully to investigate complex problems. As a process for bringing computer modelling into conversations and conversations into computer modelling, the methodology appears to have potential for wider applications in other areas of educational research and, more generally, in researching wicked problems.

In summary:

- Building institutional capacity for mainstreaming e-learning innovations involves recognising essential roles played by all key stakeholders in innovation adoption and how these roles are connected.
- Mainstreaming an innovation needs to be a planned process. Interpretive Case-Based Modelling can assist with this.
- While each context is unique, a planning process can be undertaken in situ by modelling and exploring connections and levels of influences between common stakeholder roles in innovation adoption to reveal actionable insights.
- Interpretive Case-Based Modelling has potential for wider applications in other studies of complex problems in complex systems.

One of the unexpected outcomes of the study came from participants' enthusiastic reactions to using the MMM tool during interviews. The application of Interpretative Case-Based Modelling in this study using MMM together with an array of other technologies provided opportunities for personal interaction between researcher and study participants not previously found in other methods used in case-based modelling. The final words in this thesis come from the voices of three of the 15 Australian and New Zealand participants who so generously gave their time and shared their experiences and insights to make this study possible:

> I think having someone else involved in this conversation is the most important thing.
>
> It's where models and technology like this actually enable an open conversation about change and reflection of change. So, I think it's been brilliant.
>
> I really like your model. That was the most fun I have ever had in an interview.

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APPENDIX 1. POSTER SUMMARY OF RESEARCH

Figure 25 is a poster summarising the research in this thesis that was presented at Flinders University Docfest 2019.

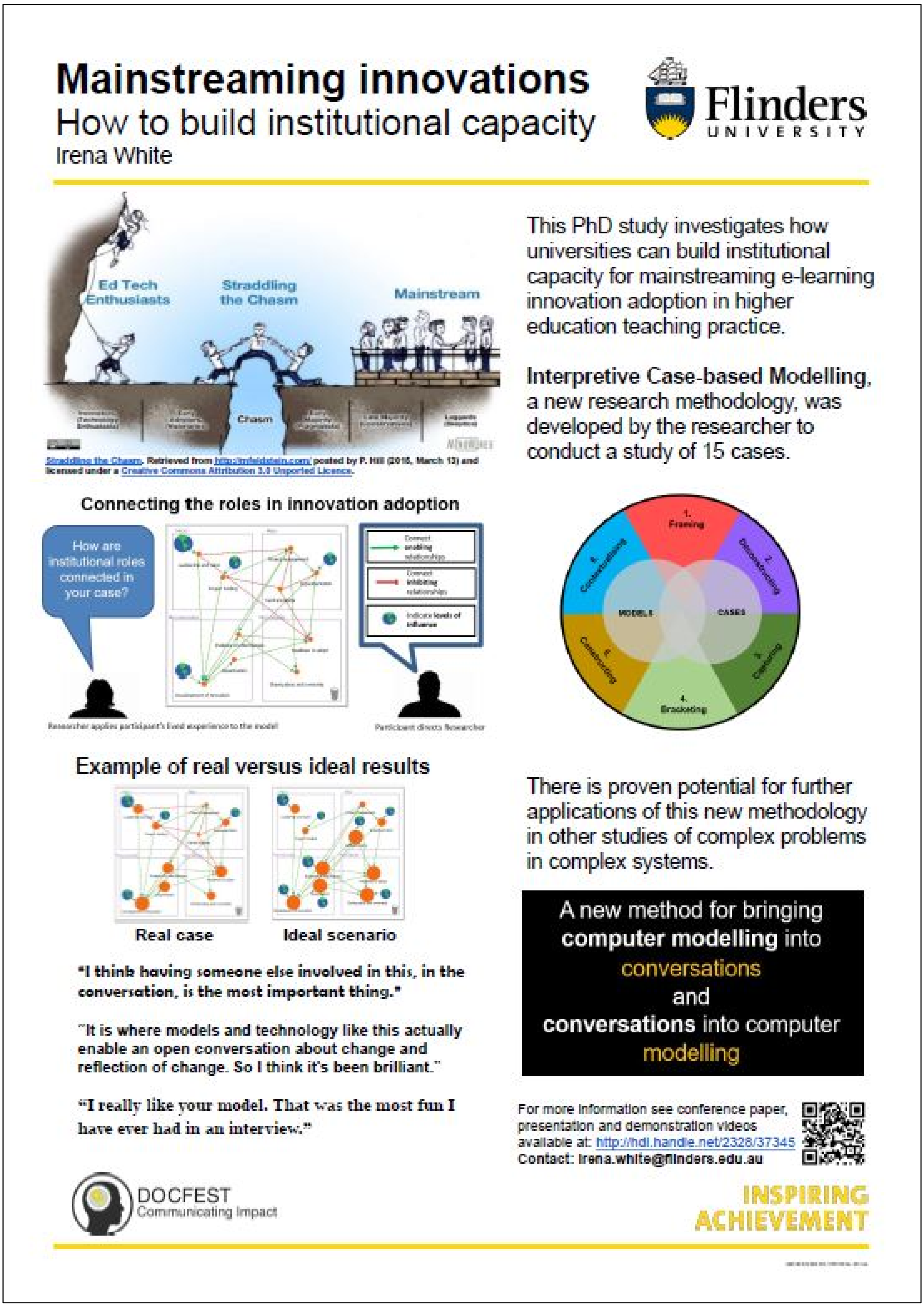

Figure 25. Poster summarising research in this thesis.

APPENDIX 2. COMPARISON OF E-LEARNING TIMELINES

The following table contains a comparison of e-learning timelines for significant studies.

Table 30. e-learning timelines for significant studies.

Year	Conole (2017) as a priority	Weller (2018a) as relevant/significant	Adams Becker et al., (2018) as a trend	
			Technology developments	Significant challenges
1980s	Multimedia resources			
1993	The Web	Artificial Intelligence (AI)		
1994	Learning objects	Bulletin Board Systems		
1995	Learning Management Systems (LMS)	The Web		
1996		Computer Mediated Communication (CMC)		
1997		Constructivism		
1998	Mobile devices	Wikis		
1999	Learning Design	E-learning		
2000	Gaming technologies	Learning objects		
2001	Open Education Resources (OERs)	E-learning standards		
2002		Open licences and OERs		
2003		Blogs		
2004	Social and participatory media	Virtual Learning Environments (VLE)/LMS		
2005	Virtual worlds	Video streaming		
2006		Web 2.0		
2007	E-books and smart devices	Second Life and Virtual Worlds		
2008	Massive Open Online Courses (MOOCs)	E-portfolios		
2009		Twitter and social media		
2010	Learning Analytics	Connectivism		
2011		Personal Learning Environments (PLEs)		
2012		MOOCs	Analytics technologies Games and gamification Internet of things Mobile learning Natural user interfaces Tablet computing	Competition from new models of education Integrating technology in faculty education Insufficient metrics for evaluation Embracing the need for radical change Documenting and supporting new forms of scholarship

Year	Conole (2017) as a priority	Weller (2018a) as relevant/significant	Adams Becker et al., (2018) as a trend	
			Technology developments	**Significant challenges**
2013		Open Textbooks (extension of OER)	Wearable technology MOOCs	Personalised learning Academics' attitude about technology
2014		Learning Analytics	Flipped classroom Quantified self Virtual assistants	Authentic learning experiences Rewarding teaching Scaling teaching innovations Expanding access
2015		Digital Badges	Bring Your Own Device Adaptive learning technologies Makerspaces	Blended formal and informal learning Improving digital literacy Teaching complexity thinking
2016		The return of AI (in the future)	Affective computing Mixed reality Robotics	Balancing our connected and unconnected lives
2017		Blockchain (for recording educational progress)	AI Next generation LMS	Rethinking the role of educators Achievement gap Advancing digital equity Managing knowledge obsolescence
2018		Need for ethical, practical and conceptual frameworks - Critical Ed Tech (digital sociology)		Adapting organisational designs to the future of work Economic and political pressures

APPENDIX 3. ANALYSIS OF INITIAL SEARCH FOR E-LEARNING INNOVATION ADOPTION STUDIES

This appendix contains tables that outline the scope of the initial search for e-learning innovation adoption studies for use in this study.

Table 31 lists influences identified in 13 studies of e-learning innovation adoption in higher education. In the centre of the table the focus of these studies is divided between Critical Success Factors (CSF) associated with *individual* (teaching roles), *institutional* (management roles and support services), and *other influences* found to play a part in e-learning innovation adoption. The studies span the decade between 2005 to 2015. The *source* and *type of study* are also provided, together with the origins and drivers of adoption of e-learning innovations that were investigated, for example, top-down (management originated/driven) or bottom-up (teacher originated/driven) together with other study details.

Table 31. Initial search of e-learning innovation adoption studies.

Higher Education/University Studies				
Source	**Individual**	**Institutional**	**Other influences**	**Type of study**
Hardaker & Singh (2011)	Individual	Structure		UK Universities Exploratory case studies (5) plus interviews (36) Top-down, integrated top-down, bottom-up, research-driven and project-driven approach
Singh & Hardaker (2014)	Individualist (*micro*) – social factors	Structuralist (macro) – management issues		Higher Education in Australia, USA, UK (mainly), Canada and Africa Literature Review of 340 articles (p. 109) Top down and bottom up
King & Boyatt (2015)	Individual attitudes and skills	Institution infrastructure	Student expectations [extends Singh & Hardaker (2014)]	UK University (1) Focus groups (37 participants) plus interviews (11) with academic teaching staff
Alexander (2006)	Academics' perception Enthusiasm of adopters		Ease of adaption of the project	Australian Universities (2) spread from one university to another Case study of role-play simulation in use after 10 years Bottom up project
Birch & Burnett (2009)	Individual	Institutional	Pedagogical	Australian University (1) Exploratory case study
Csete & Evans (2013)		Procedures and practices		Hong Kong University 43 Longitudinal case studies spanning 2006 to 2012 Centrally funded bottom

Higher Education/University Studies				
Source	**Individual**	**Institutional**	**Other influences**	**Type of study**
				up projects
Elgort (2005)	Individual university teacher as practitioner	Institutional organisational, socio-cultural with a focus on professional learning	Teaching and learning processes plane of technology and the plane of pedagogy	Universities in Australia, NZ and the UK Universities (22) interviews with 59 university staff Top down (LMS)
Gunn (2010)		Organisational structures, institutional systems and practices		New Zealand Universities (8) Interviews with 30 staff from six of New Zealand's eight universities and three polytechnics Bottom up and top down
Gunn & Herrick (2012)	Role of innovator/s (p. 10) CSF – "passion and commitment of the champion along with persistence/stubbornness" (p. 6)	Institutional context i.e. university values, structures, policies and processes (p. 10) CSF – "the support of the institution" (p. 6) CSF – "getting the right team together with a mix of academics and technical people" (Gunn & Herrick, 2012, p. 6)	Funding sources and conditions (p. 10) CSF – "staff salaries and various types of internal grants" (p. 6) CSF – "ease of use, low barrier to entry and integration with Moodle [Learning Management System]" of the product	Australian Universities (22) Case studies - mostly bottom up
Henderson (2015)	Educators	Institution	Learners	Australian Universities (39) 114 survey responses from university leaders and managers including 85 senior leaders
Salmon & Angood (2013)		Behavioural Organisational Facilitation		Australian and UK universities Discussion paper with supporting examples
Sharpe, Benfield & Francis (2006)	Beliefs	Infrastructure		UK University Case study(1) Top down and bottom up
Smigiel (2013)	Staff perceptions and attitudes		Student perceptions	Australian University (1) Case study

Tables 32 through 35 group factors identified from the above 13 studies (Table 31) across three system levels: *macro*, *meso* and *micro*. Within higher education these three levels are respectively "the organisational activity system – largely represented by management … the technological activity system – largely represented by information technology specialists … the pedagogic activity system – represented by those with primary responsibility for teaching and learning" (Robertson, 2008, p. 821). In the following tables, further references to *institutional* and *individual* factors are identified from the 13 studies and associated with *macro*, *meso* and *micro* level roles. A further separation is made of the *micro* (teaching practice) level into the Rogers (2003) innovator and adopter roles.

References to roles and related factors in e-learning innovation adoption are grouped in the following tables as follows:

- *Macro*: Leadership & vision; Project funding; Policies
- *Meso*: Management; Systems & support; Expertise
- *Micro adopter*: Skills & attitudes; Ownership & control; Recognition & reward
- *Micro innovator*: Evidence of effectiveness; Innovation development; Dissemination

Table 32. Initial studies on *macro*-level roles.

***Macro*-Level Roles**		
Leadership and vision	**Project funding**	**Policies**
Ensure "communication of clear vision" (Singh & Hardaker, 2014, p. 110) Provide "a clear institutional direction, vision and policies concerning the design and delivery of e-learning environments" (Birch & Burnett, 2009, p. 129) Statements that demonstrate "senior executives value IT's contribution" (Salmon & Angood, 2013, p. 921) Promote "IT understanding and the role of learning technologies in the future for teaching" (Salmon & Angood, 2013, p. 921) Recruit "champions from senior executives or governance processes" (Salmon & Angood, 2013, p. 922) Provide "strategic direction" (King & Boyatt, 2015. P. 1275) "recognise [eLearning] as a priority" (King & Boyatt, 2015, p. 1275) "develop a supportive	Ensure "a transparent review process for approving projects" (Csete & Evans, 2013, p.166) Provide "staff salaries and various types of internal grants" ... and "other sources of available funding" (Gunn & Herrick, 2012, p. 7) Provide "awareness of and engagement with … the range of existing support and funding across the institution" (King & Boyatt, 2015, p. 1276)	Provide "policies or directives from the top through formal channels or via emails or intranet" (Hardaker and Singh, 2011, p. 230) Support and promote the "role of eLearning strategy" and "creation of common goals" (Singh & Hardaker, 2014, p. 110) Dismantle "the silos and [promote] sharing of thoughts, ideas and capability (Australian Learning and Teaching Council, 2013)" (Salmon & Angood, 2013, p. 920) Involve "students as key stakeholders and future thinkers" (Salmon & Angood, 2013, p. 921) Develop "learning, teaching and assessment strategies and policies in combination with digital technologies plans" (Salmon & Angood, 2013, p. 922) Also see Birch & Burnett, 2009, p. 129 in *Leadership & Vision* column

Macro-Level Roles		
Leadership and vision	**Project funding**	**Policies**
institutional culture offering time and space” (King & Boyatt, 2015, p. 1275)		

Table 33. Initial studies on *meso*-level roles.

Meso-Level Roles		
Management	**Systems and support**	**Expertise**
Ensure that "formal project management methodology is applied to development and delivery of elearning products once proof of concept has been established" (Gunn & Herrick, 2012, p. 2) “foster culture and climate for adoption” (Singh & Hardaker, 2014, p. 110) Implement "cross-silo networking for decision making" (Salmon & Angood, 2013, p. 921) Recruit for and promote “the role of 'learning technologists'" (Salmon & Angood, 2013, p. 922) Provide "a structured innovation 'pipeline' ... that moves project to prototype and then to mainstreaming" (Salmon & Angood, 2013, p. 922) Promote "informed decision making at every stage" (Salmon & Angood, 2013, p. 922) Provide “documentation designed to assist quality assurance and thoughtful feedback” (Csete & Evans, 2013, p. 171) Provide “access to specialised technical support, training, administrative support and development and delivery time for eLearning courses” (Hardaker & Singh, 2011, p. 231) Encourage “the reporting of challenges and difficulties encountered in the projects”	Ensure “robust and high capacity technical infrastructures” (Henderson, 2015, Slide 27) Provide “technology infrastructure" (Smigiel, 2013, p. 85) Provide “access to resources” … “technology drivers” … “centralised/decentralised structures” … “availability of technical resource” … “training/support” (Singh & Hardaker, 2014, p. 110) Ensure that “lecture theatres/seminar rooms are flexible & reliable spaces for different technology” (Henderson, 2015, Slide 27) Provide “a set of tools that make it possible for others to adopt the innovation” and “ease of adaption” (Alexander, 2006, p. 29) Integrate “technological and pedagogical support that closely matched staff needs” (King & Boyatt, 2015, p. 1275) Ensure "that systems specifications meet institutional requirements and standards first and local desires second" (Salmon & Angood, 2013, p. 921) Provide “online how-to guides, recipes for implementing new technology” (King & Boyatt, 2015, p. 1276) Provide "space in the university for creative and exploratory activities" (Salmon & Angood, 2013, p. 921)	Ensure availability of “technical expertise" (Smigiel, 2013, p. 85) Provide “professional learning design assistance” (Csete & Evans, 2013, p. 168) Provide “availability of specialized design, programming and multimedia assistance” (Csete & Evans, 2013, p. 168) Provide access to “project management and marketing expertise” (Gunn & Herrick, 2012, p. 2) Provide “professional evaluation assistance” (Csete & Evans, 2013, p. 170)

Meso-Level Roles		
Management	**Systems and support**	**Expertise**
(Csete & Evans, 2013, p. 171) Support “staff to recognise the affordances of technology and how it might help them to maintain a high-quality learning experience for their students” (King & Boyatt, 2015, p. 1275) Use “a collective rather than a collaborative approach to streamline institutional response times and policy development processes” (Gunn, 2010, p. 101) Have “the right processes and people involved to ensure that management supports, and does not stifle, innovation” (Gunn & Herrick, 2012, p. 12) Provide "governance and decision-making structures" (Salmon & Angood, 2013, p. 921) Manage "risks of smaller-scale prototyping within an innovation centre" (Salmon & Angood, 2013, p. 921) Establish “a framework to guide evaluation” (Csete & Evans, 2013, p. 170)	Demonstrate "obvious benefits, impacts and efficiencies" through audits (p. 922) for example, "IT maturity model (Salmon & Angood, 2013, p. 923) Ensure "efficient and effective customer relations management and IT help desk systems" (Salmon & Angood, 2013, p. 922) Provide “integration between the available tools and central systems” (King & Boyatt, 2015, p. 1275) Ensure “available tools and central systems [are] … integrated with existing pedagogic practices and systems” (King & Boyatt, 2015, p. 1275) Ensure “ICT tools [are] … aligned with … [teachers’] beliefs about teaching and learning” (Elgort, 2005, p. 184) Deliver “staff development interventions” (Elgort, 2005, p. 184) Maintain and update “the software" (Gunn & Herrick, 2012, p. 8) Provide "training and support for users" (Gunn & Herrick, 2012, p. 8) Provide “assistance to academic staff who were drafting project proposals” (Csete & Evans, 2013, p. 166)	

Table 34. Initial studies on *micro* adopter-level roles.

Micro Adopter-Level Roles		
Skills and attitudes	**Ownership and control**	**Recognition and reward**
Develop “IT skills/competence” (Singh & Hardaker, 2014, p. 110) Overcome "veiled suspicion [amongst teaching staff] regarding the motivation for the university exploring and	Gain “control over their academic roles in teaching and learning” (Hardaker & Singh, 2011, p. 230) Have “ability to intervene or refrain from action thus having influence on adoption	Achieve “the winning of awards for teaching and learning and resulting high profile of adopters of the innovation” (Alexander, 2006, p. 29)

Micro Adopter-Level Roles		
Skills and attitudes	**Ownership and control**	**Recognition and reward**
promoting online methods of teaching and learning" (Smigiel, 2013, p.85) Build "staff confidence" (King & Boyatt, 2015, p. 1275)	processes" (Hardaker and Singh, 2011, p. 231) Ensure "the opportunity for potential adopters to take on a legitimate role within an early stage of the innovation, enabling them to see the value of the project to enhancing the quality of learning" (Alexander, 2006, p. 29) Publish "papers in journals and conferences by adopters describing the adoption and adaptation of the innovation" (Alexander, 2006, p. 29) Have a "shared vision and sense of ownership" (Gunn, 2010, P. 100) Maintain "locus of control of ELearning: … control of curriculum, changes to academic roles, … academic identity" (Singh & Hardaker, 2014, p. 110)	

Table 35. Initial studies on *micro*-innovator roles.

Micro-Innovator Roles		
Evidence of effectiveness	**Innovation development**	**Dissemination**
Demonstrate "the value to students" (Alexander, 2006, p. 29) Demonstrate "increase [in] the quality of student learning outcomes" (Alexander, 2006, p. 29) Engage in "in joint research and development activities" (Salmon & Angood, 2013, p. 922) "pilot early in the project development process" (Csete & Evans, 2013, p. 168) Provide "evidence of the effect on teaching and learning" (Gunn & Herrick, 2012, p. 8) Demonstrate "the value of the original idea, its ease of use, low barrier to entry and integration with Moodle [LMS]"	Allow for adequate "development time" (Singh & Hardaker, 2014, p. 110) Have "time to do the necessary curriculum development" (Smigiel, 2013, p.85) Refuse "to conform to the institutional requirements" (Hardaker & Singh, 2011, p. 231) Involve "IT staff, learning technologists and academic teachers in the design of new types of courses and modes of delivery" (Salmon & Angood, 2013, p. 921) Build in "explicit expectation that even early versions of deliverables be used with students" (Csete & Evans,	Appoint "champion/s of the innovation (other than the original developer) who was/were instrumental in persuading others of its value" (Alexander, 2006, p. 29) Use "passion and commitment of the champion" (Gunn & Herrick, 2012, p. 7) Change "the focus of conversations about TEL [eLearning] from the technology to the learning" (Henderson, 2015, Slide 27) Stimulate "TEL [eLearning] interest amongst staff other than the 'early adopters'" (Henderson, 2015, Slide 27) Publish "a paper in a journal by the original innovator describing the innovation"

Micro-Innovator Roles		
Evidence of effectiveness	**Innovation development**	**Dissemination**
(Gunn & Herrick, 2012, p. 7)	2013, p. 170) Expect and accommodate "change as a positive and formative process" (Csete & Evans, 2013, p. 171) Ensure "autonomy [of academic teaching staff] to employ and manage their own project staff" (Csete & Evans, 2013, p. 172) Recognise "students need to be supported to develop realistic expectations" (King & Boyatt, 2015, p. 1277) Recognise "students need to be supported to develop skills to engage effectively with the opportunities e-learning affords" (King & Boyatt, 2015, p. 1278) Work "directly with students to help them learn how to learn with technology" (Henderson, 2015, Slide 27) Develop/use "forms of TEL [eLearning] that mirror familiar everyday uses of technology" (Henderson, 2015, Slide 27) Get "the right team together" (Gunn & Herrick, 2012, p. 7) Draw on "'Communities of Practice' literature in Wenger, 2006" (Salmon & Angood, 2013, p. 920)	(Alexander, 2006, p. 29) Provide "opportunities for conversations with potential adopters" (Alexander, 2006, p. 29) Use "social networks" and "interpersonal communication" (Singh & Hardaker, 2014, p. 110) Use "collaboration and interprofession engagement" (Salmon & Angood, 2013, p. 923) Recognise "the benefits, acknowledging the barriers and raising awareness" (King & Boyatt, 2015, p. 1275) Provide "opportunities for sharing practice" (King & Boyatt, 2015, p. 1276) Use "cross-functional collaboration to accommodate different and sometimes conflicting perspectives" (Gunn, 2010, p. 100) Establish "an internal community of professional practice, with more and less experienced academics working together on common goals" (Gunn, 2010, p. 97)

APPENDIX 4. SAMPLES OF INTERVIEW TRANSCRIPT

This appendix contains parts of the edited versions of the interview transcript of participant Meso 3. This participant was involved with the e-learning innovation “location-based mobile learning games”. Table 36 contains transcript of the participant’s lived experience.

Table 36. Edited transcript of participant’s lived experience.

Edited transcript of the scenario [participant’s lived experience]
The innovation that I want to share with you today is about location-based mobile learning games, which is something that we've been running with at the university since 2014. Before that, I was engaging in the same pedagogy in the K-12 sector. It grew from my experience in that area and I've been able to now apply it relatively effectively in higher education as well. So, when we talk about location-based mobile learning games, it often doesn't immediately bring a metaphor to people's minds. Just explaining briefly what they are, we've got a location-based mobile learning game bringing three technologies together: mobile learning, digital storytelling and location-based learning. This integrates storytelling, rich digital media, maps, augmented reality and some gamification to turn learning into a personal engaging experience and an authentic experience as well because you're actually in the real world outside the classroom where this is going on. That's where we have been heading towards and we've been very successful in doing that. In 2014 we began at the university by bringing a location-based mobile learning game into a core undergraduate first year course in the business division to assist with an approach to blended learning that the head of schools was looking to bring in. One of the existing activities was a small field trip where students would go out into the city and use a pen and a paper to record some answers to questions that were on that paper. We knew that mobile phones are in the hands of young people everywhere and there was enough evidence to suggest that our students were engaged with using their mobile phones, though not necessarily for study. These were probably over 90% of our students at that stage who owned a mobile phone. It was quite natural for learning to progress towards that mobile domain and so we changed that activity and took the pencils and paper away and we brought in the multi-modality features of mobile phones like connectivity, GPS, location and awareness and brought the learning experience to the students so that they engaged with authentic content outside of the classroom. We added gamification elements through quizzes and time limits so that there was some strategy to effectively winning the game. It might be a coffee and cake voucher or something else that occurred at their last location. So all of those sorts of things were involved. What set this apart was the fact it's just not another app that pushed out information. We wanted to bring information from the students back into the learning environment. They were able to use the app to take photographs of where they were to validate personally that they'd been to that location and to effectively bring their own content back into the game. So that's working very well, that two-way interaction. The platform that we're using is called the Mobile Learning Academy. That platform has mobile apps to play the games. It's got an online game maker that allows anybody without any programming experience to be able to develop the location-based mobile learning game very effectively. We used it in that core undergraduate course. It was successful. Over 500 students played in that pilot back in 2014 and the app took them around the businesses in one end of the city. Students formed small teams. It was by led by a tutor. They walked the trail and engaged with the content. We surveyed the students and 73% of them said it was engaging and a fun way to learn and 69% said it assisted them to understand the concepts in that part of the course. While we'd designed the app to be able to improve learning outcomes for students, we found we had an unintended positive effect. Because this was an activity right at the beginning of a class, where students didn't yet know each other and because we used small teams to play the game, it was an icebreaker for these students. It was an opportunity for them to make friends in their tutorial groups because we ran it that way. Certainly, research has highlighted that if students make friends in their tutorials or courses, retention is improved. That's where we started back in 2014 and from there we applied for teaching and learning grants, to be able to bring the opportunity for other staff within the university, to engage with that content. We were able to bring on about 10 more staff. As an online educational designer I worked with them to bring their course concepts into the location-based mobile learning game and we did that in education, we did it in the arts and we also did it in science. We were now going across disciplines and during 2016, in total we supported about 16 staff and also some students, postgraduate students and some undergraduate students, to do some design and development work themselves. Now we've produced over 80 games in seven

Edited transcript of the scenario [participant's lived experience]
undergraduate courses and one postgraduate course. So, it's been elevated up and across the university and we haven't really found any particular issues in bringing this across different disciplines. So, that's an overview of work we've done and some of the steps that we've taken along the way. It all began when we were talking with the head of the school of management and the course coordinator of that business course, called business and society, which is a core undergraduate course. The course coordinator was looking at reviewing the content that was in the course and was more than enthusiastic to become involved and became a course subject matter expert in the team. I was there to help her develop the learning concepts within the online game maker. There was certainly a seed that was growing within the business school and particularly the school of management for some innovation to happen using technology. There was somebody there with eyes open. That was the head of school at the time and while he is now retired he was the person at the time who was bringing the people together to make it happen after he saw the potential. I guess what we did to sell the idea to him. We made a prototype game which he and the course coordinator played. They saw its pedagogical value immediately afterwards and I guess that it escalated from there. We've used the same process with other course coordinators as well. There is a subscription service that is paid [for the platform]. We bought a two-year subscription through the teaching and learning grant and that expires in August 2017. One of my tasks is to rally the troops to see whether there is some money available to continue that subscription beyond August. We certainly would not like to see it disappear into the wilderness because of no money but, as you are fully aware, universities are prioritising and we have to have some good solid pedagogical grounds to convince people that this is the way to go. The results of some online surveys that we've run over a period of time from 2014 onwards have quite conclusively shown that the students are engaged with the learning activity, they are motivated and they appreciate the authenticity that this is offering them. Whether it's done as a tutorial type activity in a guided group or whether it's done as a self-guided discovery exercise, which has also been done, it works equally as well. Students, in one particular course, a geology course, went on a field excursion to look at the building stones along a city street. They would have normally gone there with a pencil and paper but now they went with a mobile app and went to the art gallery, to the museum and to different statues, etc, along the way and were able to record their information within the app and share it with other people. Another good point about this is that once you've taken some photographs and added some comments, you're able to share that information through Facebook or Twitter. There are some built in tabs in the app that you can use for that but it's coming back onto the companion web site that's created along with the app in the online platform that allows players to share their whole experiences (where they went, what they did, etc.) with friends, family or class members. That's a very nice thing to be able to do afterwards. Our work has gone in a different direction this year and there are various reasons for that. Regrettably the only thing we've been able to do this year is to work with the education faculty and bring a group of undergraduate students into the process of designing and developing a location-based mobile game for assessment. It has been very exciting and what we've been able to do in this particular case is to test out the framework that we have put together in a prototype form over the last three years to see how useful and how functional it is for students to follow and be able to do the design work themselves. The second thing we've been able to do is to test the perception that we've had that the educational experiences of students who design their own games will be amplified as they apply new ICT skills to the process. So that was the second thing that we've been testing. The third one is that we've now been able to put together a rubric and a summative assessment process with a whole group of students that hasn't been done before and finally we've identified the challenges and the support issues and the opportunities of bringing this type of activity from face to face courses to a fully online course. The course that we ran it in, in this last study period, was an external course so there were no students on campus. So, we've learned quite a lot as a result of the work in 2017, and moving forward from playing to designing, from the feedback that we've had from the peer reviews. We had the students peer review other students' games and used the rubric to summatively assess it. I must say, we had quite a lot of distinctions, a few high distinctions and credits. Everybody did it. It was a small group of only 16 students in this particular course but the conclusion is that we've got every confidence that what we've been doing is able to be applied into an online course, that students' ICT skills are elevated as a result of them going through the process and their stories, their games are incredibly creative, much more creative than that I could possibly have imagined. So, I've been very thrilled with what's happened this year as a result of that particular project.

Table 37 contains another part of the edited transcript of participant Meso 3: model development.

Table 37. Edited transcript of participant's model development.

Edited transcript of model development
What were the enabling relationships between university roles in your experience of technology adoption?
We'll begin with *Leadership and vision* because that's where we had the initial thrust but at the same time, as I mentioned beforehand, I came to the University with knowledge and skills in this through my work in the K to 12 sectors. So, while there was somebody in the university who saw some potential, there was an enabler between that person, the Head of the School of Management, and myself that brought us together for me to share that. I'm attached to a school not so much as central support but that'll change. There was something that I wanted to bring into the higher education sector and there was somebody that came and enabled the school, the Head of School, and myself to have the initial conversation. I'm tied to a school so that's where it began and from there, we did initial experimentation, that's basically where we went. We were given an opportunity to experiment in that course, that I talked about, in 2014. Initially the cost came out of my own subscription to the mobile learning platform that we started with. The university didn't have its own subscription at that time. I used my own to kick it off and then we applied for the grant to get the university to have a subscription. It was the experimentation that allowed that to happen. After the experimentation the Head of School, the leadership, was saying they wanted to be involved: "Now how can we do this without any money?" I said, "well I have my own subscription. Let's use my subscription to start the process off". We were experimenting within the university. We were just using technology that the university didn't have at the time. Funding came after the experimentation. The people involved were one course developer and her Head of School and myself. The three of us applied for funding for the university to buy their own subscription of the mobile learning academy platform. We got a grant that enabled wider use within the university. So we took what was done in my private channel and moved that game over to the university's channel and then we were able to proliferate that and engage other academics through some sharing sessions with them. It fed into an opportunity for other people within other divisions of the university to become involved but I must say that while we were putting some information out there, I think I was proactive in going to people and saying: "look, this is what we've done, do you want to be involved, I can see an opportunity". There certainly was dissemination. I don't think central systems were ever there to be quite honest. I feel there'll be a red line there eventually. I was disseminating to individuals who were either made aware through some sessions or I proactively engaged with them. Just as an example, because my background is geology I went to the geology people at the university who I didn't know and said to them: "look guys, this is what we've been doing in business and society; my background is geology, I know this will help the pedagogy of what you're trying to do with geology field excursions", and they leapt up and said: "yes, we can see what you've done, we'd like to apply too". But unless I went to them, they would not necessarily have found out about it as quickly, perhaps. I would say at that particular time, I did have support from my Dean of Academic, the Head of School was supportive but learning system, library, professional learning were not involved. We had a teaching and learning grant that allowed us to be able to produce, as we had the software platform enabling us to do that. I was hosted externally by the vendor site, not within the university's system. Then we were able to get a second teaching and learning grant and that enabled us to bring a project officer on board for a little time and allowed me, for the very first time, to have a part time commitment to managing a wider project. Before this, it was being done as an ad hoc, micro type innovation but the second grant, the teaching and learning, formalised that in some way and put some project management around it. That was during 2016 but project management was not there prior to 2016. While that was happening, dissemination was getting stronger because we were able to have opportunities to speak at conferences and deliver the outcomes of a wider group of people that we were experimenting with at that time. As more and more academics were involving themselves, with me at elbow support with them, we were conducting online surveys of students who had been playing the games and a group of students who were designing games, and again this was in 2016, and we were getting those results. Plus, follow-up focus groups were done to get that evidence of effectiveness. The project management side of things was enabling us to have a project officer who created the surveys for us. We were surveying the tutors and the course coordinators as well. So, there's an arrow going from *Development of innovation* up to *Evidence of effectiveness* which is starting to grow.

Edited transcript of model development
From there you go across to where the sharing of ideas is starting to occur. We were getting opportunities to share so another arrow could go from *Project management* to *Sharing ideas and ownership* as well because again, through that grant and enabled by project management, we were able to share that effectiveness with a wider group both within the university and outside the university. Some of the experimentation was being done by people who were not directly involved with me although I had a hand in most of it but there were some people doing some of their own stuff and independent and their experimentation led to adoption as well. There was also definitely guidance there. We were managing people and there is also a link that can go directly from *Evidence of effectiveness* across to *Readiness to adopt*. So that sort of covers what we've talked about here. Like I said, the key player retired and so it was just the course coordinator and I after that.
What were the inhibiting relationships in this experience? Some inhibiting factors start at central systems. Now, in 2017, these red lines start. Everything's hunky-dory in 2016. It was a project and projects have lives and financial endpoints and I completely understand that. There was an opportunity for central support to say, look, this project has been successful because there were reports written to the central support about it, and let's mainstream it or let's expand this readiness to adopt but they didn't do that. They chose, in 2017, to discontinue my involvement with the project and the project was gone. There was no such thing as a project. There was no opportunity to mainstream it further. There's a nice diagram working out there with a red spider web coming in. The opportunity to share ideas and ownership has been reduced but it is still there so I think I've covered the red lines. I can't do any location-based mobile learning Monday to Wednesday. I'm not allowed to anymore so there's a complete stop to what I've been doing. There's a different leader. If an academic came to me now and said: “could you help, I’ve really got this cool idea, we can really do this”, I'd have to say: “no, I can't help you, I'm not permitted, I'm on another task”. So I'm angry because I think it is affecting readiness to adopt and it's effecting sharing to some extent. As I said before, the red lines come in, in 2017. It's all green before then.
Which roles were the most influential? The students' designing of summative assessment for a new online course was happening and then, two months into March in 2017, management put a stop to all that. Without project funding we wouldn't have got it through to there so that was a major influence. Leadership is going to be an influence too but both as a plus and a minus. The opportunity to experiment was important. I would have thought by now there was stronger dissemination and sharing of ideas but there hasn't been enough of that. It's just because it's come to a halt this year. Ideally, we would have been in a position to disseminate and share a lot more. The development of the innovation has got to be up there too as an influence. That's certainly strong. I think we go back to *Project funding* and increase the influence of that one a little bit, less than the *Development of the innovation*, but it's definitely a little bit stronger because that did lead the way for us throughout. *Experimentation* was probably up to about 50. *Leadership and vision* ended up a more a powerful force for evil than it was for good. It was there initially but then it disappeared.
How does running this model reflect your experience? [See *real* model in Table 19] It reflects how the project funding and project management came after a lot of stuff had happened. Central systems didn't play a big factor so I think it's measuring this. The project management allowed certain things to happen but the driving force and sphere of influence was sort of more ad hoc, just linking up with people and getting them to be effective in what they were doing and that's the way it evolved. I would have liked to have been able to have the circles of sharing and dissemination to be stronger but that's reflecting where we are at the moment. If things change next year and we can carry on and then those circles may well be larger but at this point of time I think it's a pretty good representation. I do want the people to move on with it and I'll fall back but we're not there yet, no. We possibly should have had a direct line between *Dissemination* and *Sharing ideas and ownership*. I would like to have captured a bit more evidence of effectiveness. I didn't get a chance to do control groups and things like that. There was possibly more to achieve there that we didn't do. It's important to do that. It's already saying the evidence of effective business is strong with the size of that circle diameter now.

Edited transcript of model development
What adjustments would you make to create an ideal model of sustainable eLearning innovation? Let's bump up *Evidence of effectiveness* a bit and let's add an influence around dissemination as well. I'd like that to be about same size as *Sharing ideas and ownership*. *Central systems* doesn't have anything on it at all at the moment. In an ideal world the central systems functions of the library and professional learning for student engagement provide an opportunity for central systems to do more support than what they offered in the actual scenario. *Central systems* needs to be more important in the ideal world. In the ideal, well, you can take all those inhibitors away. There should not be any reds at all. *Dissemination* would have a green line through to *Central systems*. We can put a globe next [influence] to *Central systems* and say that in an ideal world that's quite important and bring that up to 60. I'm thinking library when I'm thinking central systems more than anything and while they're not involved in experimentation or necessarily getting project funding they have a role to play with readiness to adopt. We need to be able to keep funding going like we talked about early on for the subscription. It's not project money but ongoing funding that the project needs from now. They won't call it a project, it's not a project - it's going mainstream now. But you do need to continue subscriptions for software. So where's that going to come from? It comes from showing there is effectiveness and therefore you try to secure ongoing funding. Now, that might be for more project management or it might be for more costs of subscriptions but it comes from the evidence of the effectiveness. It's probably not project funding but it's just general funding that's needed. Maybe we're talking about a role for central support and the evidence of effectiveness goes back to central and central says, “we've got another bucket of money that will keep that going, it is not a project anymore, it's now central”.
How does running this ideal model reflect your expectations about ideal relationships for sustaining eLearning innovations? [See *ideal* model in Table 19] In the real world, for mainstreaming, central support has to be involved. It's saying that a lot of the innovation is still happening in those two bottom quadrants but central support is impacting on that work much more than it was in the project stage. I think that's saying it's important to kick it off and then let the micro innovators influence the process from then on. You've got to keep showing them evidence for that to keep going. I think you've captured in the initial model my frustration this year, in particular, but also some excitement as well with some new stuff coming through but, in general terms, in an ideal world there's no red lines for me. To make it happen, and make it continue to happen, central support has to play a wider role and that's only going to probably come when you can gain that evidence of effectiveness and show that you are disseminating and you are sharing and you've got the readiness to adopt. I think that's capturing where it needs to go and what I would like it to move towards in a more perfect world.

APPENDIX 5. APPLICATION FORM FOR REGISTRATION OF INTEREST IN STUDY

This appendix contains the application form for registration of interest in the research study (Figure 26).

Registration of expression of interest as a volunteer for a PhD research study

This study examines organisational relationships and roles in sustaining the diffusion of eLearning innovations in universities. The elearning innovations that are the focus for this study must originate in *faculties and be proven to be effective in teaching and learning.

Previous studies of elearning diffusion in universities have relied on case studies and surveys to identify individual and institutional actors and causal factors in the dynamic and complex process of technology adoption. This is the first study to connect these actors and factors to reveal the critical relationships and roles within university systems that enable and inhibit bottom-up elearning adoption in higher education teaching practice. The study uses an interactive computer simulation in a 60 to 90 minute interview with volunteer participants to model and explore participants' experiences in bottom-up adoption of proven elearning innovations in universities. Interviews will be conducted between June and August 2017. To register for this study please complete both sides of this form.

1. Please assess your eligibility to participate in this study by indicating your experience of elearning innovations in higher education teaching practice.

○ I have first-hand experience in a faculty-originated elearning innovation that has been implemented and proven through evaluation as effective in teaching and learning within my university during the past three years.

○ I do not have first-hand experience in a faculty-originated elearning innovation that has been implemented and proven through evaluation as effective in teaching and learning within my university during the past three years.

2. Please indicate your further eligibility to participate in this study by ticking **at least one** of the following:

☐ I currently work in a senior university-wide leadership role with responsibility for elearning policy and/or funding of faculty-based elearning projects.

☐ I currently provide elearning advice and services with responsibility for information technology and/or professional learning support for academic teaching staff.

☐ I currently teach in a faculty where I have developed, or worked with a faculty-led team to develop, a proven elearning innovation that has been implemented in the faculty.

☐ I currently teach in a faculty where I have adopted a proven elearning innovation that has been developed by another member of the academic teaching staff or faculty-led team.

☐ I do not meet any of the above eligibility criteria for this study but am interested in the outcomes of this research project

Please provide any further information about yourself that you would like to share with the researcher:

Figure 26. Registration of Interest Form.

APPENDIX 6. MMM BASELINE MODEL INTERFACE

This appendix contains an enlarged view of the MMM interface (Figure 27).

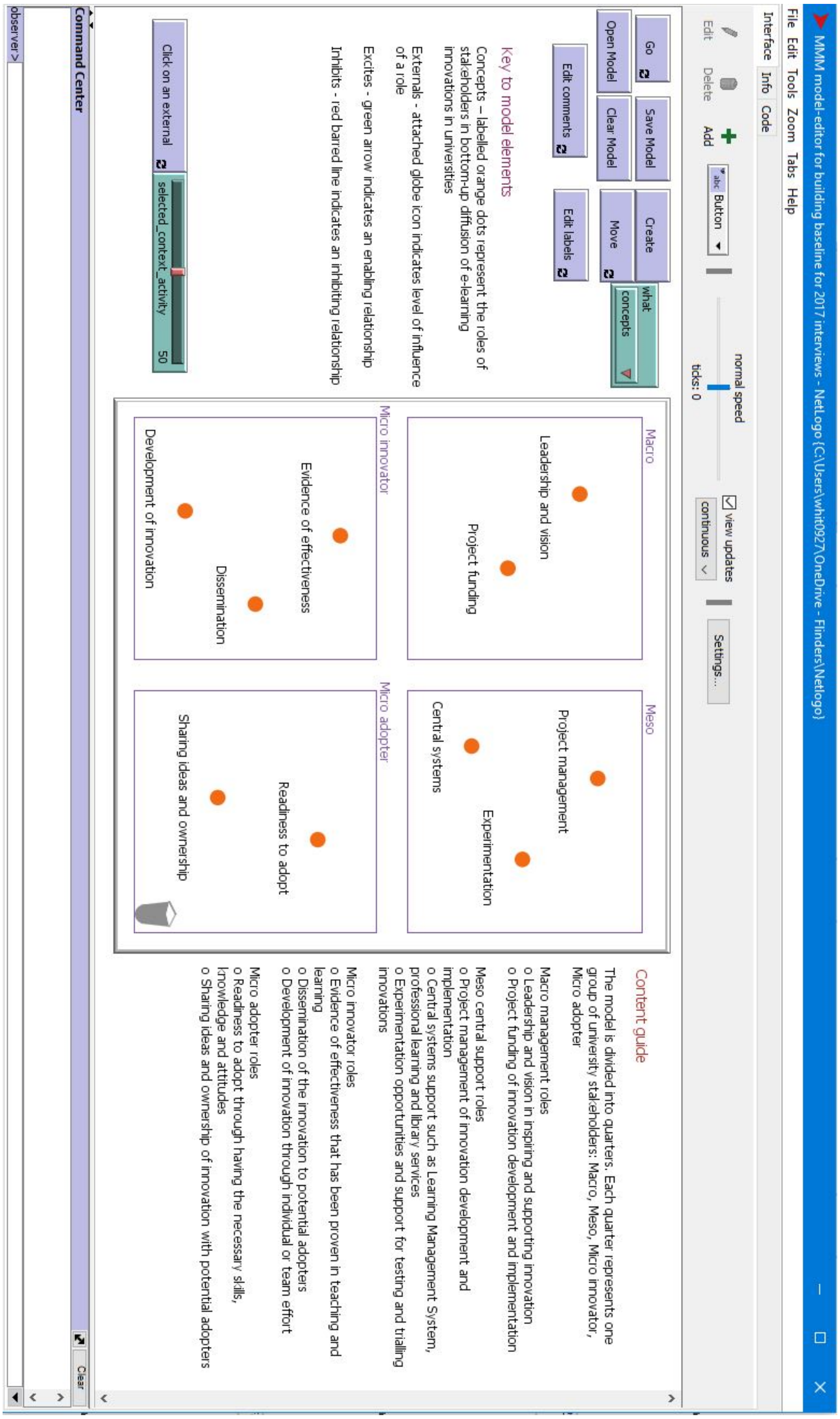

Figure 27. Interface for MMM baseline model (enlarged).

APPENDIX 7. MAP OF COMPLEXITY SCIENCES

This appendix contains the full 2018 Map of the Complexity Sciences (Figure 29).

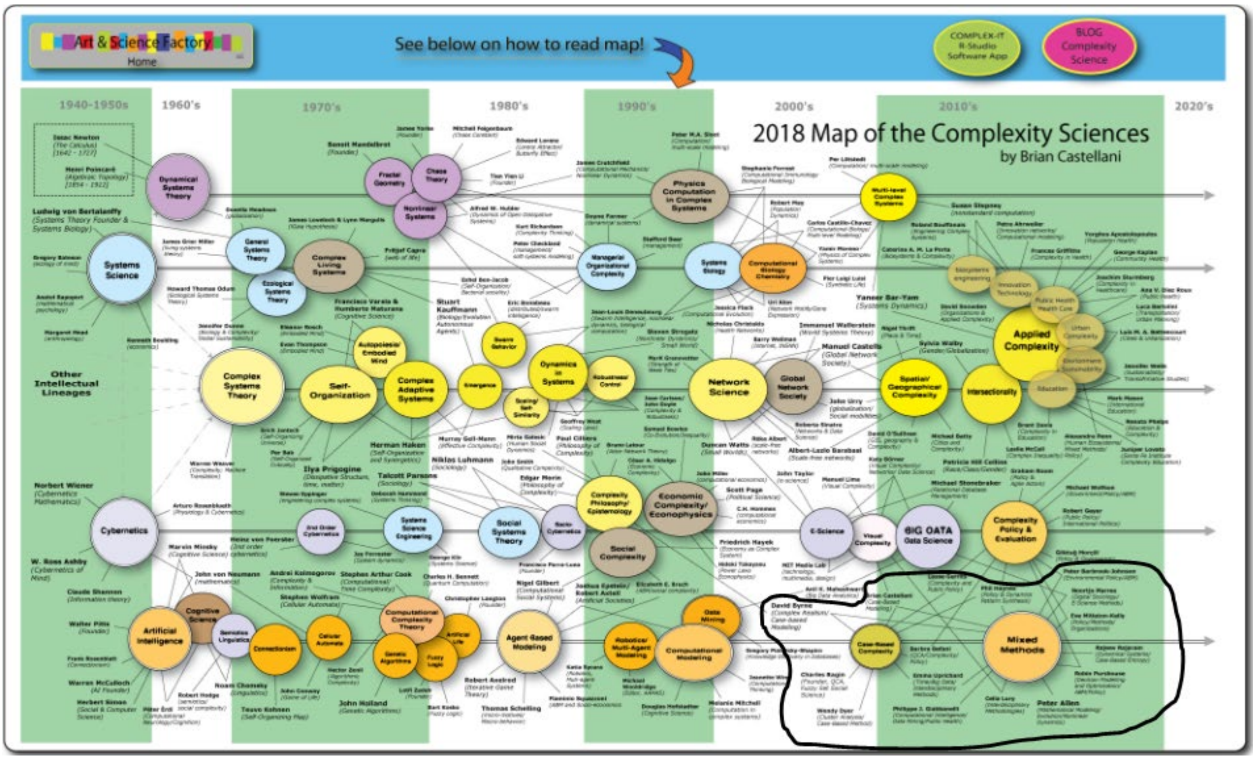

Figure 28. 2018 Map of the Complexity Sciences. Retrieved from http://www.art-sciencefactory.com/complexity-map_feb09.html. Licensed under a Creative Commons Attribution 3.0 Unported Licence.