

TEACHERS' ADOPTION OF INFORMATION AND COMMUNICATIONS
TECHNOLOGY FOR TEACHING AND LEARNING IN MALAYSIA: AN ECOLOGICAL-
COMPLEXITY ANALYSIS OF A PROFESSIONAL DEVELOPMENT INNOVATION.

by

Wagheeh Shukry Hassan

A thesis

submitted to the Victoria University of Wellington
in fulfilment of the requirements for the degree of
Doctor of Philosophy
in Education

Victoria University of Wellington

2010

ABSTRACT

This study explored the factors that influenced teachers' Information Communications Technology (ICT) adoption in teaching and learning, and the adoption of an ICTPD innovation by 44 teachers in four schools in Malaysia. The research focused on understanding teachers' uptake of ICT in teaching and learning in the context of an Information Communications Technology Professional Development (ICTPD) programme, which was implemented in these four schools. This in-school and cluster based ICTPD programme, which was introduced from New Zealand, was the first of such projects carried out in Malaysia.

To address the study's research questions, a collective case study approach was applied. It employed a qualitative approach through the use of mind maps, factor sheets, and semi-structured interviews as the major methods of data collection. The qualitative data was gathered from teachers who participated in the ICTPD programme. Other stakeholders were also included to ensure different perspectives were acquired in understanding teachers' uptake of ICT in the context of the ICTPD programme.

An ecological framework, which incorporated complexity thinking, was employed to inform many aspects of this study, from the selection of methods to the analysis of the data. This framework assumes that factors influencing adoption are complex, interdependent, and independent; it assumes linear factors and linear stages in adoption do not explain the complexities of adoption.

The research revealed that teachers' ICT adoption in teaching and learning was low and superficial. Teachers used ICT as a tool and their practices remained teacher-centred. Teachers *perceived* that their practices changed when

they used ICT in their classroom but very few actually did. The ecological framework identified three levels of linear factors (individual, school, and external). The consequent application of the ecological-complexity perspective on these linear factors revealed complex factors and dynamic interactions between teachers within schools.

The study also discovered that the uptake of the ICTPD programme was similarly superficial. Teachers and schools were reluctant to embrace the in-school facilitation process and the cluster model of the ICTPD programme due to the current priorities of delivering examination results. The findings initially showed the influence of three levels of factors (individual, school, and the innovation) on teachers' adoption of the ICTPD programme. An analysis of the factors according to the ecological-complexity perspective shed light on the extent of adoption and its processes, suggesting that teachers and schools dynamically negotiate with the innovation.

Two ecological-complexity models were developed to explain and understand complex factors and interactions in the two types of adoption. The ecological-complexity perspective showed that the current discourses on linear factors and processes do not fully explain the complexities of teachers' ICT adoption and the uptake of an innovation. The discussions on practical applications for this perspective in education are examined.

The ecological-complexity perspective highlights the importance of re-thinking our frames of understanding teachers' ICT adoption and the adoption of an ICTPD programme; instead of thinking about adoption as an end product, it is a dynamic and continuous process, which is negotiated between teachers and schools and the innovation.

Keywords:

Teachers; ICT adoption; Professional development; ICT policy; ICT and pedagogy; Innovation adoption; Complexity thinking; Ecological perspective; Emergence

ACKNOWLEDGEMENTS

First and foremost, I dedicate this dissertation to my wife, Ann, and to my children, Adam and Danial. Since starting the PhD journey, they have endured periods of absence and, at the end, frenzied agitation. Ann's support and understanding have given me inspiration to achieve my goal.

I am very fortunate to be advised by two outstanding PhD supervisors. I am vastly indebted to my primary supervisor, Barbara Craig, of the Faculty of Education, whose ideas, advice, encouragement, and faith throughout this PhD have aided me tremendously. Equally, and no less important in any means, is my secondary supervisor, Daniel Dorner whose care, attention and assistance have helped me through all phases of this dissertation. I am thankful they have been with me from the start and have given me the confidence to finish the PhD journey.

I would like to thank the Malaysian Ministry of Education for awarding me a scholarship and the sabbatical leave necessary to complete the PhD. Their trust and confidence is greatly appreciated.

I have had the great fortune of meeting wonderful people who have helped me make sense of my study. One such friend, aptly nicknamed the PhD 'hare', due to her quickness and intellectual insight, is Bronwyn Wood. Her help is greatly appreciated and friendship, boundless. This PhD turtle is thankful that the hare is along for the journey.

I would also like to thank David Copeland for helping me settle into Wellington and showing me great kindness and care for my family's well being. David and his family will always, for us, define Kiwi hospitality and spirit.

I must also thank the participants and other people who have helped in this research, given me their time and provided me with a rich and varied data set, which has made this research all the more interesting and absorbing.

This experience has made me grow intellectually and personally.

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	Research problem.....	1
1.2	Innovation and a dual lens approach to examine adoption.....	4
1.3	Research goals.....	6
1.4	Theoretical motivation.....	6
1.5	Overview of my research	8
1.6	The research questions	9
1.7	Audience	10
1.8	Definition of key terms.....	11
1.9	Organisation of the remaining chapters of the thesis.....	14
2.0	RESEARCH SETTING.....	17
2.1	Malaysian development	17
2.2	Education system.....	18
2.3	ICT in education	22
2.3.1	ICT projects and programmes in schools	22
2.3.2	ICT and the curriculum	26
2.3.3	Teacher training in ICT	27
2.4	Issues in ICT	28
2.4.1	Funding.....	28
2.4.2	Hardware.....	28
2.4.3	Software	29
2.4.4	Curriculum	29
2.4.5	Policy	30
2.4.6	Teacher training	30
2.5	ICT professional development in New Zealand	31
2.6	The K Perak E-Learning Cluster Project	35
2.7	Summary	37
3.0	LITERATURE REVIEW	40
3.1	"Adoption"	40
3.2	Review of models in ICT adoption.....	41
3.2.1	Recent models.....	43
3.2.2	Stages of ICT adoption in teaching and learning.....	44
3.2.3	Pedagogy and change: constructivism and the transformation of practice	45
3.3	Factors influencing teachers' ICT adoption in teaching and learning.....	47
3.3.1	Teacher or individual factors	48
3.3.2	School level factors.....	49
3.3.3	External factors (outside schools)	52
3.3.4	Summary - factors in ICT adoption	54
3.4	Factors in the adoption of an ICT professional development innovation.....	54
3.4.1	Rogers' Diffusion of Innovations	55
3.4.2	Hallinger's innovation, change & culture	58
3.4.3	Fullan's educational change.....	60
3.4.4	Transfer and culture.....	61
3.4.5	Summary - adoption of an ICT professional development innovation	63

3.5	Summary - ICT adoption and adoption of an ICT professional development innovation.....	63
4.0	THEORETICAL FRAMEWORK.....	66
4.1	The ecological framework: overall structure.....	66
4.2	The ecological framework: internal structure.....	68
4.3	The ecological framework: differences in theories.....	69
4.4	Macrosystem and mesosystem theories and models in teachers' adoption of ICT.....	70
4.4.1	Wilson's eight conditions that facilitate adoption.....	70
4.4.2	Tearle's whole school characteristics.....	72
4.5	Microsystem theories and models in teachers' adoption of ICT and pedagogical change.....	75
4.5.1	Teachers development in ICT.....	76
4.5.2	Pedagogical change in teachers' adoption of ICT.....	77
4.6	Mesosystem theories and models in teachers' ICT adoption and the adoption of an ICT professional development innovation.....	79
4.6.1	Zhao & Frank's ecological perspective in teachers' ICT adoption.....	79
4.6.2	Ecological perspectives and complexity thinking.....	82
4.6.3	Complexity thinking.....	83
4.6.4	Emergence.....	84
4.6.5	Tatnall & Davey's ecological model: the adoption of a training innovation.....	86
4.7	Summary - ecological framework.....	89
5.0	METHODOLOGY.....	92
5.1	Theoretical basis.....	92
5.2	Philosophical stance.....	93
5.3	Qualitative research approach.....	95
5.3.1	Collective case study.....	96
5.3.2	Selection of cases.....	97
5.3.3	Participants - teachers as the main unit of analysis.....	99
5.3.4	Other participants.....	101
5.4	Methods - data collection.....	102
5.4.1	Rationale and protocols.....	103
5.5	Transcription and translations.....	110
5.6	Data Analysis.....	110
5.6.1	Software used in analysis.....	112
5.7	Coding process - overview of open, axial, and selective coding.....	112
5.7.1	Emergence of factors.....	113
5.7.2	Primary Data.....	114
5.7.3	Secondary data.....	116
5.7.4	Referencing data.....	117
5.7.5	The factors according to the ecological framework.....	118
5.8	Validity and reliability.....	119
5.9	Role of the researcher.....	123
5.10	Ethics.....	125
5.11	Summary.....	126
6.0	TEACHERS' ICT ADOPTION.....	127
6.1	The case study schools.....	128
6.1.1	School A (urban primary school).....	128
6.1.2	School B (rural primary school).....	129
6.1.3	School C (urban secondary school).....	129
6.1.4	School D (rural secondary school).....	130

6.2	Teacher demographic data	131
6.3	Definition of teachers' ICT adoption	132
6.4	Factors influencing teachers' ICT adoption: individual level	132
6.4.1	Personal Motivations.....	133
6.4.2	Professional motivations	134
6.4.3	Teachers' background.....	137
6.4.4	Teachers' ICT confidence	142
6.5	Factors influencing teachers' adoption of ICT: school level	146
6.5.1	Curriculum	147
6.5.2	Teachers' practice.....	151
6.5.3	School leadership.....	155
6.5.4	ICT infrastructure and support	159
6.6	Factors influencing teachers' adoption of ICT: external level	165
6.6.1	Context: community involvement and socio-economic status.....	166
6.6.2	Policy	167
6.7	Summary of linear factors in teachers' ICT adoption in teaching and learning	169
6.7.1	Individual teacher factors	170
6.7.2	School factors.....	171
6.7.3	External factors.....	173
7.0	ADOPTION OF AN ICT PROFESSIONAL DEVELOPMENT INNOVATION	175
7.1	Structure of the data analysis	176
7.2	ICT confidence and pedagogical change	177
7.3	The differences between KPEC I & II	179
7.3.1	Research timelines	179
7.3.2	KPEC - overall differences.....	180
7.3.3	KPEC - structure and facilitation	181
7.3.4	An overview of KPEC I and II.....	184
7.3.5	KPEC II influence	190
7.3.6	Summary of KPEC.....	192
7.4	KPEC's influence on ICT confidence and pedagogical change	193
7.4.1	Teachers' perception of ICT confidence	194
7.4.2	Pedagogical change	195
7.4.3	Superficial change in student learning	196
7.5	Snapshot of teachers' progress in ICT - ACOT model	198
7.5.1	Teachers and ACOT stages.....	199
7.5.2	ACOT stage 2 teachers.....	200
7.5.3	ACOT stage 3 teachers.....	201
7.5.4	ACOT stage 4 teachers.....	202
7.5.5	Summary	203
7.6	Adoption of innovation - factors at the individual level.....	203
7.6.1	Lack of time for the innovation	204
7.6.2	Anxiety and the innovation.....	206
7.6.3	Teachers' burdens and avoidance of the innovation.....	208
7.7	Adoption of innovation - factors at the school level	211
7.7.1	Support from school leadership.....	211
7.8	Factors related to the ICTPD innovation	213
7.8.1	Clarity of implementation in KPEC I and KPEC II	213
7.8.2	Professional development process	216
7.9	Summary on factors influencing adoption of KPEC.....	221
7.10	A short reflection on teachers' ICT adoption and the adoption of an ICT professional development innovation	224

8.0	DISCUSSION	227
8.1	Teachers' ICT adoption in teaching and learning	228
8.1.1	Ecological concepts	228
8.1.2	Complexity thinking and interactions in complex systems	229
8.1.3	The ecological-complexity perspective	232
8.1.4	Teachers' ICT adoption in the ecological-complexity perspective	251
8.1.5	Emergence and teachers' ICT adoption	257
8.1.6	Summary	261
8.2	Adoption of an ICT professional development innovation	263
8.2.1	Ecological perspectives: species, ecosystem and disruption	263
8.2.2	K-Perak E-Learning Cluster (KPEC) as an innovation	264
8.2.3	Theme 1: co-operation	266
8.2.4	Theme 2: energy and satisfaction	269
8.2.5	Theme 3: competition	271
8.2.6	Theme 4: filling a niche	274
8.2.7	Themes: summary	278
8.2.8	Complexity and distance	280
8.2.9	Distance between schools	281
8.2.10	Emergence and the adoption of an ICT professional development innovation	295
8.2.11	System level - cluster adoption	296
8.2.12	Ecosystem level - professional development	297
8.2.13	Summary: adoption of an ICT professional development innovation	298
9.0	IMPLICATIONS OF THE RESEARCH	300
9.1	The implication of the ecological-complexity perspective	300
9.2	Innovation anxieties	303
9.3	Cultural factors	304
9.4	Limitations and future research	305
9.5	Summary	309
	BIBLIOGRAPHY	310
	APPENDICES	318

List of Tables

Table 1. Models of ICT adoption.....	42
Table 2. Eight conditions that facilitate the implementation of educational technology innovations.....	71
Table 3. The ACOT three stage development model for teacher proficiency in technology –based classrooms.....	76
Table 4. The ACOT five-stage model of teacher progression.....	78
Table 5. Characteristics of ecological model of ICT innovation.....	87
Table 6. Research matrix	102
Table 7. Research data-references.....	118
Table 8. Teacher responses on school leadership.	157
Table 9. ICT Profile of Schools.	160
Table 10. KPEC ICTPD programme implementation differences.....	181
Table 11. KPEC I - barriers.....	188
Table 12. Teachers according to ACOT stages.	199
Table 13: Different responses on facilitation and the roles of facilitators, mentors, and mentees in KPEC.	217

List of Figures

Figure 1.1: Dual adoption lens	5
Figure 2.1. The relationship between the National Education Philosophy, the Malaysia Plan or National Economic Plan, and the National Educational Blueprint.	20
Figure 2.2. An overview of the school structure and the public examinations according to the school level.	21
Figure 2.3: The K-Perak E-Learning Cluster timeline	35
Figure 4.1. Levels of complex factors affecting teachers' adoption	67
Figure 4.2. Theories & models within the framework	68
Figure 4.3. The interrelationships between ecological perspectives, complexity thinking, and emergence in this research.	82
Figure 4.4. An overview of the ecological framework.	90
Figure 5.1. Collective case study - each school represents a category or type of school in Malaysia.	98
Figure 5.2. The facilitators and mentors involved in KPEC.	99
Figure 5.3. The roles and responsibilities of facilitators and mentors in KPEC.	100
Figure 5.4. External, internal, and individual factors that influence teachers' ICT in teaching and learning and the adoption of an ICTPD innovation.	119
Figure 6.1. Teachers' professional backgrounds.	131
Figure 6.2. The number of teachers according to subject areas.	135
Figure 6.3. External, internal, and individual factors that influence teachers' ICT adoption.	169
Figure 7.1. The 'pyramid' structure of training in KPEC II.	182
Figure 7.2. The Reflection-On-Action action model used in KPEC.	185
Figure 7.3. The adoption of KPEC framed in the ecological framework.	222
Figure 7.4. An integrated model incorporating teachers' ICT adoption and the adoption of an ICTPD innovation.	225
Figure 8.1. The ecological-complexity perspective.	233
Figure 8.2. Interactive units in the ecosystem.	234
Figure 8.3. The complex relationships between factors in ICT confidence.	236

Figure 8.4. Shifts between adoption or non-adoption of ICT at the ecosystem level.....	241
Figure 8.5. The differences in ecosystem states - stability and instability.....	246
Figure 8.6. Feedback loops that occur at the ecosystem level.....	249
Figure 8.7. A model of interactions and the emergence of teachers' ICT adoption in my ecological-complexity perspective.....	253
Figure 8.8. The emergence of ICT adoption at different levels.....	258
Figure 8.9. The levels of adoption in relation to the components of the innovation.....	265
Figure 8.10. An ecological model of an adoption of an ICT professional development programme.....	277
Figure 8.11. The basic and ideal 'models' of distance and space between the ecosystem and the 'invading species'.....	283
Figure 8.12. Distance, priorities, and multiple distances in School A.....	285
Figure 8.13. Distance, priorities, and multiple distances in School B.....	287
Figure 8.14. Distance, priorities, and multiple distances in School C.....	289
Figure 8.15. Distance, priorities, and multiple distances in School D.....	292
Figure 8.16. Overall distance of schools in relation to the innovation.....	294
Figure 9.1. New research areas in relation to levels of emergence.....	308

1.0 INTRODUCTION

This chapter provides a brief background on the research, and describes the research problem and its importance for Malaysia and the theoretical motivation and framework used. Then, the research questions and sub-questions are discussed in relation to the research problem. The structure of the thesis is outlined with a brief summary of each chapter.

1.1 Research problem

There are two distinct lines of inquiry in this research that are interrelated. The research problem first addresses factors that support or hinder teachers' use of ICTs in teaching and learning. The second line of inquiry investigates teachers' change in pedagogical practices as a consequence of a deliberate innovative professional development innovation. The broad problem that I explore is to understand how to promote pedagogical change through ICT adoption.

As an advisor for the Malaysian Ministry of Education (MOE), I have often wondered about teachers' ICT adoption in teaching and learning in Malaysian schools. Mae (2004) in a UNESCO report pointed out, "...teachers are using ICT mostly for word processing, for presentations and for spreadsheets. It is also usually introduced as one component or as a class period within a subject area, rather than becoming actually infused within lessons..." (p. 4). Teachers in Malaysia, as Mae suggests, are still focused on ICT skills rather than using ICT in teaching and learning.

My experience of managing schools, of leadership, and of ICT, has made me think about factors that influence teachers' adoption of ICT in teaching and learning. There are three areas that I thought influenced teachers: (a) *schools*, as the context of adoption, may have an influence on teachers' take up of ICT in teaching and learning; (b) the current *training* approaches implemented by the MOE may affect how teachers' use ICT in teaching and learning; and (c) the way ICT *policies* are implemented may influence schools and teachers in their

adoption of ICT in teaching and learning. From this point on, the phrase 'teachers' ICT adoption' will refer to teachers' ICT adoption in teaching and learning.

I have observed that different teachers in different schools have different levels of ICT use. This has made me wonder about the factors in the school that can influence the ICT adoption of individual teachers. For example, I believe that individual teachers' ICT adoption should include 'suitable' teaching practices (e.g., constructivist pedagogy) and wondered if teachers' pedagogical preferences were based on their professional development or if the school influenced them. Further, I wondered about the processes that led to teachers adopting ICT.

Another observation that prompted my thinking was training. I wondered whether the current approaches in teachers' training have an influence on teachers' ICT adoption. For example, all in-service training (INSET) programmes in ICT are based on the cascade model (see section 2.4.6 for further explanation) and characteristically have been at a distance from the classroom context. I also thought about the content of INSET programmes and wondered whether the focus on ICT skills rather than on teaching, had an impact on the way teachers use ICT. There was also the possibility that the type of pedagogy preferred in these training programmes influenced teachers' practices.

Apart from teachers' training, I wondered whether some of the problems related to teachers' ICT adoption were attributable to the fragmentation of ICT policies. My experience as a policy maker and implementer has led me to wonder if the proliferation of ICT policies in ICT, rather than a unified ICT strategy, has an effect on teachers' use of ICT in classrooms. Different ICT policies follow different programmes at different times, which prioritises certain subjects and may limit teachers' utilisation of ICT in teaching and learning. I wondered if this had led to the slow uptake of ICT by teachers and schools.

The second part of the research problem may have been a reaction to issues I had wondered about earlier related to training. A state organisation, K-Perak Incorporated, (KPI) recognised the need for an alternative and better approach to training teachers in ICT and employed a New Zealand (NZ) company, Innovation New Zealand Education (iNZed), to carry out an ICT professional development (ICTPD) programme in Malaysia. The KPEC ICTPD programme was the first of its kind and unique; it was the first ICTPD that used the *cluster model*¹ as an approach to group schools and teachers together in implementing a PD programme. Further, it was based on an *in-school facilitation* process where facilitators provided knowledge and on-going support in ICT in schools. The cluster model and in-school facilitation process was implemented to encourage teachers and schools to share and collaborate. The KPEC ICTPD programme focused on increasing teachers' ICT confidence and pedagogical change, i.e., teaching practices in ICT.

Thus, I was curious to see how schools and teachers perceived and adopted this internationally adapted innovation within their cultural and local context. These two threads have led me to think about the adoption of the ICTPD programme and its components plus its impact on teachers and schools in terms of their progress in ICT and their change in pedagogy.

Studies in the Asian context specifically on ICT adoption are extremely limited. Research done by Baek, Jung, & Kim (2008) was the only one found to describe factors that affected Korean teachers' use of ICT in teaching and learning. As for Malaysia, I have only found two articles related to ICT adoption, by Melor (2007), and Subramaniam (2007). These two articles did not indicate how or why teachers perceived ICT to be problematic in schools. There were other articles, which I found on ICT initiatives in Malaysian schools such as those by Wan Ali, Mohd Nor, Hamzah, & Alwi, (2009), but I did not consider them to be

¹ It is important to note that in the MOE's 2006-2010 blueprint, there was also a focus on the development of cluster schools as an approach to achieve better academic performance (Ministry of Education Malaysia, 2006, p. 31). However, the cluster concept in the KPEC ICTPD is different than the cluster concept mooted by the MOE.

relevant to this area of research, i.e., ICT adoption (refer to section 3.3). Wan Ali et al. (2009), for example, carried out research on a specific type of school in Malaysia, i.e., the Smart School (refer to section 2.3.1.2) and discussed a 'list' of conditions which influenced ICT implementation in this small subset of schools.

As of 2010, very little research has been found on teachers' ICT adoption in teaching and learning and no research has been found on the adoption of an international ICTPD from Malaysia. Thus, there is a need to explore and understand the factors that influence the adoption of an ICTPD in regards to Malaysia.

1.2 Innovation and a dual lens approach to examine adoption

At the beginning of my research journey, and constantly throughout, I struggled with the term innovation. However, following Rogers' (2003) definition, I generally understand innovation to be any "idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 11). In terms of my research, I examined two adoption processes and thus used a dual lens approach: one lens to focus on the teachers' adoption of ICT as technology, and the other to look at the teachers' adoption of KPEC as a professional development intervention.

The first lens focused on the teachers' adoption of ICT as technology, that is, in teachers' use and integration of ICT in teaching and learning. The second lens focused on the teachers' adoption of KPEC as an ICTPD innovation, that is, their adoption of the various components of KPEC, e.g., its cluster structure, the facilitation approach at school, and its specific ICT-related content. Figure 1.1 illustrates the dual adoption lens adopted in this research.

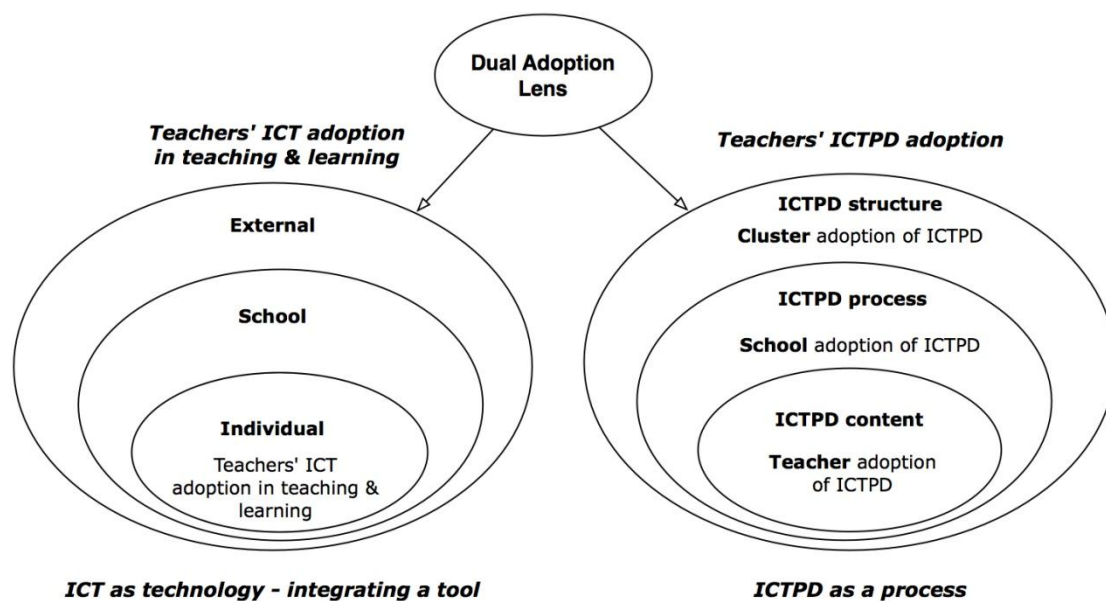


Figure 1.1: Dual adoption lens

Further, there are differences in these two types of innovation. In teacher's ICT adoption in teaching and learning, ICT as an innovation is not entirely new to the teacher (see section 3.1). Using the first lens, I am able to gauge the progression teachers made in ICT use for teaching and learning, whether they are using it at home, in school or both and I examine the different factors that influence teachers' adoption.

Using the second lens, I am able to focus on the ICTPD programme, which is a different type of innovation as it is new and specific. The ICTPD programme also has features that are new within it, e.g., the facilitation approach. This lens helps me to understand the ICTPD programme as a process, a dimension in innovation that is underdeveloped in research literature, according to Crossan & Apaydin (2010, p. 1165). Further, Crossan & Apaydin argued that a multi-level approach is useful in understanding innovation processes and outcomes from the micro to the macro level (pp. 1177-1179).

By using a dual adoption lens, I am able to ascertain and understand the factors that influence teachers' adoption of both types of innovation within the Malaysian context.

1.3 Research goals

I undertook this research with two purposes in mind. First, I aimed to identify the factors that either supported or hindered ICT adoption. I needed to understand how and why certain factors influenced teachers' adoption of ICT in teaching and learning. I also wanted to examine the influence of factors at different levels, i.e., at the individual teacher, school, and system levels.

Second, I wanted to understand the perceptions of teachers in adopting an international innovation with the new cluster and in-school PD² approaches. My goal was to uncover factors related to the implementation of the innovation and how the innovation 'fits' into a new cultural context. In other words, I wanted not only to ascertain the factors in the adoption of the ICTPD programme but also to contextualise and understand the tensions in adopting an international innovation by local teachers and schools. Apart from understanding how far teachers have progressed in ICT (ICT confidence, etc.), I also wanted to examine pedagogical change of teachers involved in KPEC, as it is one of the intended outcomes of the innovation, and explore whether teachers changed their current practices when using ICT in their classroom.

1.4 Theoretical motivation

The models and theories that are related to adoption have primarily been linear in describing factors and influences in adoption. Linear models are useful in: (a) the construction of the theoretical framework of the research and the multilevel approaches, i.e., theories or models that reflect the different levels of adoption; (b) influencing the methodological approaches and analysis of the data; and (c) providing a structure for the factors and grouping these factors into themes and levels. However, these linear theories and models did not provide a way to describe the complexities of the interactions between teachers, between teachers and school heads and between schools. Linear models and theories stress *causal* logic, i.e., one or a group of factors influencing teachers' adoption of

² I differentiate between training and professional development (see section 3.3.2).

ICT for example. In complexity (see section 1.8), I perceive that causal logical relations are replaced by *emergence* to explain the causes that underpin teachers' ICT within a specific context (school). Instead of Newtonian machine metaphors that are linear, I used Darwinian ecosystem metaphors to illuminate the complexities in adoption.

Further, I was motivated to find an approach to describe these complex interrelationships in a symbiotic sense, influenced largely by my experience in environmental studies and human development (participatory methods). Discourses using ecological perspectives are recent developments and have been confined to the area of information systems such as Nardi & O'Day's information ecologies (1999) and not widely used in education. The ecological perspectives have certain characteristics that, when blended with complexity thinking, offered me an alternative discourse for my research. I prefer complexity thinking (as a framework to be used in this thesis) to complexity theory, because complexity thinking offers a more social and qualitative approach than complexity theories, which are for the most part mathematical and are usually used in quantitative approaches. Furthermore, complexity thinking is consistent with my interpretive paradigm. Davis & Sumara (2006), suggests that complexity thinking is more suitable in education (complexity 2.0) and is an evolution from complexity theories³ (since 2000).

My motivation to use complexity thinking was also influenced by my professional experience in working with a large traditional organisation, i.e., the Ministry of Education. At MOE, the decisions made and processes followed are, according to Smith & Graetz (2006) "functionalist dogma" (p. 853), where authority and control is hierarchical and vertical as opposed to horizontal. In other words, not only did I want to understand the MOE (and its policies in ICT and PD) as it is but to conceive new perspectives on: (a) how the MOE functions

³ Davis & Sumara (2006) state that complexity thinking and complexity theory are interchangeable terms and researchers can use either. In the context of this research, complexity thinking is used to describe a social phenomena (with different units and levels which are interconnected). It implies a pragmatic use of complexity.

and how policies are implemented, and (b) the influence of the MOE and policies on schools and teachers.

Furthermore, the use of the ecological perspective fused with complexity thinking is consistent with my interpretive paradigm as an interpretive stance on a system analysis focuses on the subjective and examines the interrelationships between individuals within organisations (Smith & Graetz, 2006).

The next section briefly outlines my research.

1.5 Overview of my research

This thesis is a qualitative collective case study as defined by Stake (2003; 2005), which was carried out in four schools in the KPEC programme and involved 44 teachers who participated in the ICTPD programme. The qualitative approach was not only a condition for my scholarship award but was also due to my desire to understand the intricacies of the phenomena.

The study explores two main themes under adoption, first, the factors that influenced teachers' ICT adoption, especially in teaching and learning, and second, the factors that influenced teachers' adoption of an ICT PD innovation, adapted from New Zealand.

To address the research questions (see following section), I used a number of methods to collect the data, for example, mind maps, factor sheets, and semi-structured interviews. The qualitative data was gathered from teachers, and other stakeholders were also included to ensure different perspectives were acquired in understanding teachers' ICT adoption in the context of the ICTPD programme.

This research uses an ecological framework with multiple theories and models to represent different levels within a system, and an ecological perspective to describe the factors and process of adoption (see chapter 4). Along with ecological concepts, this research incorporates complexity thinking to

uncover the interactions between individuals and schools in adoption. An ecological-complexity perspective (see section 8.1.3) enabled me to understand the complex factors and dynamic interactions, which influenced teachers' ICT adoption in teaching and learning and their adoption of the innovation.

1.6 The research questions

The first research question examines three levels of factors (teacher, school and system) that support or hinder teachers' ICT adoption in teaching and learning. Further, this research question examines the degree of influence of these factors on teachers' ICT adoption in teaching and learning.

1. What factors support or hinder teachers in the cluster schools in adopting ICT to support teaching and learning?
 - a. What factors within the schools and outside the schools have influenced teachers' adoption of ICT?
 - b. How have the school context and the teachers' professional background influenced the adoption of ICT?

The second research question explores the influence of the ICTPD as an innovation, and how teachers and schools have adopted the ICTPD programme. This question includes examining factors that have influenced the adoption of the ICTPD programme. In exploring the impact of the ICTPD programme on teachers, this question also examines the teachers' progress in ICT and, specifically, change in teaching and learning.

2. How has KPEC as an ICTPD innovation influenced teachers' ICT confidence and pedagogical change?
 - a. What has been the impact of the ICTPD innovation, i.e., KPEC, on teachers' ICT confidence⁴ and pedagogical change?
 - b. How has teachers' pedagogy changed as a result of their participation in

⁴ KPEC uses ICT confidence as a way to gauge teachers' progress in ICT and is one of the objectives of the ICTPD.

the ICTPD programme, i.e., KPEC?

c. What factors influenced the adoption of KPEC as an ICTPD innovation in terms of the adoption of the cluster model and the in-school facilitation process?

1.7 Audience

My research has two audiences: policy makers and researchers. It can inform policy decisions related to ICT development in the MOE, and can contribute to the understanding of international innovations and the introduction and localization of innovations in schools.

My research can be used to inform new policy directions in MOE. There is currently no research data in Malaysia about ICT adoption and teacher change in practice. Policies that encourage the adoption of ICT in schools are important as more ICT projects and programmes are being planned. As MOE is currently exploring the possibility of expanding cluster programmes across the country, new policies need to be in place to reduce factors that hinder ICT adoption and encourage better use of technologies.

My research can also contribute to the introduction and localisation of ICTPDs in Malaysia, Asia, and developing countries. International organisations or providers, such as iNZed, need to understand local factors that influence teachers' adoption of an ICTPD innovation, and teachers' change (processes). My study informs new approaches for international organisations or providers to tailor innovations, such as the ICTPD programme, to local contexts. In turn, this would ensure the implementation and management of innovations in the long term and minimize constraints.

Another related audience for the research is the academic community (journal publications and conferences) as it builds on prior research in the area of ICT adoption in schools and the adoption of an ICTPD innovation in Asia.

1.8 Definition of key terms

In this section, I define the key terminology utilised in this research; in particular, the terminology surrounding ICT adoption, the differences between training and professional development, ecological concepts, and complexity thinking. The key terms are arranged *alphabetically*.

Complexity refers to complexity thinking, an evolution from complexity theories as explained by Davis & Sumara (2006). Complexity thinking is used to describe the dualities that occur in teachers' ICT adoption and the distance between teachers, schools, and the innovation.

Constructivism in this context refers to student centred approaches (instructional methods, i.e., teaching practices) where teachers scaffold student learning. Scaffolding requires collaboration for a student or group of students with a teacher or teachers who provide suitably challenging activities (Luckin, 2008).

Courseware⁵ in this research refers to software designed specifically for teachers to teach Mathematics and Science in English in Malaysian schools. The term originated from the words 'course' and 'software'. The purpose of the courseware was to assist teachers, and include teaching plans and associated resources for teachers and students.

Ecosystem refers to the school. An ecosystem includes organic organisms or species such as teachers, and inanimate organisms, such as computers.

Emergence refers to the behaviours at the system level. It is reflected in the behaviours and relationships at lower levels (in this research, at the ecosystem and species levels). Emergence is the sum effect of different factors

⁵ This researcher conceptualised, designed and developed this courseware for the MOE.

and interactions between units and levels, which contributes to the materialisation of innovations, species and niches. In the methods chapter (see section 5.7.1), emergence is used literally, i.e., factors arising from the research data. However, in the following chapters, emergence is used in relation to complexity thinking, i.e., emergence occurs by the sum of different factors and interactions between units and levels (see section 4.6.4).

ICT, or *Information Communications Technology*, is used in this research to stand for technologies, which include: (a) hardware (e.g., computers and other devices); (b) software (e.g., office applications and web-based applications); and (c) connectivity (e.g., network infrastructure and the Internet).

ICTPD, or *Information Communications Technology Professional Development*, is a specific type of professional development programme (or course) related to ICT.

ICT coordinator is a teacher who manages and deals with ICT matters in a school. In Malaysian schools, ICT coordinators manage computer labs and issues related to hardware and software, and not teaching and learning.

ICT leadership (teacher) is a term that refers to leadership in ICT and can be applied to ICT coordinators (if they take a leadership role) and teachers who lead their schools in ICT, according to Kennewell, Parkinson, & Tanner (2000).

Innovation is used to refer to *ICT* and the *ICT professional development* programme. In this research there are two innovations being investigated: ICT in teaching and learning, and the ICT professional development programme.

Pedagogy⁶ is used to refer to teachers' teaching practices. I use the term pedagogy and teaching practices interchangeably.

Professional development refers to teacher development courses or programmes in which teachers seek change and want to develop new skills or strategies by participating in professional development courses. It is viewed as a bottom-up initiative or development path in this research (e.g., The K-Perak E-learning Cluster).

School leadership or the school head is a term that refers to primary heads and secondary principals (school heads is used in this research to apply to both). To ensure anonymity of the school heads in this research, all school heads will be referred to as *she*.

Species in this research refers to organisms in an ecosystem. There are three types of species: (a) the dominant species - teachers; (b) the keystone species - school heads; and (c) niche species - ICT coordinators or ICT leaders (teachers).

Teachers' ICT adoption refers to teachers adoption of ICT in teaching and learning. Teachers' ICT adoption in teaching and learning examines how teaching practices have changed from the integration of ICT, i.e., pedagogical change. ICT adoption in this context also considers the effect of teachers' ICT adoption on student learning.

Training⁷ covers national training courses or programmes that are carried out on teachers in schools. It is viewed as a top-down teacher development approach (e.g., national training programmes such as *Bimbingan*

⁶ There are a number of definitions of pedagogy, such as those suggested by Somekh (2008). I understand pedagogy as a multifaceted concept, which includes mediation, constructivism, and skills that are reflected in teacher practices.

⁷ In-service training is a term used in Malaysia, adopted from the United Kingdom. It refers to national or state initiated training programmes or courses. Training programmes or courses are used interchangeably.

*Perguruan Professional dalam Teknologi Maklumat dan Komunikasi*⁸). I use the term training more often in this research, as it is the term used in Malaysia.

Other terms used in this research can be found in the glossary in Appendix A.

1.9 Organisation of the remaining chapters of the thesis

The following is a brief description of the remaining chapters in this thesis.

Chapter 2 Research Setting

This chapter offers background information on Malaysia, its education system, ICT development in schools, and issues related to ICT such as teacher training.

Chapter 3 Literature Review

This chapter provides relevant literature on ICT models and theories related to adoption, and adoption theories related to innovation, with specific reference to Asian characteristics.

Chapter 4 Theoretical Framework

This chapter explains the ecological framework used in my research. The ecological framework is a multilevel framework with different theories or models. It develops an approach in understanding teachers' ICT adoption in teaching and learning, and the adoption of an ICTPD innovation used for: (a) the methods to gather data; (b) the structure and analysis of data; and (c) the discussions on the adoption process and change.

Chapter 5 Methodology

⁸ Teacher Continuing Professional Development in ICT.

Chapter 5 describes an interpretive, collective case study design used in this research, and discusses the different methods used to ensure validity and credibility. The setting of the research is also discussed.

Chapter 6 Teachers' ICT Adoption

This chapter identifies the factors that influenced teachers' adoption of ICT. The factors are identified using a multilevel perspective following the theories or models outlined in the ecological framework. From chapter 6 onwards, various references to *literature* are integrated. The inclusion of literature in the following chapters help support the development and the building of the ecological-complexity perspective and the models associated with the two innovations.

Chapter 7 Adoption Of An ICTPD Innovation

This chapter describes the changes in teaching practices as an outcome of teachers' involvement in KPEC and in so doing reveals the factors that either supported or hindered the adoption of KPEC.

Chapter 8 Discussion

This chapter discusses the factors that emerged as constraints or enablers in teachers' ICT adoption in teaching and learning. The ecological framework is fused with complexity thinking to explain teachers' ICT adoption. The emergence of ICT adoption is dependent on teachers' interactions within the ecology (school) and constraints and enablers that influence these interactions. Four themes from the ecological model on training are used to elaborate on the adoption of KPEC. The distance between KPEC (its assumptions) and the factors within the context (of the implementation of the innovation) is discussed.

Chapter 9 Implications Of The Research

The discussions in the previous chapter are reflected upon in the implications chapter. The ecological-complexity model emerged to be an alternative discourse to linear explanations of factors that influence teachers'

ICT adoption. Ecological-complexity discourses offer starting points for further discussions and suggestions are argued following the concept of emergence at different levels. It is argued that international innovations need to manage the constraints of the local context and the cultural factors that support the adoption of the ICTPD innovation. Limitations of the research are also discussed.

The following chapter provides background information on the education system in Malaysia and the development of ICT in education and the issues associated with it.

2.0 RESEARCH SETTING

This chapter is a brief introduction to Malaysia and is intended to give an overview of its education system in order to provide the context in which this research is set. Further, this chapter introduces and contextualises the K-Perak E-Learning Cluster (KPEC) project.

The first part of this chapter covers information about Malaysia, the national policies and visions that have influenced education, and a brief description of the education system. The second part of this chapter covers information about the development of ICT in the Malaysian education system and the issues that surround ICT, teacher development, and the role of the ministry. The third part of this chapter provides a short summary of the New Zealand (NZ) ICT professional development (ICTPD) programme and information related to the KPEC project.

2.1 Malaysian development

Malaysia is situated in South East Asia and consists of Peninsular Malaysia and East Malaysia, which includes the states of Sabah and Sarawak (see Map of Malaysia - Appendix B), and contains approximately 26 million people (Government of Malaysia, 2007). There are three major ethnic groups, the Malays (Bumiputra), Chinese, and Indians. Bahasa Melayu is the official language and English is widely used along with the mother tongues of each ethnic group. Education is highly regarded in Malaysia and is perceived as an instrumental route to employment and thus is a high national priority (Hassan, 2004).

Malaysia set its vision in 1992 on becoming a fully developed nation by the year 2020. In 1996, Malaysia embarked on Vision 2020 (as mentioned earlier in this chapter), which aims to propel Malaysia to a developed country status (Ministry of Education Malaysia, 2006). This vision includes initiatives in telemedicine, e-government, education, and industry. One of the nine strategic challenges in Vision 2020 outlines a Malaysian society that is innovative,

forward-looking, and contributes to science and technology (Ministry of Education Malaysia, 2006).

Malaysian economic development is defined by its National Economic Plans (NEP), which span every five years. The current NEP, 9th Malaysia Plan, covers 2005-2010 and focuses primarily on the development of 'human capital' and knowledge based industries (e.g., ICT) (Ministry of Education Malaysia, 2006). Malaysia hopes to build a knowledge economy to drive future developments and not be reliant on natural resources and manufacturing.

One of the most well known projects in Vision 2020 is the Multimedia Super Corridor (MSC), which is part of the government's plans to obtain the status of a developed nation (Ministry of Education Malaysia, 2006). Under MSC, the Smart Schools (SS) project was launched as one of the seven flagship projects intended to produce knowledge workers for industries within the MSC. Initially, the SS pilot project started in 1999 and covered 85 schools with differing levels of technology, and was planned to extend to all schools.

Malaysia's economic development priorities have a strong influence on its education system. The NEP defines how the MOE develops and prioritises programmes, projects and plans in education in Malaysia.

2.2 Education system

This section gives a view of the history, goals and structure of the education system in Malaysia.

Malaysia has a centralized education system under the supervision of the MOE. A national curriculum is implemented throughout the nation. Although providing education opportunities is the responsibility of the government, sending children to schools is not compulsory. According to the government's education statistics (Ministry of Education Malaysia, 2006) Malaysia has a relatively high gross enrolment rate (GER) of 96% in primary education and 84% in secondary education (Government of Malaysia, 2007; Ministry of

Education Malaysia, 2006). Malaysia has a commitment to provide free (public) and quality education for all. The funding allocation in the education sector is almost 25% of the country's budget, or about 6% of GDP, according to UNESCO (2008).

The major milestone in the Malaysian education system was the formulation of the National Philosophy of Education in 1995, according to Azmi (2001), which manifests the country's education goals:

Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced, and harmonious, based on an affirmed belief in and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable, who possess high moral standards, and who are responsible and capable of achieving a high level of personal well-being, as well as being able to contribute to the betterment of the society and the nation at large. (p. 14)

In 2006, MOE outlined its planned development of education in Malaysia through a document called, 'The National Educational Development Blueprint 2006-2010' (NEDB) in line with the vision era phase. The NEDB outlines the specific development goals in education, for example, the development of human capital as an approach to increase Malaysia's competitiveness in the global economy.

In short, there is a strong link between Malaysia's development (economic plans) and Malaysia's educational philosophy and MOE's educational blueprint. Figure 2.1 shows the relationship between development and education in Malaysia.

To develop a world-class quality education system which will realise the full potential of the individual and fulfill the aspiration of the nation

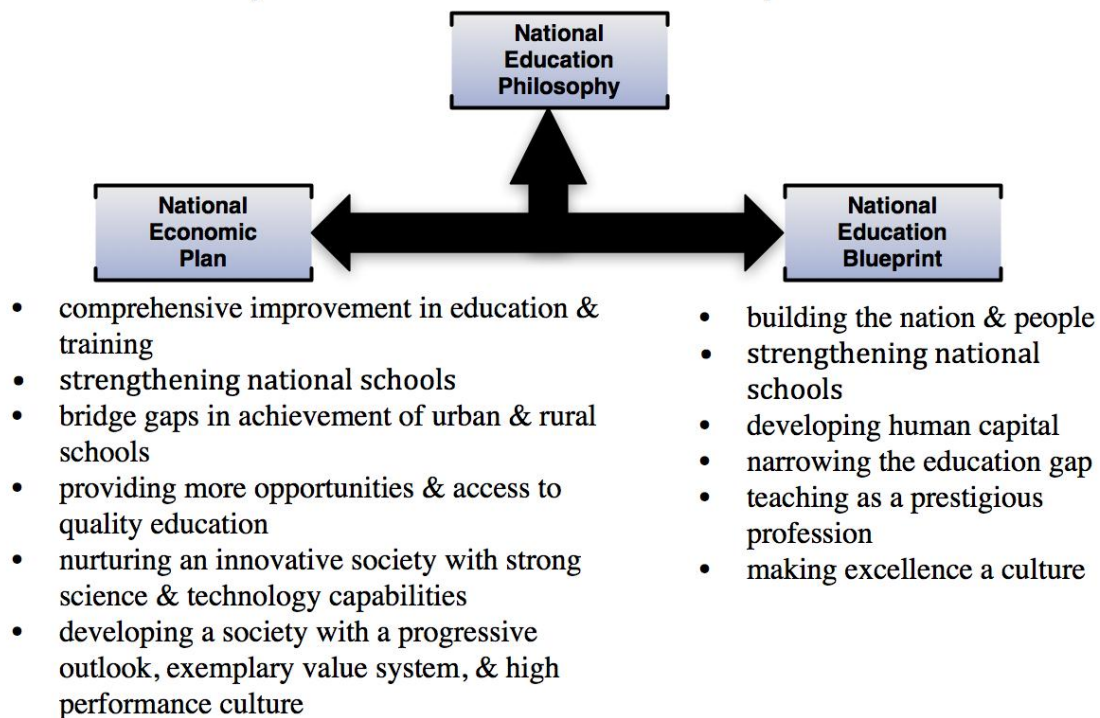


Figure 2.1. The relationship between the National Education Philosophy, the Malaysia Plan or National Economic Plan, and the National Educational Blueprint.

Adapted from: Ministry of Education Malaysia (2006).

Schools in Malaysia are characterised by six years of primary schooling, five years of secondary education, and two years of post-secondary education⁹. Post-secondary education is optional. Primary schooling starts at age seven and the medium of instruction is Bahasa Melayu, with the exception of Mathematics and Science (which use English¹⁰). After six years in primary school, pupils have to sit for the national exam UPSR (Primary School Assessment Test). Promotion to secondary level is automatic, regardless of their achievement in UPSR.

Secondary education is divided into lower, upper, and post secondary. After three years of secondary education, students have to sit for the PMR

⁹ Post-secondary education is not discussed, as it is not relevant to the research.

¹⁰ To be phased out in 2011.

(Lower Secondary Assessment¹¹). PMR results determine which *stream* students go into. They have the option, at the upper secondary level, to go into science, arts, commerce, vocational, and technical streams. In the fifth year, students sit for the national exam, SPM¹² (Malaysian Certificate of Education) and this decides whether students can proceed to post-secondary education, tertiary education, or seek employment. Students that continue in post-secondary education sit for the STPM¹³ examinations. Public examinations are very high stakes in Malaysia and serve as a measure of academic achievement. Figure 2.2 provides an overview of the types of public examinations according to the school level.

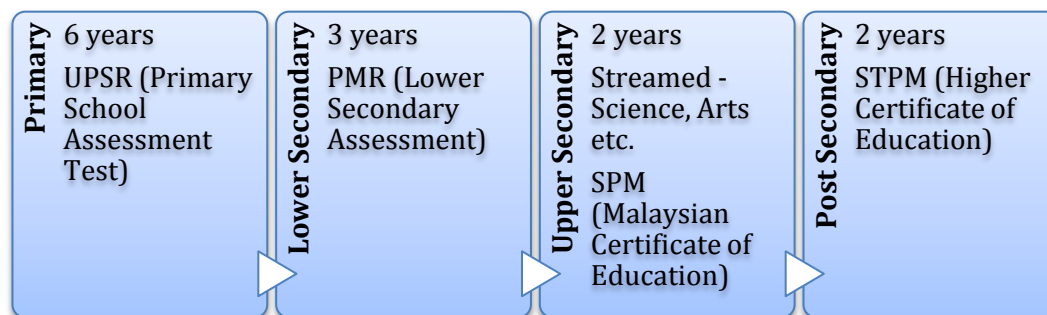


Figure 2.2. An overview of the school structure and the public examinations according to the school level.

There are different types of schools in Malaysia due to colonization and multi-ethnic groupings. Historically, the British brought in missionary schools to Malaysia in 1906, starting with the Penang Free School, and later other schools in Kuala Lumpur, like St. John's Institution. These schools are known as heritage schools. There were also 'pondok' schools (Malay), Chinese schools, and Tamil schools now known as National Schools, Chinese National Schools, and Tamil National Schools (Ministry of Education Malaysia, 2006). All of these school types are federally funded and managed centrally by MOE.

¹¹ Lower Certificate of Education - 'O' Level equivalent, previously used in the UK.

¹² *Sijil Pelajaran Malaysia* - 'A' Level equivalent, previously used in the UK.

¹³ *Sijil Tinggi Pelajaran Malaysia* - University level entrance examinations.

Malaysian schools are also categorised, according to the Economic Planning and Research Division (EPRD) in MOE, under its locality, whether it is a rural school or an urban school. Rural schools make up around 40% of schools in Malaysia (Government of Malaysia, 2007; Ministry of Education Malaysia, 2006). According to 2006 statistics, there are about 10,000 schools (Ministry of Education Malaysia, 2006) excluding private schools and international schools.

2.3 ICT in education

This section describes the development of ICT in education in Malaysia and will cover: (a) ICT projects and programmes that are related to this research; (b) the development of the curriculum in ICT; and (c) teacher training in ICT.

This section is based on two sources. First, my own professional experience¹⁴ of working as the State Education Officer for ICT, and in both the Computers in Education Unit and in the Systems & Administration Unit of The Curriculum Development Centre (CDC). Second, the National Educational Development Blueprint 2006-2010 (NEDB) (Ministry of Education Malaysia, 2006, pp. 23-26).

2.3.1 ICT projects and programmes in schools

The rationale for ICT in education in Malaysia, according to Hawkrige, Jaworski, & McMahon's (1991) rationales for ICT development, is driven by the need to develop information (communications) technology¹⁵ as an industry. As a consequence, the programmes, projects, and related policies in ICT in education tended to focus on building ICT capacity (investing in ICT infrastructure, hardware, and software) and ICT literacy. Vision 2020 specifically refers to

¹⁴ I have been involved in every ICT project in the MOE since 1996, when I joined the State Education Office in Kuala Lumpur.

¹⁵ Hawkrige, et al. (1991) used the term Information Technology (commonly used at that time).

technology as an enabler for the creation of knowledge and as an economic driver for Malaysia, moving Malaysia from an industrial economy to an ICT led economy. ICT thus became an important priority for the MOE as it is integral to the development of education, as shown in the Educational Blueprint 2010 (Ministry of Education Malaysia, 2006). The use of ICT in education according to the MOE includes:

1. ICT for all students, focusing on ICT literacy.
2. The role and function of ICT in education as a teaching and learning tool, as part of a subject, and as a subject in its own right.
3. Using ICT to increase the productivity, efficiency, and effectiveness of the management system.

(translated to English, Ministry of Education Malaysia, 2006, p. 56)

2.3.1.1 Computers in Education (CIE)

This is the first computer project implemented by MOE. It started in 1992 when computers were put into schools and syllabi were given to teachers to be carried out. From this small beginning, the project was expanded to many rural and urban schools (primary & secondary) throughout Malaysia, and covered 575 schools (Hassan, 2004). This project was based on the lab model, where there were 10-20 computers linked through a closed network. Later, modems and printers were supplied to these schools. This model would later influence other projects implemented in the future.

2.3.1.2 Smart School (SS)

The Malaysian Smart School (SS) project was launched in 1999 and was another major ICT project (Ministry of Education Malaysia, 2006 p.23). In this project, all aspects of a school's operations, including school administration, curriculum, pedagogy, ICT facilities, and assessment, were to be systematically transformed. The main thrust of the transformation was based on schools becoming learning institutions, in order to prepare children for the information

age. Apart from having state of the art ICT facilities (at the time), these schools were also linked to the Internet using 128Kbps lease lines. The number of computers supplied to each school varied; schools at technology levels A, B and C each received a total of 120, 60, and 40 computers respectively. The schools developed as Smart Schools were nearly all secondary schools except for two newly built primary ones. The major difference in terms of ICT was that the computers were also placed in the classroom (minimum of 5 computers) and that the teachers would change their *pedagogy to be constructive*. This pilot project ended in 2003 and has been reworked as the Smartising School programme (explained later in this chapter).

2.3.1.3 Computerisation Project (CP)

This project was developed as an extension to CIE. Originally proposed for development under MOE, the Economic Planning Unit (EPU) under the Prime Minister's Department, took over and implemented this computerisation programme for all schools in Malaysia. The project started in 2000 and intended to equip all schools (primary & secondary) with computer labs (depending on size of the school) within a five year period. The CP implementation sought to equip every school with one or two labs. It is estimated that 4,500 labs have been built with 22-42 computers (1 or 2 labs per school) with LCD projectors and printers (Ministry of Education, 2007).

2.3.1.4 SchoolNet

SchoolNet started in 2002 as a 'broadband' project and initially had 1 Mbps¹⁶ speed (access) shared across all schools in Malaysia. SchoolNet was upgraded to 2 Mbps speed in 2006. It is a centrally controlled and filtered network. An estimated 8,200 schools are connected under SchoolNet (Ministry of Education, 2007 p.24).

¹⁶ Mbps refers to millions of bits per second or megabits per second (measure of the speed of connection).

2.3.1.5 ETEMS (English for the Teaching of Mathematics and Science)

In 2002, the Government decided to change its policy in the teaching and learning of Mathematics and Science. English was used to teach Mathematics and Science instead of Bahasa Melayu¹⁷ (Ministry of Education Malaysia, 2006).

The ETEMS initiative required a courseware¹⁸ component to support teachers in the teaching of the two subjects in English. It aimed to provide a structure and process within a software package (for teaching). Along with the software, every teacher of Mathematics, Science and English was given a laptop and other peripherals like LCD projectors to help them teach using the courseware (Ministry of Education Malaysia, 2006).

However, as of July 2009 the ETEMS programme has been discontinued, as reported by Haziq, Nizam, & Shofi (2009).

2.3.1.6 The Smartising Schools (TSS)

The Smartising Schools initiative was implemented to complement the ideas in the Smart Schools project. Access Centres (2006-2010) were proposed to 'smart enable' schools under the 9th NEP (Ministry of Education Malaysia, 2006).

However, the MOE did not state specifically how it was supposed to smart enable schools. It was proposed as an additional 'lab' (smaller) with 10 computers with Internet access, situated within a school, so that students could enter these centres and use computers at any time during school hours. All schools were provided with one access centre.

¹⁷ National Language

¹⁸ Courseware - specific software designed to assist teachers to teach ETEMS.

In sum, according to the MOE statistics (2006), there are about 155,500 computers, 97,000 notebooks, 70,000 LCD projectors and 4,600 servers so far in Malaysian schools (Ministry of Education, 2007 p.24).

The next section discusses the development of the curriculum in ICT, other related ICT programmes, and training programmes in ICT.

2.3.2 ICT and the curriculum

Since 1996, the curriculum development of ICT is both 'add-in' (separate subject) and 'add-on' (integrated). With CIE, a literacy curriculum guideline was developed. This guide stressed the basic skills required to operate and use simple software provided by CIE such as MS Paint. In 2001, the guide was revised to cater for new developments in the field of ICT. In 2003, a new and updated ICT Literacy Curriculum (LC) was launched in primary schools. The LC guidelines extended the role of ICT in primary schools from a mere teaching and learning tool to include some IT literacy components. Though purporting to integrate with subjects such as English, it remains as a discrete ICT skills curriculum that focuses on basic ICT literacy, such as switching on a computer and using a mouse. A step-by-step guide for every skill was created in module form for teachers to use.

There were two other curricular innovations of relevance. The first was the new Smart School Curriculum or SSC (1999). This curriculum integrated all ICT elements or skills, for example word processing, in all the subjects within the national curriculum. This extended to non-core subjects like History and Art. The 'add-in'¹⁹ strategy modified the primary (*Kurikulum Baru Sekolah Rendah*) and secondary (*Kurikulum Baru Sekolah Menengah*) curriculum²⁰ to provide an extension to the current academic curriculum carried out in schools.

¹⁹ Add-in is a curricular term. It refers to adding new elements into an existing curriculum.

²⁰ Current national curriculum.

In 1999, the MOE introduced Information Technology (IT curriculum) as a new elective subject at upper secondary level. It aims to equip students with knowledge of IT, and skills to manipulate and use information, as well as the capability to use IT to solve problems. Currently, this is the only IT subject assessed in SPM (Ministry of Education Malaysia, 2006 p.20).

2.3.3 Teacher training in ICT

The first national ICT in-service training programme called *Komputer Dalam Pendidikan* (KDP)²¹, started in 1999 and continued until 2003. Teacher Training Division (TTD), the organisation responsible for teacher training in the MOE, introduced *Bimbingan Perguruan Profesional Dalam Teknologi* (BPPT) in 2004. This was a one-week intensive ICT skills programme, where teachers were taught how to use applications, the Internet and how to use ICT in teaching.

In conjunction with BPPT, TTD hired a consortium of companies to train teachers for ETEMS. The ETEMS course essentially trained teachers to use the laptops given to them to run the courseware via LCD projectors. This course also taught teachers to troubleshoot. This three to five days training course was compulsory for all teachers involved in teaching Math, Science and English. As an incentive, all teachers under ETEMS were given an additional allowance of 5 to 10% on top of their salaries.

According to TTD (Ministry of Education Malaysia, 2006) 145,524 teachers have a basic level of ICT training, 53,326 at intermediate level, and 2,188 at advanced level. In the ETEMS project, an estimated 80,000 teachers have been trained (either 3 days to 5 days) and about 170,000 teachers were involved in the Smart School Training programme.

²¹ As part of KDP, and to encourage ICT ownership, the government provides loans to teachers to buy computers.

2.4 Issues in ICT

This section discusses specific challenges currently with ICT projects in schools. This discussion is necessary as it provides a background of the general issues in ICT in Malaysian schools.

2.4.1 Funding

Funding allocation for the maintenance of IT hardware is an ongoing issue. Funding is currently calculated on electricity, Internet charges (dial-up), and maintenance (hardware only) costs. This usually translates to about RM500-2000 depending on the population of the school. Often, this is inadequate and schools supplement this funding with monies raised through clubs and activities. This is partly due to the high cost of running the air-conditioning units in the computer labs as Malaysia has a hot climate.

Schools do not have any allocation for purchasing software. All software is provided by the MOE, and includes operating systems such as Windows. However, department heads in schools can purchase software using their own funding allocation.

Though the MOE provides funding for maintenance (a yearly allocation), it is not given directly to schools. ICT companies contracted to carry out maintenance often do not have a fast turn-around time for repairs, as there are necessary bureaucratic checks for repair claims. This increases the cost of maintenance of the ICT hardware and it has become a major challenge for the MOE as most hardware in the schools is three years or older.

2.4.2 Hardware

Obsolescence is inevitable in terms of IT hardware, i.e., a relatively short lifecycle of one to three years. Today's computers are obsolete as soon as they are deployed in schools.

There is a need for the MOE to replace computers (or any hardware) after three years but the MOE cannot afford to replace them all. Nearly all ICT projects before 2000 (see earlier section) have computers that are more than 7 - 15 years old. Replacement parts are often hard to get and usually much more expensive when compared to replacement parts for more current components. Thus, the MOE often purchases new computers to replace older ones rather than upgrade them. Furthermore, there is no standard policy on upgrading computers.

In short, hardware will continue to be an issue in the MOE.

2.4.3 Software

Software issues are complex due to operating requirements (to run on the computers) and licensing (schools and teachers).

The cost of licensing both the operating system and specific software is often very high. The cost of providing software packages for schools can be higher than the cost of purchasing computers. Furthermore, there are recurring costs (yearly school licensing), which are paid by MOE to the vendor.

At the school level, the perceived lack of 'current' software becomes a challenge and some schools 'selectively' ignore issues of software piracy and upgrade their software illegally (Hassan, 2004).

2.4.4 Curriculum

The Malaysian curriculum is largely content-based, and in ICT, for example, the Literacy curriculum mentioned earlier has led to ICT skills and applications being the focus in teaching. Previous research (Hassan, 2004) indicates a distinct lack of understanding by teachers between what is required by the curriculum and the pedagogical processes in schools, i.e., the separation between the content of the curriculum and how it is delivered.

2.4.5 Policy

According to Mae (2004), the Smart School (SS) policy is the MOE's education ICT policy. However, there is no evidence (official MOE documents) to support this claim.

Further, there is currently no overarching policy on ICT and education in Malaysia. Instead, there is a range of policies, implemented according to the programme or project. For example, ICT as referred to in the NEDB (2006, in earlier sections of this chapter) does not state any policy direction but merely lists ICT projects and targets which are planned during the five year period.

In sum, policies in ICT suffer from fragmentation, which can result in conflicting policy messages.

2.4.6 Teacher training

As mentioned earlier in this chapter and in chapter 1, teachers in Malaysia have not integrated ICT into teaching and learning, and have not changed their teaching practices (pedagogy) when ICT is used in their classrooms.

The training of teachers has become an important issue for the MOE. The typical model for all teacher-training programmes is the cascade model²², which is in-service training (INSET) and carried out off-site (outside of school). The cascade model works by training a small team of trainers, who will then train a larger group of teachers, and so on. The MOE and TTD favours this approach to training as it is perceived to be efficient and cost-effective.

Issues in teachers' training may have been part of the reason behind the implementation of K-Perak E-Learning Cluster (KPEC) programme in Malaysia.

²² Top-down, pyramid shaped training strategy. Often used in developing countries. Seen as an efficient and cost effective approach for training large numbers of teachers. The cascade method of diffusion works on the belief that a small team of trainers will train a larger group and so on down a hierarchy, according to McDevitt (1998), Sayed (2001), and Jansen (2002).

The next section provides a short summary on the NZ ICTPD programme and the KPEC project. This section intends to show the linkages between the NZ ICTPD programme and the KPEC ICTPD programme.

2.5 ICT professional development in New Zealand

Before 1998, according to Ham (2005) teacher training initiatives related to ICT in NZ were piecemeal, ad-hoc, and centrally-managed. The national policy statement in 1998, *ICT Strategy for Schools*, Ham argued, gave NZ education a vision for ICT in schools and subsequently, a new approach for professional development (PD), which was devolved and contestable. Twenty-three schools were involved in the first ICTPD School Cluster project.

There were four key features in this type of ICTPD programme:

- The funding for teacher PD in ICT was to be devolved directly to schools as simultaneously both 'producers and consumers' of their own PD programmes, rather than being open to tenders from traditional 'providers' such as the Colleges of Education Advisory Services who then invited schools or teachers to participate.
- The programmes were only available to groups of schools, which had committed to a 'clustered' model of PD for the benefit of teachers in all the participating schools.
- Programmes that were to last for three years were to be funded over three years, much longer than the one year that had been the custom in the past.
- No particular delivery model was mandated in the contracts themselves. Applicants for ICTPD Cluster funds were expected to develop and propose their own models of delivery, rather than to implement a variation on a predetermined, ministry-approved model as had tended to be the case in the past.

Ham (2005, pp. 4-5)

Sahin & Ham (2010) further note that the ICTPD clusters are centrally coordinated through the NZ MOE with a team of national facilitators who provide support, advice and coordination to the clusters as a national community (p. 6).

The basic cluster has one lead school (not a necessity), which has a collaborative partnership with other schools around a geographical area. The lead school is often the school with a track record of best practices and collaboration between schools. Schools select the cluster they want to become a member of and are encouraged to develop and run their own models and modes of PD. The lead school within the cluster would receive NZD 100,000 - 120,000 per annum. These funds are spent on primarily teacher PD and not for procuring ICT hardware or software.

Briefly, the in-school PD approach enables teachers to develop skills and knowledge within the school context, and has proven to be an effective approach in NZ, according to Ham (2005). The cluster model of PD essentially recognises that the expertise and experience within a community (of practice) provides a better approach in teachers' PD. The cluster approach thus emphasises peer mentoring and facilitation among teachers in a cluster of schools.

According to Sahin & Ham (2010) the objectives of a ICTPD cluster are to:

- increase understanding by teachers, principals, students, and school communities of the educational benefits of ICT
- increase capability of teachers and principals to use ICT for their own professional learning
- increase capability of teachers and principals to use ICT to facilitate improvements in students' learning and achievement
- strengthen professional learning communities and increase collaboration within and across schools

- develop a rich resource of expertise, experience, and materials in effective ICT use at a local and national level.

Sahin & Ham (2010, p. 6)

As of 2010, there are 11 ICTPD clusters, three are currently running (2008-2012) and eight have been completed (1999-2009) according to the Te Kete Ipurangi (TKI) website (N. Z. Ministry of Education, 2010).

Extensive research was carried out with each ICTPD cluster programme implemented in NZ, starting from the 1999-2002 report by Ham et al. (2002). Since then, consecutive research evaluation reports have demonstrated that the ICTPD clusters have shown improvements in teachers' ICT confidence and ICT skills, teachers' understanding of ICT in teaching and learning, and providing students with quality learning experiences in ICT.

Sahin & Ham (2010), in their most recent research report, offered two main conclusions, first, the ICTPD programme continued to impact primary school teachers more than secondary school teachers and second, the frequency of participation and teachers' involvement (duration) in the three-year programme were important factors that influenced the effectiveness of the ICTPD programme. Sahin & Ham (p. 42) stated that the objectives of the ICTPD clusters were met, i.e., increasing teachers' ICT confidence and the use of ICT in teaching and learning, providing ICT mediated learning for students and the development of communities of practice for PD.

Apart from these two main conclusions, there were other elements in the 2010 report that are of interest to my research. I selected a few factors that are most relevant:

1. ICT provision remained a concern for teachers, who believed they lacked time to update their ICT skills, the students lacked access to ICT, and there were technical reliability issues with equipment.
2. Teachers involved at the entry point to the cluster had moderate or high levels of ICT skills.

3. ICT confidence of teachers involved improved but personal confidence in ICT was higher than teachers' confidence in integrating ICT in teaching and learning.
4. Teachers' classroom practices were variable from teacher to teacher, school to school, but generally changed over time. Gender and school types influenced practices.
5. The sharing of knowledge and expertise between facilitators and teachers and the reflective processes on teachers' use of ICT were important aspects of the PD.
6. Teachers' use of ICT in classroom was significantly higher (77%) when they first started and most teachers regularly used ICT in their classes.
7. The length of time and the frequency of teachers' involvement in the programme were important; significant increases resulted from the time teachers stayed in the programme and the more frequently they attended the PD.
8. Teachers of English used ICT the most, followed by teachers of Mathematics and Science.

Sahin & Ham (2010, pp. 1-3)

The NZ ICTPD three year structure is a programme for transformative change, according to Cranefield (2009, p. 86). This programme focused on professional (pedagogical) change, which leveraged ICT as an impetus for change. It is essentially led by teachers for teachers with lead teachers (facilitators) acting as change agents from the ground up. The NZ ICTPD programme hinged on teachers' readiness for change, at Year 1 of the programme, and continued on until Year 3, where teachers exited from the programme with the ability to be ready for future challenges in teaching. Thus, the ICTPD programme not only looked at integrating technologies and new practices but also at changes in their understanding of their profession, i.e., changing teachers' beliefs and knowledge (2009, pp. 87-88).

2.6 The K Perak E-Learning Cluster Project

In terms of the project's timeline (implementation) and its relationship to my research, a clarification is necessary at the outset. The initial K-Perak E-Learning Cluster Number 1 (KPEC I) project was carried out in Malaysia between 19th March and 25th May 2007. Innovation New Zealand Education (iNZed) was involved in the designing, planning and implementing KPEC I. Its objective was to develop teachers' capability in their understanding and use of ICT to enhance the quality of teaching and learning in classrooms.

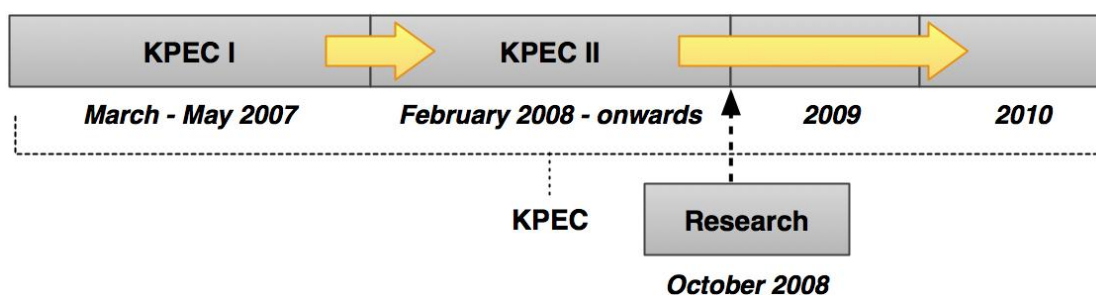


Figure 2.3: The K-Perak E-Learning Cluster timeline

To clarify, the KPEC programme was an ongoing project until the end of 2010, according to the State education officer (SEO) in charge of the project (State education officer, 2010). There were two distinct phases to KPEC: KPEC I, in which iNZed was involved²³, and KPEC II in which the schools in the cluster with the State Education Office (SEDO) continued in the project with support from K-Perak Inc. (KPI), as shown in Figure 2.3. In May 2009, KPI further invested in the schools by supplying new computers and other ICT equipment. These new media labs were to supplement the computer labs available in the five schools.

²³ iNZed's facilitation ('training' of teachers) programme ended in May 2007 in KPEC I. iNZed continued to support KPEC by arranging visits and other activities for teachers involved in KPEC until 2009.

In October 2008, when I undertook the data gathering phase of my research, the Northern Corridor Implementation Authority (NCIA - www.ncer.com.my) was planning to expand KPEC (with iNZed) to 50 other schools in Perak under their education and human capital initiative (Hassan, 2008). This was the reason behind the naming of the KPEC project as KPEC no.1 (D:064792), KPEC II and so forth. However, the transition from KPI to NCIA to fund the continuation of the cluster programme did not occur as planned due to the economic downturn in Malaysia in early 2009. Even though iNZed involvement officially ended in 2009, KPI continued to fund KPEC until end of 2010.

In general, the KPEC project spanned over three years and included the 'pilot', known as KPEC I in 2007, and the continuation, KPEC II which officially started in 2008 which carried on until 2010. The KPEC project thus, is similar, in terms of time span, to the NZ ICTPD model. However, I recognise that the teachers involved in KPEC I had limited time to adopt ICT for teaching and learning as shown in Figure 2.3. Nevertheless, the continuation of the project, KPEC II provided time for these teachers to develop and adopt the 'new' practices introduced in their teaching and learning, by the time I carried out the research.

There are many other similarities between KPEC model and the NZ ICTPD model. According to Norton (2007), the KPEC professional development (PD) model was based on New Zealand's ICTPD model, which has these characteristics: (a) in-school; (b) facilitated; and (c) cluster-based. The NZ model was structured around: (a) the promotion of ICT integration; (b) the fostering of reflective practice; and (c) supported by an online community of practice.

The KPEC project cluster concept hinges on the development of the community of practice (COP), specifically an online community, as outlined by Norton (2007). This online COP provides an environment²⁴ for teachers and schools to share resources, information, practices, and knowledge across the cluster.

As mentioned in chapter 1, the KPEC project focuses on teachers' pedagogical change and, according to Norton (2007), moving away from a 'transmissive' model of content delivery to approaches that encourage students in the learning process (p. 18). The KPEC project utilises ICT as a catalyst for pedagogical change and student learning. Students are expected to take an active role in learning and use ICT to explore, interpret, and represent their learning. Through ICT challenges, teachers and students use ICT for teaching and learning. A planning template is used by teachers and facilitators to collaboratively plan and integrate a certain ICT skill or task in the ICT challenge, which is linked to a topic in the curriculum (p. 18). This template focuses on: (a) linkages to the existing curriculum; (b) ICT skills and competencies; (c) classroom organisation; and (d) student activity and assessment approaches. Further details on the structure of KPEC and its development will be discussed in chapters 5 and 6.

In sum, the KPEC project sought to change teachers' pedagogical approaches and student learning through the in-school facilitation PD cluster approach adapted from New Zealand.

2.7 Summary

Malaysia's educational development is connected to its economic development path. Thus, objectives outlined in the National Economic Plan are echoed in the National Educational Blueprint.

Essentially, the Malaysian educational system is centralised, with the MOE as its central agency (see Appendix C). Examinations dominate the educational

²⁴ The URL for this site was: <http://www.kperakcluster.net/> (no longer available)

system as a way to measure academic performance. This has a strong influence in schools in Malaysia. The rationale for ICT is strongly linked with the approach taken to develop ICT in schools. MOE has tended to focus on ICT infrastructure and less on the development of teachers in ICT. As a result, a number of issues have emerged in relation to ICT in education. As discussed throughout this chapter, the issues are as follows:

1. Funding.
2. Obsolete hardware.
3. Obsolete software.
4. Curriculum and pedagogy.
5. Educational policy in ICT.
6. Teacher training.

These issues have a bearing on the research questions, the analysis of the data (in chapters 6 & 7), and the discussion and implications chapters (8 & 9 respectively).

The NZ ICTPD model and its transfer to Malaysia, as the KPEC project by iNZed were also discussed in this chapter. The similarities between the two ICTPDs were outlined. The differences are discussed later in section 7.3. Further, the discussions on the NZ ICTPD programme and the KPEC project also highlighted the necessity of applying a dual lens in this research (see section 1.2). In the adoption of ICT in teaching and learning, certain comparisons can be made between NZ and Malaysia, but in terms of the adoption of the ICTPD programme, the initial transfer and consequent adaptation that occurred within the Malaysian context, distinguishes KPEC model from the NZ model. In sum, the transfer of an innovation from one culture or context to another one will always go through a process of reinterpretation, where the innovation is changed to fit the values, practices of the new culture.

The next chapter provides relevant literature on ICT adoption and the adoption of an ICTPD innovation. This following chapter provides a bridge to the construction of the theoretical framework used in this research.

3.0 LITERATURE REVIEW

The literature review explores the theories, models, and factors associated with "adoption". In the first part of this chapter, I review the different models that highlight the factors that influence ICT adoption in teaching and learning. In the second part of this chapter, I discuss various theories and models to understand how innovations are adopted.

The literature review has informed my research focus and questions. Further, this literature review provided a starting point and a structure to understand the ecological concept that I use for my research (that I elaborate in the following chapter - theoretical framework).

3.1 "Adoption"

The literature on adoption is extensive. Rogers' (2003) *Diffusion of Innovations* (DOI) is extensively used in understanding and explaining adoption in a number of fields, such as technology. Rogers' DOI framework provides a structure to understand the diffusion process, the decision-making processes in adoption and the different categories of adoption within a social system. Several researchers such as Newhouse (2002), have pointed out that Rogers' DOI (2003) has helped in explaining the adoption process in schools. Rogers' five characteristics of innovations, i.e., relative advantage, compatibility, complexity, trialability, and observability, illustrate and explain the rate of technology adoption (see section 3.4.1 for further detail). In my research, Rogers' DOI has influenced my initial thinking about contextual factors, the stages individuals progress in deciding to adopt an innovation and the concerns individuals have about an innovation.

To clarify, I differentiate "adoption" into ICT adoption and the adoption of an ICTPD innovation. This differentiation is related to the research problem, which has two lines of inquiry. The first research question explores how teachers adopt ICT for teaching and learning in their schools, and the second research question focuses on the extent in which an ICTPD innovation is adopted.

Further, I explore the decisions, the key players, and factors that influence the success or failure of an innovation.

In the next section, I discuss the literature around the models related to ICT adoption in teaching and learning, and review the literature on factors related to teachers' ICT adoption. The following section of the literature review offers models that are pertinent to education and ICT.

3.2 Review of models in ICT adoption

There is significant literature on models related to the adoption of ICT in teaching and learning. These range from Apple's *Apple Classrooms of Tomorrow* or ACOT (1995) model to Milken Exchange's *7 Interdependent Dimensions* (Lemke & Coughlin, 1998). Newhouse (2002) comprehensively reviewed and categorised a number of models of ICT adoption in education according to two characteristics: the scope of the target group they address and the relevance of an individual's learning to the models (p.32). I offer Newhouse's categorisation of models which I have adapted and illustrated in Table 1 .

Table 1. Models of ICT adoption.

Category	Model
Population models	Diffusion of Innovation model (DOI) <i>Examples: Rogers (1995) & Geroski (2000)</i>
System models	Milken's 7 dimensions for gauging progress, National Education Technology Standards (NETS) and Technology Maturity Model (TMM) <i>Examples: International Society for Technology Education²⁵ (2000)</i>
ICT-oriented micro models	These models are the Instructional Technology model, the ACOT model, and the Levels of Technology implementation (LoTi) model <i>Examples: Moersch (1997) & Dwyer et al. (1991)</i>
Learning/micro models	CBAM (Concerns-Based Adoption Model), the Typology of Uptake (TIU) model, and the Stages of Concern ICT model <i>Examples: Fuller (1986), Rutherford (1977) & Carter (1986)</i>
Ecological/Cybernetic models	Perceptual Control Theory (PCT), Ecological Perspectives and Information Ecology Theory (IET) <i>Examples: Zhao & Cziko(2001), Zhao & Frank (2003) Nardi and O'Day (1999)</i>
	<i>(updated and adapted²⁶ from Newhouse (2002, pp. 16-31).</i>

I draw on a number of these models or theories and considerable research literature in conceptualising my research. For example, Rogers' DOI (1995, 2003) is used extensively in describing the issues and factors related to the adoption of an innovation. I concur with Newhouse (2002) who recognises that Rogers' DOI has influenced a number of models and theories, like ACOT (1995) and Zhao & Cziko's PCT (2001), among others. Unlike Newhouse, who categorises these models according to target group and learning models, I characterise and apply the models to different levels of ICT adoption, i.e., from individual (micro models), school (organisational models), and external levels (population/system models). Though I differentiate these models, I see them as complementary and interrelated. For example, I find that the Milken Exchange

²⁵ International Society for Technology Education website (www.iste.org).

²⁶ I updated Newhouse's summarised models to include Ecological Models as viable models for consideration.

(Lemke & Coughlin, 1998) model is useful to describe ICT adoption at the policy level, whereas I use the ACOT model to describe stages of instructional technology and CBAM for pedagogical development with ICT.

There are strengths and limitations from all these models. In terms of the choice of models, Newhouse (2001) rightly suggests, "...no point choosing or disregarding these models ... no model is going to describe perfectly the circumstances teachers may find themselves in." (p.32). Furthermore, Newhouse's categorisation gives an indication that there is no single model as yet to describe the whole process of teachers' ICT adoption.

3.2.1 Recent models

I updated Newhouse's categorisation (in Table 1) in view of recent models of ICT adoption in teaching and learning that take into account complexity thinking, namely Nardi & O'Day's (1999) information ecology theory (IET), Zhao & Cziko's (2001) perceptual control theory (PCT), and Zhao & Frank's (2003) ecological perspective. I have included these as alternative models for ICT adoption, in that they provide a more organic and granular perspective or approach to ICT adoption in teaching and learning. I offer brief explanations for Nardi & O'Day's IET and Zhao & Cziko's PCT in this section but explain in detail Zhao & Frank's ecological perspective in the theoretical framework chapter (see section 4.6.1).

Nardi & O'Day (1999) proposed in their IET that the introduction of technology into an established ecology (of an organisation or school) creates disruption. In the school context, newly introduced technologies such as computers are viewed to be disruptive to the normal day-to-day activities, much like introducing a new species into an ecosystem. Nardi & O'Day explain that there are four metaphors to describe technology- as tools, as texts, as systems, and as ecology. More importantly, Nardi & O'Day espouse that the way we think about and view technology determines the relationship we have with technology, especially when metaphors are used to describe technology.

In addition, Zhao & Cziko (2001) purport to integrate psychological system theories and ICT in relation to adoption and seek to introduce the model of goal oriented behaviour in PCT. More importantly, they focus on teachers specifically, "this new framework attempts to understand teacher adoption of technology from the inside." (p. 1). Through PCT, Zhao & Cziko seek to understand the reasons behind why teachers use technology; teachers as purposeful 'organisms'. A major element in PCT is the teachers' perception of ICT as a need in relation to enhancing effectiveness of teaching and learning. Zhao & Cziko stress that effectiveness does not lie with the technology or ICT per se but with the teacher's perception as an internal goal. Further, Zhao & Cziko claim that it is necessary to understand the individual teacher's goal before ICT can be introduced and adopted. They further suggest the minimization of 'disturbances' or 'disruptions' from using ICT, and perceive that adoption of ICT or any innovation requires it to fit into existing practices and cultures. Thus, PCT can inform our understanding of ICT adoption or of an innovation.

3.2.2 Stages of ICT adoption in teaching and learning

There is extensive literature which indicates that teachers proceed to adopt ICT in teaching and learning in stages (ACOT, 1995; Lemke & Coughlin, 1998; H. Sandholtz, Ringstaff, & Dwyer, 1992b; Somekh, 2008; Somekh & Davis, 1997). Newhouse (2002), for example, in a review of the literature on teachers' ICT adoption and change (focusing on the integration of ICT in learning and teaching processes) has suggested teachers integrate or adopt ICT in stages. Even though the literature is extensive on the stages teachers go through in adopting ICT, Dall'Alba & Sandberg (2006) and Orlando (2009) remind us and state that teachers do not follow a fixed sequence of stages. Schibeci et al. (2008) concur with Dall'Alba & Sandberg and add that teachers' 'progression' may move forwards or backwards depending on individual and contextual factors.

The ACOT (1995) research is one of the most influential in illustrating the stages teachers go through in ICT adoption. From ACOT, there are two models of 'staged' ICT adoption, namely the Three Stage Development Model and the Five Stage Progression Model (ACOT, 1995; Newhouse, 2002; Ringstaff, Yocam, &

Marsh, 1996). According to Newhouse (2001, 2002), these two models are micro-models which are relevant in describing teachers' progression in ICT adoption and change. These two models will be explained in greater detail later in the theoretical framework chapter.

3.2.3 Pedagogy and change: constructivism and the transformation of practice

Part of teachers' ICT adoption is the change teachers experience in integrating ICT in teaching and learning. The literature suggests that teachers who adopt ICT *should* consequently change their pedagogy or teaching practices (Burniske, 2002; Crawford, 1999; Loveless, 2003; Loveless, Devoogd, & Bohlin, 2001; Somekh, 2008). Further, there is a wealth of discussion in literature that suggests a certain type of pedagogical change is most appropriate for ICT and constructivist practices or approaches (ACOT, 1995; Newhouse, 2002; Ringstaff et al., 1996; Somekh, 2008). Sandholtz et al. (1997) suggest that teachers who adopt ICT should change their teaching approach from teacher directed to student centred (i.e., from instruction to construction). They argue that:

Teachers using a constructivist approach realise that learning is not only a matter of transferring ideas from one who is knowledgeable to one who is not - a view in which a teacher's work is construed as instruction. Instead, learning is perceived as a personal, reflective, and transformative process where ideas, experiences, and points of view are integrated and something new is created - a view where teachers' work is construed as facilitating individuals' abilities to construct knowledge. (1997, p. 12)

Thus, Sandholtz et al. (1997) argue that firstly, teachers' pedagogical change is rooted in the teachers' beliefs about teaching and learning, and secondly, that constructivism would change the relationships between teachers and students. Furthermore, teaching practices would become more collaborative where learners solve problems through conversation, inquiry, trial and error, and constant comparisons with other solutions or ideas. However, the literature has also shown that there is a misconception among teachers that constructivism means that all learning has to be driven by discovery and that the teacher and

curriculum materials are irrelevant. This misconception has led to teachers being less inclined to change their practices. More accurately, according to Loveless et al. (2001), constructivism is based on the premise that pedagogy and ICT interact within the teaching and learning process. Furthermore, Loveless et al. stress that pedagogy is influenced by the interaction of a range of factors for both teachers and students (p. 65).

It is clear from a number of studies that teachers should understand the role and value of integrating ICT in teaching and learning (Ertmer, 2005; Judson, 2006; Riel & Becker, 2000). Integration of ICT requires teachers to change their teaching practices. Perraton & Creed (2001) suggest the need for teachers to understand teaching (approaches) before technology, "pedagogy precedes technology" (p. 81). Teachers should be first taught to understand the different teaching practices or pedagogical approaches that are appropriate when integrating ICT in teaching and learning. Studies suggest constructivist approaches as an essential part of the teachers' repertoire (Judson, 2006; Somekh, 2008).

However, Orlando (2009, p. 119) opines that research literature often suggests that constructivist practices are *the* 'desirable' practices in ICT. According to Orlando, there is an implicit assumption that teacher practices do not change when ICT is adopted (p. 34). Loveless (2003) and Orlando suggest that teachers' change in ICT adoption is a complex process that includes social and cultural factors which go beyond changes in teaching practices and class organisation. Orlando asserts that,

"...if we are to properly study teachers' practices mediated by ICT and how and why they change, there is a need to acknowledge aspects such as the role played by social, cultural, and institutional representations of ICT, school organisation of ICT, other stakeholders, and professional and personal experiences with ICT, as well as teachers' beliefs regarding ICT in their role as a teacher in a school."
(p. 35)

These social, cultural, and institutional factors, as well as other perspectives within the school and outside, should be sought in understanding the change in teachers' practices in ICT.

3.3 Factors influencing teachers' ICT adoption in teaching and learning

Research studies have shown that there are many factors influencing teachers' adoption of ICT in schools, for example, research done by Drent & Meelissen (2008), Tearle (2003), and Mumtaz (2000). Mooij & Smeets (2001) and Tondeur, Valcke, & Van Braak (2008) advocate that factors can be viewed at multiple levels or multidimensionally, considering influences from international organisations, down to the individual learner (student). However, in general, the literature separates these factors at three levels - at the external level (for example, policies from the Ministry of Education), at the school level (for example, school culture), and at the teacher level (for example, teachers' background). Factors are further suggested to be of two sorts, those that support and those that hinder the adoption of ICT. Literature points to the need to reduce barriers that hinder the adoption of ICT and help support factors that facilitate the adoption of ICT by teachers (Drent & Meelissen, 2008; Eteokleous, 2008; Lowther, Inan, Daniel Strahl, & Ross, 2008). However, the large amount of literature is often Western centric, primarily from the United States or Europe. There is unfortunately a dearth of research from Asian countries and, as of now, there appears to be only one published paper, by Baek et al. (2008) from Korea.

A review of literature on ICT in Malaysian schools showed research in this area was rather limited. Examples of recent research such as those by Khalid, Nawawi, & Roslan (2009) and Wan Zah, Hajar, Azimi, & Hayati (2009) are focused on ICT integration and not adoption. Khalid et al. (2009) (positivist, quantitative) and Wan Zah et al. (2009) (positivist, mixed-method) both used Ely's conditions (1990) as the basis of their research (both papers are from the same university). I did not consider these articles because they merely re-affirm factors or conditions found in other research, e.g., leadership and do not show cultural factors or discuss the context in which ICT adoption occurs. Also, this

article focuses on the smart schools in Malaysia, which have a different technology level to other schools.

In the next section, I discuss the factors that support or hinder teachers from adopting ICT.

3.3.1 Teacher or individual factors

The majority of research studies state that teachers are the main or key agents who deliver ICT into schools and classrooms (Judson, 2006; Ringstaff et al., 1996; Williams, Coles, Wilson, Richardson, & Tuson, 2000). Teacher factors in the context of this research refer to factors that influence teachers as individuals, i.e., their characteristics. Tondeur et al. (2008) aptly refer to teacher factors as individual-level factors. Research shows that teachers' ICT adoption varies from one teacher to another and from school to school (Kennewell et al., 2000; J Tondeur et al., 2008). Recent literature indicates that teacher factors should be viewed as a complex group of factors rather than a list of factors.

Studies on teacher factors, for example, from ACOT (1995) and BECTA²⁷ (2005), suggest a number of teacher characteristics, such as teachers' background and level of education age, gender, professional development, ICT ownership, and experience in using ICT or computers. For example, one of the findings in BECTA's research showed that ICT ownership had a strong influence on teachers' ICT adoption. ACOT researchers suggest that teachers' education, background and development, i.e., how teachers were trained (whether for their profession or in professional development courses), influences ICT adoption. Wozney, Venkatesh, & Abrami (2006) note that teacher training is an important factor in developing teachers' competencies in ICT as well as teachers' attitudes towards ICT. Research on the influence of age, gender, and teaching experience on ICT adoption suggests that these factors are less important among teachers (Christensen & Knezek, 2008; Demetriadis et al., 2003; Mueller, Wood,

²⁷ British Educational Communications and Technology Agency - UK based government agency that promotes ICT in schools.

Willoughby, Ross, & Specht, 2008; J Tondeur et al., 2008). Mueller et al. indicated that *teaching experience* was not a significant factor in their research.

More importantly, Mueller et al. (2008) indicate that individual teacher factors related to *experience with ICT* were the most important variables in determining ICT adoption, such as teachers' confidence with ICT, ICT training (skills), and higher frequency of ICT use. Further, Muller et al. suggest that teachers use ICT more in teaching if they have positive experiences with ICT, i.e., if ICT can improve the learning of students (p. 1532). These positive experiences are supported with frequency of ICT use, as it builds on teachers' ICT confidence and repertoire.

In relation to teachers' ICT confidence, anxiety can be a factor in teachers' ICT adoption (Christensen & Knezek, 2008). According to Christensen & Knezek, teachers who feel anxious about ICT, for example, integrating ICT in the curriculum, develop negative attitudes and express opposition in using ICT in the classroom (2008, p. 353). Mueller et al. (2008, p. 1533) found that teachers' anxiety had an indirect effect on the adoption of ICT.

According to Mueller et al. (2008, p. 1533), teachers' perceptions of ICT usefulness is a very important factor in motivating teachers to adopt ICT. For example, Mueller et al. indicate that intrinsic motivation (e.g., personal enjoyment) has more influence on teachers rather than extrinsic motivation (e.g., rewards). Wozney et al. (2006) discussed the effects of motivation on teachers in adopting ICT, specifically examining the relationship between teachers' beliefs on ICT and their classroom practices. Wozney et al. found a link between teachers' personal use of ICT and teachers' use of ICT in teaching and learning.

3.3.2 School level factors

There is extensive literature that deals with environmental barriers, such as hardware issues, limited networking, and technical problems. I define these environmental barriers as school level factors that relate to ICT provision.

ICT provision covers ICT hardware, software, network (connectivity), and other similar issues. Sandholtz et. al (1997), Becker (2000), and Cuban (2001) have pointed out that ICT provision in schools is a constant factor that hinders teachers' ICT adoption. One example is the type of ICT provision provided to teachers. In computer labs-type setup, ICT access may be limited due to obsolete computers (issues of maintenance). Recent literature suggests that school level factors related to ICT provision may be less of an issue due to advancement of technology, as argued by Mueller et al. (2008). However, in developing context, ICT provision is still a major issue due to financial constraints.

At the school level, most researchers discuss the importance of leadership in facilitating teachers' adoption of ICT (Dexter, 2008; Kennewell et al., 2000; Riel & Becker, 2008). Leadership is discussed in two general terms (non-exclusive): first, the school head or school leadership, and second, leadership in ICT (beyond the school head). Kennewell et al. state that school leader support is essential for a successful implementation of ICT in school. Kennewell et al. and Tearle (2003) provided evidence that school heads' influence on ICT adoption does not only affect teachers but how the whole school views ICT. For example, the appointment of key personnel, such as the ICT coordinator or manager, is an indication of how ICT is adopted in school (Tearle, 2003).

Leadership in ICT, as the literature suggests, goes beyond school heads. Leadership in ICT implies that the school head empowers the ICT coordinator, the teacher leader and other stakeholder in the process of ICT adoption (Dexter, 2008; Kennewell et al., 2000; Miller et al., 2003). Kennewell et al. and Dexter have argued that ICT leadership is dependent on the school ICT strategy or policy that involves all stakeholders. This is due to the need for teachers and leaders to define, develop, and share goals towards ICT adoption in school. Furthermore, Kennewell et al. argue that the design of the ICT strategy has to include elements of evaluation and assessment to ensure ICT adoption in a school.

The research literature on ICT training or ICT based professional development (PD) courses is often discussed at the school level. To clarify, there is a slight distinction between ICT training and ICT professional development (ICTPD) courses. ICT training refers to nationally initiated programmes (Galanouli, Murphy, & Gardner, 2004) and is, according to Clarke & Hollingsworth (2002), "something done to teachers" (p. 948). PD courses are often related to and initiated by the school, such as the school-based ICTPD cluster in New Zealand (NZ). PD courses differ from ICT training as it suggest that teachers seek change to improve development and develop new skills or strategies (Clarke & Hollingsworth, 2002, p. 948). Galanouli et al. have shown that ICT training can contribute to ICT adoption if done well. In terms of ICT based PD, Ham et al. (2002) have shown in the NZ context that PD programmes are able to contribute to ICT adoption and school change or improvement. Both approaches have been shown to influence how teachers adopt ICT in teaching and learning. In general, research shows that teachers' ICT adoption in teaching and learning involves adequate and continuous ICT training or PD of teachers. These ICT training and PD courses should not only provide ICT skills such as word-processing (applications) but also learning about integrating ICT into teaching and learning (Boshuizen & Wopereis, 2003; Burniske, 2002; John & Sutherland, 2004).

As mentioned earlier in this chapter, constructivist approaches are viewed to be an appropriate form of teaching (practice) in ICT. Mueller et al. (2008) found that there was a small correlation between teachers' self-reporting on their stated beliefs and actual behaviour or practice, which was similarly found by Judson (2006). According to Judson and Mueller et al., teachers are more likely to use ICT in teaching to support their current teaching practices and not adopt constructivist approaches.

Other school factors relate to concepts of school improvement such as developing school culture, collaboration (sharing knowledge and practices), and communities of practice (Kennewell et al., 2000; Trinidad, Newhouse, & Clarkson, 2006). A school culture that encourages teachers to share, collaborate,

and take risks is seen as essential if change is to occur in adopting ICT in schools (Fullan, 2001; Guhn, 2008). Further, collaboration between schools is seen to be important. The approach of clustering schools in the New Zealand ICTPD programme is based on the concept that schools can share and collaborate on best practices and issues related to ICT. It is shown to be an effective approach in New Zealand (Ham, 2005).

3.3.3 External factors (outside schools)

The literature related to external factors, as defined in this study, discusses the implications of educational policies and the involvement of the community or parents in the process of ICT adoption. Mooij & Smeets (2001) and Tondeur et al. (2008) provided evidence that ICT policies, such as those from a central agency like MOE, impact the implementation of ICT at school level. I differentiate policy at this level and at the school level as discussed earlier. At the ministry level, the implication of policy or policies are intertwined, i.e., policies may not only cover ICT, but they also may cover subjects and/or finances, for example. Tearle (2003) suggests that policy related to ICT implementation has two characteristics: (a) policies directly influence schools and indirectly influence teachers; and (b) policies are mandated and are not optional, i.e., schools and teachers do not have a choice. Policies from the MOE as discussed earlier suffer from what Fullan (2001) calls policy clutter²⁸ and policy contradiction²⁹. Unlike Cyprus (Eteokleous, 2008) and the Netherlands (J. Tondeur et al., 2008), Malaysia does not have a central unified policy on ICT. According to Wozney et al. (2006), the lack of a systematic policy may hinder teachers' adoption of ICT. The literature points out that policies tend to deal with technical areas rather than teaching and learning (curriculum support), as mentioned by Somekh & Davis (1997).

Fullan (2000, 2001) has argued that governments or states involve the wider community in educational reform or change. Parents or other

²⁸ Policy introduced without implementation strategies and timelines.

²⁹ One policy is inconsistent with another.

organisations play a role in supporting and ensuring schools create a learning environment for students. Fullan (2000) aptly points out that schools and communities (parents) have 'reciprocity', i.e., they mutually influence each other (p. 61). Thus, if the community in which the school is in values learning in a certain way, the school reflects this value. I also note that societal values may influence educational policy and thus the school.

Somekh (2008) argues that socio-cultural factors, such as the local community, national policies, educational systems, and national cultures (p. 450) influence the adoption of ICT in teaching and learning. They may affect how the school operates as well as the teachers' beliefs and attitudes, and their confidence with ICT. For example, if the school is rural, there may be a lack of support from parents as they are unable to contribute to the development of the school in ICT. The local community may have an indirect influence on ICT adoption in a school.

Somekh (2008) indicated that teachers' ICT adoption in teaching and learning is influenced by the cultural, social and organisational contexts in which the teachers live and work. She demonstrated the influence of cultural factors in ICT adoption in relation to teachers' practices, citing Asian case studies that showed that Asian schools did not connect or network with each other or with external organisations as compared to schools in Western contexts, such as schools in Finland, which tended to have high levels of inter-connectedness (p. 456). The comparison was further made between Hong Kong (HK) and Finnish schools wherein HK society is competitive and socially stratified, while Finland has no distinct social classes. This comparison illustrated, according to Somekh, how national social and cultural contexts influenced how life is enacted in classrooms.

McGrath (2001) discussed cultural factors in relation to ecological anthropology. McGrath's discussion is relevant to my research as it argues that ecological concepts, as used in my research, may also incorporate cultural factors. McGrath explained how cultural factors can influence changes in as

environment (pp. 2-3). Thus, the tracing of cultural factors is important in understanding how culture (external) may influence an ecology or how an ecology (internal) may influence the culture.

Research carried out by BECTA (2005), discussed socio-cultural factors that are important factors to be considered in an adoption. BECTA research identified social and cultural factors as barriers to change and cited Rogers' *compatibility* (as discussed in section 3.4.1) as an approach to reduce the influence of these barriers.

3.3.4 Summary - factors in ICT adoption

In summary, there are a number of theories and models that explain teachers' ICT adoption in teaching and learning. Further, the literature review has shown that researchers have identified a number of factors that affect teachers' ICT adoption at different levels, ranging from the individual, the school, and the system.

3.4 Factors in the adoption of an ICT professional development

innovation

In the previous section, I focused specifically on the adoption of ICT by teachers and schools. In this section, I focus on the adoption of an ICTPD innovation and its implementation in the research context, i.e., a cluster based professional development programme in ICT for teachers, the KPEC ICTPD programme.

Substantial literature reviews were done in two main areas - theories and models related to innovation and change (primarily institutional perspectives), and the factors that influence the adoption of an innovation, its implementation and change. I have selected three theories or models that have influenced my understanding of the adoption of the ICTPD innovation and change that may occur. These three theories or models will provide a bridge to understanding the

use of the ecological perspective in the theoretical framework section of this chapter.

The next section reviews three theories or models that provide factors and influences to be considered in my research, namely, Rogers' (2003) Diffusion of Innovations (DOI), Hallinger's (2001) change and cultural propositions and Fullan's (2000, 2001) educational change .

3.4.1 Rogers' Diffusion of Innovations

The literature related to the adoption of innovations has provided a range of factors that can influence outcomes. The most seminal work on theories of diffusion is described by Rogers (2003) in his book, *Diffusion of Innovations* (DOI). I present Rogers', DOI in some detail in this section because it provides an understanding of the processes and factors in adoption, and informs my selection of ecological concepts, models and theories and my inclusion of complexity in my theoretical framework.

Rogers (2003) defines an innovation as an "idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 11). He characterises diffusion as "the process by which an *innovation* is *communicated* through certain *channels* over *time* among the members of a *social system*" (p. 10). Rogers describes four main factors or variables: the innovation, the communication channel, time, and the social system.

According to Rogers (2003), there are five attributes of an innovation: (a) relative advantage; (b) compatibility; (c) complexity; (d) trialability; and (e) observability. Three of these attributes are considered to be important, namely relative advantage, compatibility, and trialability. Individuals do not adopt an innovation if they do not understand its relative advantage and compatibility. However, an innovation with a high degree of relative advantage and compatibility could still be hindered by complexity, i.e., be too complicated to be understood by individuals or organisations. Trialability is also important as it relates to changes and modifications to the innovation that the individuals make

to fit their needs and culture. The innovation goes through a process of 're-invention' and diffuses more rapidly (p. 183).

Next, the communication channels relate to how information about the innovation is communicated from one individual to another. Mass media channels are more effective in creating knowledge of the innovation, whereas interpersonal channels are more effective in forming and changing the attitudes towards a new idea, and thus, could influence decision to adopt or reject. Rogers (2003) suggests that communication is more effective if individuals are similar in education and socio-economic status. However, an individual or individuals initiating the innovation or change, i.e., change agents, are often better educated (may also be from a different cultural background) and thus create a barrier. Consequently, one approach is to have change agents and individuals (potential adopters) similar in education, culture and language.

Time is articulated as a temporal variable in the diffusion of innovation in three contexts: the innovation-diffusion process, innovativeness, and the rate of adoption. In the innovation-diffusion process, the potential adopter goes through the process of acquiring knowledge of the innovation, then forming an attitude, deciding whether to adopt or reject the innovation, implementation, and lastly confirming the decision to adopt the innovation. Rogers (2003) describes innovativeness as the degree to which an individual adopts new ideas compared to other members in a social system. These individuals can be classified into: (a) innovators; (b) early adopters; (c) early majority; (d) late majority; and (e) laggards. Lastly, the rate of adoption is the relative speed with which members of a social system adopt an innovation.

An important factor in the diffusion of innovation is the *social system*. Rogers (2003) defines social system as "a set of interrelated units that are engaged in joined problem solving to accomplish a common goal." (p. 23). A system has structure, and distinct arrangements or patterns (p. 24). The structure regulates an individual's behavior within a system. The social structure and communication structure of a system can either facilitate or hinder the

diffusion of innovations. A social system also demonstrates norms, defined as the established behaviour patterns for the members of a social system. According to Rogers, norms can be a barrier to change in a social system. There are two important aspects related to social system that can influence the diffusion of innovation, which are the opinion leadership and the change agent. Rogers defines *opinion leadership* as "the degree to which an individual is able to influence other individuals' attitudes or overt behavior informally in a desired way with relative frequency." (p. 27). When the opinion leaders are more innovative, the social systems are more receptive to change and thus, diffusion is much more likely to occur. Opinion leadership is also mutually influenced by the system norms because opinion leaders reflect these norms. The second aspect of the social system that can influence the diffusion of innovation is the change agent. Ottaway & Cooper (1976) discuss the role of change agents in Rogers' DOI; they consider a change agent³⁰ as an individual who influences other individuals in the innovation-decision in a direction desirable to the innovation adoption process. Change agents often use opinion leaders to influence the diffusion activities.

In terms of other related factors in DOI, Rogers (2003) also discusses prior conditions that can influence the innovation-decision process. They are: (a) the previous practice; (b) felt needs or problems; (c) innovativeness of the individual or members of the social system; and (d) norms of the social system.

In summary, Rogers' (2003) DOI illustrates three elements or factors in the adoption of an ICTPD innovation: an individual's (or adopter's) perception of the ICTPD innovation, the decision making process in adopting an ICTPD innovation, and the social systems (values & norms) within which the ICTPD adoption is taking place. DOI implies that social factors are the most important in ICTPD adoption.

³⁰ Ottaway & Cooper (1976, p. 177) also relate change agents as outside people who are providing specialist or technical knowledge or assistance in the change effort.

3.4.2 Hallinger's innovation, change & culture

Hallinger's (2001) theory is particularly important to my study as it provides an Asian perspective on the adoption of an innovation (generally). Hallinger's theory explores how Asian schools adopt and implement innovation at school level.

According to Hallinger (2001), the adoption of an innovation and the consequent change that occurs in East Asian societies are influenced by cultural dimensions (p. 61). Hallinger discusses limitations of Western models of change in terms of their application in East Asia (p. 69). His review of the Western theory of change process depicts inherent assumptions of how it occurs:

1. Change is a process, not an event.
2. Change takes place in individuals before it takes place in organisations.
3. The process of change involves a gradual growth in both skills and feelings.
4. Individual members of a social system will react differently to the same change.
5. People will implement change more effectively if they understand why they are undertaking a new policy or innovation and are committed to it.
6. There are institutional components that support the capacity of individual learning.
7. Leaders play a key role both through their role as organisational gatekeepers and through the emotional and technical support they provide during the change process.
8. Change takes place within a social system as well as within an institutional structure.

(Hallinger, 2001, pp. 69-70)

These assumptions are important to my research as the ICTPD programme tries to bring about change in the cluster schools.

Overall, the change process goes through three main stages: (a) adoption; (b) implementation; and (c) institutionalisation. In brief, Hallinger (2001) proposes that the adoption stage is where there are distinct differences between Western and Asian cultures. In an Asian context, there is less concern about creating interest and building commitment. In a culture of compliance, there is an assumption that change will be directed from the top-down. Those individuals involved comply with change and concentrate on the practicalities, rather than questioning the underlying assumptions of the directive (p. 68). Hallinger notes, "...the passive acceptance of orders to implement the innovation is neither a guarantee of support nor a predicator of success." (p. 68). However, more importantly, the lack of information and understanding may lead to a failure to identify obstacles and build support for the innovation, and thus jeopardise the implementation of the innovation.

The implementation stage is where the innovation is put into practice and is where it is most likely to fail. Two key points emerge. First, training may not be sufficient to bring about change in itself but only with, "...skilful support of the group and the individuals who comprise it [innovation]." (Hallinger, 2001, p. 68). Second, the learning of new skills required for change, "...entails an interactive process of training, coaching, feedback, and support." Often, change is discarded and old practices return (p. 68).

Institutionalisation is where innovations are diffused and merged into common practice. Hallinger (2001, p. 70) suggests that time frames for the innovation to be institutionalised may take five to ten years, whether in the West or in Asia. The permanence of an innovation is dependent on the organisation and, "...gains in knowledge of implementing the innovation or policy are put into use." (p. 70). The innovation may be adapted to ensure that it is more suitable for the context it is in. More importantly, Hallinger notes that the curriculum or software will need to be revised. These adaptations only occur after there is experience of the innovation. Hallinger argues that Asian schools are at an advantage in carrying out innovations due to 'obedience' to directives.

Hallingers' (2001) propositions on change and culture provide an approach to incorporating cultural factors into my research. It is an important aspect in my research as the ICTPD model is brought from New Zealand (NZ) to be implemented in the Malaysian school context.

3.4.3 Fullan's educational change

Though there is substantial research on innovation and change, I have found Fullan's work (2000, 2001, 2003a, 2003b) on educational change to be influential due to his focus on 'practical approaches' in initiating change and 'lessons learnt' in understanding change. There were two important ideas³¹ that I learnt from him, first, there was no simple answer to change (no silver bullet) and second, schools are overloaded with innovations. In terms of the adoption of an innovation in education, Fullan provides an institutional perspective to describe change that occurs at the individual, collective, and system levels.

Fullan (2001) suggests that innovation and change are multidimensional and subjective. Fullan indicates that change involves many levels, from the district and the school, to the teachers. Fullan's trilogy of educational change³² such as the book entitled *Change forces with a vengeance* (2003a) discusses the need to understand the educational reform process at three levels, i.e., Fullan's tri-level reform. Each of these levels has different stakeholders that dynamically engage and interact with each other to influence change. Importantly, Fullan suggests that multilevel change is a complex and complicated process and that change at one level will only bring about partial change. Fullan applies complexity theory³³ and evolutionary theory to show that change is complex and dynamic, and that the individual is integrated and interconnected with the

³¹ M. Fullan was a consultant for the Malaysian Ministry of Education (MOE) from 2006-2007. I was the officer in charge of institutional change at MOE.

³² Change Forces series.

³³ Complexity theory is complexity version 1.0, according to Davis & Sumara (2006). Complexity thinking evolved from complexity theories.

environment he or she belongs to. Further, these theoretical concepts were used by Fullan to explain the emergence and unpredictability of change.

Most relevant to my research are Fullan's factors related to characteristics of change. There are four factors according to Fullan, namely, need, clarity, complexity, and quality (2001, pp. 75-80). Briefly, *need* corresponds to a school's perceived need to adopt the innovation; not only whether the innovation is important, but the innovation's relative importance to other innovations. *Clarity* relates to the identification of the essential features of the innovation. The lack of clarity in an innovation represents a problem, as does false clarity in which change is interpreted in an over simplified way, i.e., individuals perceive that they have changed (superficial change). *Complexity* is related to the difficulty that the individual experiences in the change process (or the adoption of an innovation). The type of change required, such as a change in teaching practices that is of relevance to my research, has an influence on the adoption of the innovation. Teachers, for example, need to understand the change that is required of them as well as the overall change (at school) that is necessary. The *quality and practicality* of an innovation influence how an innovation is adopted and implemented. Fullan equates quality to materials and resources for change and points out that politically driven projects often have short time lines, which affect the materials and resources necessary for implementation.

Fullan (2000, 2001, 2003a, 2003b) has provided key concepts or elements in understanding innovation and change, the use of complexity theory (or, in my research, complexity thinking at different levels), and factors that influence the adoption of an ICTPD innovation and the change that follows.

3.4.4 Transfer and culture

Another aspect that needs to be considered is the transfer of the ICTPD innovation from NZ to Malaysia, i.e., the innovation's move from one country to another.

There is extensive research on technology transfer in literature, primarily from technology, manufacturing and business, e.g., Reddy & Zhao (1990), Bozeman (2000) and Eneh (2010). Eneh, in a review of technology transfer (TT) and adoption considered technology transfer as the process of sharing skills, knowledge, technologies (p. 1814). Technology transfer often refers to manufacturing, where joint ventures or partnerships are created to transfer technology from one company to another. It considers the innovation as a whole (unchanged), transferred straight across to the new context without adaptation and imposes a new structure on the recipient. Thus, the transfer of this innovation, i.e., the ICTPD model is not viewed as a transfer of technology. In this research, when the ICTPD innovation was transferred, it went through a process of adaptation and change, e.g., the cluster schools were selected to participate instead of schools volunteering to participate. In this research, transfer as a concept is different from the transfer of technology.

In an attempt to understand the transfer of the ICTPD innovation from NZ to Malaysia, I have selected to review literature regarding international aid, e.g., Leach (1999) and organisation, culture and leadership, e.g., Bush, Bell, & Middlewood (2010), Schneider & Barsoux (1997) and Handy (1993). I found Handy's discussions on the role of culture in organisations to be relevant, where he identified four types of 'cultures', role culture, power culture, task culture and person culture. Of these four, two are relevant to the discussions on cultural factors in this research, role culture and power culture. In role culture, organisations such as the Malaysian MOE and schools, are bureaucratic, with rigid rules, regulations and policies are enforced through a hierarchical and centralised manner. In addition to role culture, power culture, e.g., school heads, relate to figures that hold power, make important decisions about a programme or project and also maintain rules and regulations. The existence of these cultures in the Malaysian context can hinder or support the adoption of the ICTPD programme. The transfer of the innovation can be circumvented by these

cultures and thus, making the ICTPD innovation incompatible. The potential incompatibility of the transfer from one country to another, where a different set of socio-cultural norms exists has to be taken into consideration in implementing the ICTPD programme.

In sum, I focus on the adoption rather than the transfer of the ICTPD innovation because the successful transfer an innovation from one culture or context to another one will always go through a process of reinterpretation and change to fit the values and practices of the new culture. Further, adoption better suits my study focus as I am concerned with understanding the impact of the ICTPD innovation on teachers, and adoption allows me to apply a more coherent dual theoretical lens to the case study.

3.4.5 Summary - adoption of an ICT professional development innovation

In summary, the literature review has shown that the adoption of an ICTPD innovation and its consequent change are dependent on a slightly different set of factors and processes. Consequently, for my research, a different perspective is required to understand the factors, decisions, and processes that teachers and schools implement to adopt an innovation, as compared to factors that influence the adoption of ICT.

3.5 Summary - ICT adoption and adoption of an ICT professional development innovation

In this chapter, I have distinguished two types of adoption in relation to my research, and reviewed the relevant literature on ICT adoption and the adoption of an ICTPD innovation. From this literature review, there are a number of factors that can influence teachers' adoption of ICT at different levels (from individual factors to system factors). These factors do not, however, indicate the complex relationship within the school (and beyond) that occurs in teachers' adoption in teaching and learning.

Another key element in teachers' ICT adoption in this literature review is the focus on pedagogy as an element in the change process, i.e., teachers' ICT adoption is indicated by their change in teaching practices (and consequent change in student learning). In this research, pedagogy is the component which distinguishes teachers' technical use of ICT from teachers' ICT integration in teaching and learning (the integration of ICT in teaching and learning). In the next chapter, I discuss the use of ACOT models to describe the progression of teachers' adoption in teaching and learning.

The models and theories in this chapter provide a useful 'list' of factors and a number of perspectives in understanding teachers' ICT adoption in teaching and learning. However, these models and theories are basically linear and compartmentalised, and do not provide an understanding of the whole as well as the parts that influence teachers' ICT adoption in teaching and learning.

The adoption of an ICTPD innovation, in this research, refers to the adoption of the KPEC ICTPD programme. The KPEC ICTPD programme was adapted from New Zealand and implemented into another context, i.e., Malaysian schools. Thus, the literature review discusses the elements that may influence the adoption of the ICTPD innovation by first covering organisational adoption (school) and then focusing on adoption by individuals (teachers). More importantly, innovations can be perceived to be social (processes), are culturally bound (context), and can be complex (degrees of adoption), as illustrated by the three theories chosen. Further, factors at different levels of ICTPD adoption (such as those offered by Fullan), are important as they show that adoption is not a singular process but is co-constructed, by individuals, schools, and systems. It is essentially a complex process, requiring an understanding of *what* occurs between *teachers* within schools and between *schools* in adopting an innovation such as the PD programme.

The models and theories in this chapter provide an underlying structure for me to construct a theoretical framework for my research. In the next chapter,

I discuss my theoretical framework, which outlines the use of the ecological perspectives, complexity, and emergence.

4.0 THEORETICAL FRAMEWORK

In this chapter I describe the theoretical framework of the research in two sections. The first section discusses the main models and theories within a multi-level ecology, and the second section integrates complexity thinking and emergence with the ecological perspective.

According to Anfara & Mertz (2006, pp. 189-190), a theoretical framework plays an important role in qualitative research, providing links between theory and research in that the theoretical framework directs the research approach and process. The theoretical framework used in this research is derived from several fields in education, ICT, business and innovation. A number of models and theories were considered and reflected upon; from them a selection was made to create a theoretical framework that fit, made sense, and resonated with my own thinking (p. 191). Furthermore, Anfara & Mertz (p. 192) contend that a theoretical framework should be able to: (a) focus a study; (b) reveal and conceal meaning and understanding; (c) situate the research in a scholarly conversation and provide a vernacular; and (d) reveal its strengths and weaknesses.

4.1 The ecological framework: overall structure

Bronfenbrenner's (1979) multisystem or 'super-ecology' provides the overall structure from the *macrosystem* to *microsystem*. Bronfenbrenner's ecology (pp. 22-26) has system and nested characteristics, which I have adapted and illustrated in relation to my research in Figure 4.1.

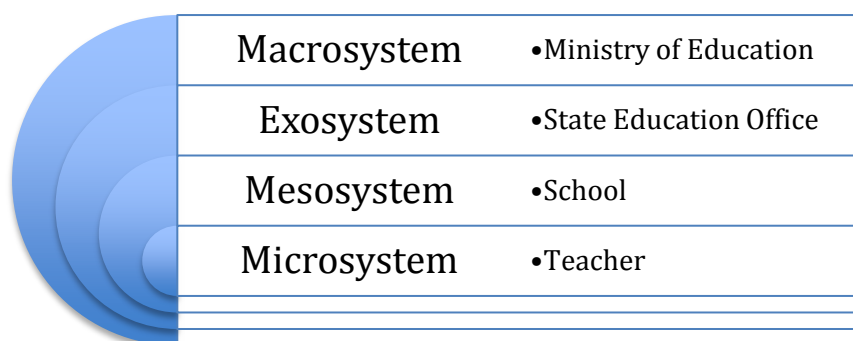


Figure 4.1. Levels of complex factors affecting teachers' adoption

Figure 4.1 shows the nested systems that are involved in the research. The external factors are within the exosystem and macrosystem, and the internal factors are within the microsystem and mesosystem. Individual factors are subsumed in the microsystem.

Bronfenbrenner's (1979) ecological systems theory is applied in this theoretical framework to address the multiple levels of educational stakeholders and factors that influence: (a) teachers' adoption of ICT in teaching and learning, and (b) teachers' change in pedagogy in relation to the adoption of an ICTPD innovation. The ecological metaphor is used to describe the complexity that exists in relation to the factors that influence change and the linkages between them. Bronfenbrenner (p. 16) explains how an individual (e.g., a child) is affected by the environment they are in (e.g., home) and how the connections of that individual (e.g., a child's relationship with family members) within the environment, affect development.

Bronfenbrenner's (1979) ecological theory also situates the teacher within the *microsystem* level, as a key agent. In this research, the teacher is the main unit of analysis and, thus, the school environment and other external influences play a role in affecting ICT adoption and change in teaching and learning. The main ecology or environment in which the teacher is situated is the school at the *mesosystem* level. Outside the main ecology, the external factors and conditions are linked to the *exosystem* and the *macrosystem*. In my research,

Bronfenbrenner's multilayered approach is useful for identifying the factors that influence teachers' adoption of ICT, and linking the factors together from the teacher, the school, and external influences. Further, this multilevel approach is useful in understanding the multitude of factors that influence both types of adoption, i.e., ICT and the ICTPD programme.

By employing Bronfenbrenner's (1979) theory, I focus on the teacher as a living organism who is influenced by the ecology of the school, which in turn is interconnected with external influences.

4.2 The ecological framework: internal structure

Bronfenbrenner's (1979) ecological systems theory is used also to provide a structure for theories and models at different levels. Each system within the structure is based on either a theory or a number of theories that intersect or overlap. These theories are divided into three main elements; the first describes the *external* factors affecting ICT adoption (*macrosystem & exosystem*), the second describes the *internal* factors affecting ICT adoption (*mesosystem*), and the third describes the *individual* factors (*microsystem*) affecting ICT adoption by teachers and the process of ICT adoption and subsequent change in teachers' practice. Figure 4.2 illustrates the linkages between the theories or models used and the levels in the system. Each of the theories is discussed in the following sections.

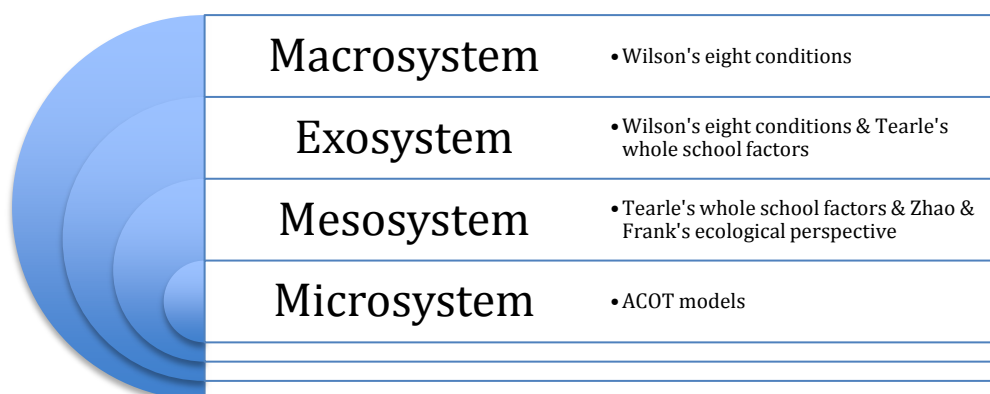


Figure 4.2. Theories & models within the framework

The ACOT models, as shown in Figure 4.2, focus on teachers' ICT adoption in teaching and learning and the adoption of the innovation through the progression of change in pedagogy.

Wilson et al.'s (2001) conditions provide a number of factors that help to explain teachers' adoption of ICT at the *macrosystem* and *exosystem* levels. Next, Zhao & Frank's (2003) ecological perspective and Tearle's (2003) whole school factors provide explanations about the relationships and factors in ICT adoption at school level (*mesosystem*). Finally, the Apple Classrooms of Tomorrow (ACOT) models, namely the ACOT three stage development model for teacher proficiency in technology - based classrooms (H. Sandholtz et al., 1992b) and the ACOT teacher progression model (ACOT, 1995), provide the micro-models that describe teachers' adoption of ICT in teaching and learning and the progression of change in pedagogy (teaching practices in ICT) in the adoption of the innovation, which are the two main foci of this research.

4.3 The ecological framework: differences in theories

Silverman (2006) advocates the use of 'useful theories' in doing research and, as such, different theories are used for different areas of interest in my research. However, there are subtle differences between the theories and models used in this framework. I explain briefly how each theory or model links into the research area and indicate differences between them.

At the school level, two theories are used - Zhao & Frank's (2003) ecological perspective and Tearle's whole school characteristics (2003). Zhao & Frank's perspective differs from Tearle's model in terms of its use in this research as it is applied to the introduction of an innovation, in this case, the ICT professional development programme, looking at the teachers' adoption of innovation in ICT and progression as a result of participation. Zhao & Frank advance that within the ecology, an intervention, such as the adoption of new ICT, can be viewed as disruptive to the school. They characterise the disruption brought about by adoption in terms of the effort required to adopt, other

competing activities or projects that influence adoption, and filling the needs of the school and teacher. Zhao & Frank's ecological perspective differs from Tearle's whole school characteristics because it focuses on the *innovation within the context of ICT and its impact on teachers*. It is discussed further at the latter end of this chapter.

In terms of factors related to teachers' ICT adoption, Tearle's whole school characteristics model (2003) extends Wilson et al.'s (2001) conditions and further details the factors that influence the adoption of ICT by teachers within the school structure and suggests that teacher choices play an important role. At the individual level, focusing more specifically on the teacher, the Apple Classrooms Of Tomorrow (ACOT) models are used as a lens to understand the process of change in adopting ICT.

In sum, an ecological framework provides a higher-level understanding of factors in teachers' adoption of ICT and their progression rather than a linear, technical, cause and effect 'laundry list' of factors. The next section explains in detail the theories and models at the different levels related to Bronfenbrenner's (1979) super ecology.

4.4 Macrosystem and mesosystem theories and models in teachers' adoption of ICT

Two models commonly used to identify factors at the macrosystem and mesosystem levels are Wilson et al.'s eight conditions that facilitate adoption (2001) and Tearle's whole school characteristics (2003).

4.4.1 Wilson's eight conditions that facilitate adoption

Wilson et al. (2001) identify eight conditions that facilitate ICT adoption in schools. These are presented in Table 2.

Table 2. Eight conditions that facilitate the implementation of educational technology innovations.

Condition	Description	Linked to	Reinterpreted
Dissatisfaction with the status quo	Feeling a need to change	Leadership	<i>Need for adoption - motivation for adopting ICT in teaching</i>
Expertise	Access to the knowledge and skills required by the user	Resources, rewards & incentives, leadership, and commitment	<i>Knowledge or expertise in ICT - ICT skills and pedagogical knowledge</i>
Resources	Things needed to make it work, e.g. funding, hardware, software, tech support, infrastructure, etc	Commitment, leadership, and rewards & incentives	<i>Resources to support adoption - ICT resources, ICT support, and ICT access</i>
Time	Prioritised allocation of time to make it work	Participation, commitment, leadership, and rewards & incentives	<i>Allocated time for adoption - time to prepare and use ICT</i>
Rewards or incentives	Internal and external motivators preceding and following adoption.	Participation, resources, time, and dissatisfaction with status quo	<i>Incentives for adoption - school or external influences that support ICT use</i>
Participation	Shared decision-making; full communication; good representation of interests	Time, expertise, rewards & incentives	<i>Participation and support for adoption (ICT) - networking or collaboration of teachers in adopting ICT</i>
Commitment	Firm and visible evidence of continuing endorsement and support	Leadership, time, resources, and rewards & incentives	<i>Commitment - adopting ICT practices needs support from other teachers and school heads</i>
Leadership	Competent and supportive leaders of projects and larger organisations	Participation, commitment, time, resources, and rewards & incentives	<i>Leadership - support and understanding of ICT adoption in schools</i>

(adapted from Wilson et al., 2001, p. 3)

Wilson et al.'s (2001) eight conditions or factors help to build a useful framework to explain teacher adoption of ICT in schools. Wilson et al. (2001, p. 3) argue that certain conditions, as illustrated in Table 2, influence how ICT is received in a school. For example, a supportive school head, a full time ICT manager or coordinator, access to ICT, ICT provision, and extensive professional development courses in ICT are school level factors that influence ICT adoption by teachers and the adoption of an ICTPD innovation within a school.

I reinterpreted these conditions (see Table 2, under the *reinterpreted* heading) and related them to the main stakeholders in a school, the teachers and the school leadership (school head), and the context of the school (resources etc.) following Wilson et al.'s conditions. These reinterpreted conditions serve as a practical list of contributing factors and provide a useful guide to understanding ICT adoption in schools.

However, the conditions as suggested by Wilson et al. (2001) do not represent the linkages between factors nor the complexities of ICT adoption by teachers within a school. Schools are complex organisations, each with their own set of goals and values. In ICT adoption, schools and teachers are involved in a reciprocal relationship and thus there is a need to identify characteristics that influence the process as a whole.

The next section discusses Tearle's model (2003), which differs from Wilson et al.'s conditions as it examines factors within a school and is applied as a research model within my framework.

4.4.2 Tearle's whole school characteristics

The conditions or factors discussed above were used by Tearle (2003) to investigate the use of ICT in a United Kingdom (UK) school using an interpretive case study approach. The case study highlighted a number of features that affected the use of ICT by teachers, including the 'whole-school' characteristics that

supported the process of ICT adoption within the school. Tearle's model differs from Wilson et al.'s conditions, as it centres on teachers' practices and looks at the factors within a school that facilitate or hinder the use of ICT by teachers.

Tearle argues for considering these factors as a whole rather than as separate items because the factors are inter-linked in a complex way (2003, p. 579). Tearle also highlights the links between the teacher and the school context and looks at factors that influence teachers' adoption of ICT and change in practice:

Given that it is the individual teacher who, in practice, uses (or doesn't use) ICT in a teaching and learning context, it [actual ICT use] has been directly linked to those issues which at an individual level are seen to be most influential in bringing about actual ICT use. (Tearle, 2003, p. 579)

Apart from factors that influence teachers at the individual level, Tearle also found that external influences and whole school characteristics (internal) play a role in ICT adoption. Tearle found that factors at the external level did not come from an external event or influence, but is a reaction and response towards external influences (p. 572). Thus, external factors may not be directly evident in data, but related to factors such as national training courses and, in the case of the UK, the National Opportunities Fund (NOF) training.

Tearle also discusses a continuum of external influences, with choice at one end and no choice at the other. Tearle explains that at one end of the continuum, such as the "no choice" end, factors such as the national curriculum and examinations (which are mandatory), influence schools and teachers negatively in adoption. At the other end of the continuum, such as at the "choice" end, schools and teachers have a choice to adopt ICT and positively impact adoption in terms of the availability of computers for teachers, and the ICT projects and programmes that the school chooses to be involved in.

At the school level, Tearle (2003, p. 573) identified four factors that emerged as important findings relating to the effective implementation of ICT, which were:

1. Strong leadership with high expectations of the school, staff and students.
2. The whole school is viewed as being “excellent” in many aspects, not just ICT.
3. Positive ethos and a collaborative culture which promoted learning.
4. Well motivated and caring staff.

From the four factors above, I summarise that: (a) school leadership; (b) the school as a whole (contextual features); (c) school culture; and (d) teachers' motivation are factors in encouraging adoption of ICT. Tearle found that extrinsic motivation in schools, such as high expectations from the school head within the school, affect ICT adoption as much as intrinsic motivation does in a teacher (p. 573).

At the individual teacher level, the ICT implementation process takes into account key events in the implementation of ICT, which are: (a) the quality of people; (b) resources; and (c) training and support. In her findings on the quality of people, Tearle stresses the importance of the ICT co-ordinator, as such an appointment would have a direct impact on ICT adoption. In terms of ICT resources, the availability of ICT hardware, such as computers for teaching, had an impact on the frequency of ICT use by teachers. For ICT training and support, the training of teachers was cited as a relatively small factor, but significant in terms of the types of training that the teachers found useful.

In general, Tearle's (2003) whole school model provides insights related to different levels of ICT adoption and provides factors and processes that affect ICT adoption. Tearle's model, for example, points to factors that may support or hinder adoption within a school, which are also dependent on external factors and contextual characteristics of the school. Tearle further proposes that this

model is more suitable for case-study research because the model has a more local and contextualised focus. However, Tearle's model does not describe specifically the background and processes of ICT adoption by teachers within the school, but rather focuses on factors that affect teachers and the key instigators that initiate teachers' adoption of ICT within a school. Furthermore, Tearle's model, I would argue, leans toward explanations that are school centred rather than teacher centred.

The next section discusses the Apple Classrooms Of Tomorrow (ACOT) models (1995) in terms of factors that influence individual teacher adoption of ICT and their progress in adopting ICT. The ACOT models (micro-models) are stage models that take into account teachers' characteristics and the types of change that may occur when using ICT.

4.5 Microsystem theories and models in teachers' adoption of

ICT and pedagogical change

The ACOT models (1995) are very influential in terms of describing teachers' proficiency in using technology and the progression of ICT use in classrooms. The ACOT models are significant because they were based on ACOT studies over a ten-year period from the mid 1980s, which provided research into teachers' progression in the integration of ICT in their teaching. There are two models, which are complementary to each other; the first is the ACOT three stage development model for teacher proficiency in technology-based classrooms (H. Sandholtz et al., 1992b), and the second is the ACOT teacher progression model (ACOT, 1995).

To clarify, the ACOT (1995) models have a dual purpose in my research. First, the ACOT models supply the micro-level factors that inform my research in relation to teachers' adoption of ICT. Second, the two models provide an approach to gauge teachers' pedagogical change, as a component of the innovation. In other words, to understand the adoption of KPEC's ICTPD programme by teachers, I use the ACOT models to gauge teachers' progression in ICT and pedagogy. Thus, the ACOT models apply to both research questions.

4.5.1 Teachers development in ICT

Sandholtz et al. (1992b) proposed a developmental model that describes teacher proficiency in technology based classrooms. They categorised teachers' progress in technology adoption in three stages: *survival*, *mastery*, and *impact*. Newhouse (2001), whilst writing about the impact of ICT models used in education, had summarised the main components of the ACOT three stage development model in Table 3.

Table 3. The ACOT three stage development model for teacher proficiency in technology -based classrooms.

Stage	Defining features
Survival	<ul style="list-style-type: none"> • preoccupation with own adequacy • concern about ability to maintain control over the classroom and students • react to problems rather than anticipate them
Mastery	<ul style="list-style-type: none"> • anticipate problems and develop solutions to them • increased technical competence and experience and confidence
Impact	<ul style="list-style-type: none"> • focus on effects of teaching on students • use technology to assist in managing the classroom

(adapted from Sandholtz et al.(1992b, pp. 2-7))

At the survival stage, teachers characteristically struggle to adopt ICT in their classrooms as they begin to accommodate ICT in their teaching. At mastery level, teachers are able to foresee issues in using ICT in teaching and learning and have coping strategies in teaching as well as more skills in ICT. At the impact level, teachers are able to move towards learner-centred pedagogies and are more confident in using ICT for learning. At this level, teachers believe that ICT benefits outweigh their drawbacks (H. Sandholtz et al., 1992b, p. 6). This three-stage model informs my theoretical framework by providing an approach towards understanding how teachers adopt ICT in teaching and learning. This ACOT model provides part of the rubric for sub-questions that relate to teachers' skills and confidence in ICT in teaching.

This ACOT (1992b) three stage development model is limited as it focuses solely on teacher's adoption of ICT and its (simple) stages, and does not give any indication of the factors beyond teachers, at school or external level. Sandholtz et al. (1992b, p. 7) recognise that the impact of ICT adoption on teachers does not necessarily follow a clear path of progression, as issues may appear or disappear to influence teachers' ICT adoption. Furthermore, the model does not address certain issues that may arise which influence progression, neither does it describe the complexities of influences, the progression of teachers in a non-linear path or the socio-cultural context of the school that may affect teachers, as suggested by Somekh (2008). Furthermore, this ACOT model does not explain the reasons behind an individual teacher's progression in adopting ICT, from one stage to the next, or the regression to a previous stage.

4.5.2 Pedagogical change in teachers' adoption of ICT

The second ACOT (1995) model describes a five-stage pattern in terms of change in teacher instruction or pedagogy. This differs from the first model because it specifically looks at change in teachers' teaching practices when adopting ICT. It gauges teachers' change in terms of the types of teaching practices that start from ICT use with traditional practices (instructivist approaches) and end with innovative teaching practices when ICT is used (constructivist approaches). I use this ACOT model in my analysis more extensively as it provides a basis to determine where teachers are in their adoption of ICT in teaching and learning in relation to the teachers' adoption of the ICTPD programme. In other words, I examine the progression of teachers' pedagogy in ICT as part of the ICTPD programme.

The ACOT (1995) model describes a five-stage pattern: *entry, adoption, adaptation, appropriation, and invention*. Table 4 illustrates the five-stage progression.

Table 4. The ACOT five-stage model of teacher progression.

Stage	Examples of what teachers do
Entry	Learn the basics of using the new technology
Adoption	Use new technology to support traditional instruction.
Adaptation	Integrate new technologies into traditional classroom practice. Here, they focus on increased student productivity and engagement through using word processors, spreadsheets, and graphic tools
Appropriation	Focus on cooperative, project based, and interdisciplinary work - incorporating the technology as needed and as one of many tools
Invention	Discover new uses for technology tools, for example, developing spreadsheet macros for teaching algebra or designing projects that combine multiple technologies

(adapted from ACOT research 1995, p. 16)

The ACOT (1995) model of teacher change and progression provides the descriptions and examples to gauge individual teachers' progression in ICT adoption, specifically in relation to pedagogy. Teachers change their teaching practices from traditional instruction to knowledge construction.

The ACOT (1995) five-stage model of teacher progression also proposes that the teachers' background, experience in teaching, classroom organisation, and level of ICT skills and ICT confidence influence change in teachers' practice. Micro-models such as the ACOT models are descriptions of features and teachers in relation to the patterns that shape the adoption process. In terms of the main research questions, teachers' backgrounds and experiences, for example, remain as factors in adoption of ICT and also serve as a link to change of teachers' practice.

However, the ACOT (1995) five-stage model and the previous ACOT (1992b) three stage development model are descriptive models of adoption and change rather than exploratory ones. Neither model explores factors that affect change and, as such, do not take into account school-based and external influences which affect teachers' progression in ICT adoption in teaching and learning. For example, the ACOT five-stage model does not describe how a

teacher arrives at a certain level of progression, i.e., the individual route teachers take in adopting ICT in teaching and learning.

The next section discusses Zhao & Frank's (2003) ecological perspective, which uses the ecological metaphor in explaining teachers' progression in ICT adoption in relation to an innovation, i.e., the cluster based professional development programme in ICT (KPEC) in Malaysia.

4.6 Mesosystem theories and models in teachers' ICT adoption and the adoption of an ICT professional development innovation

The following ecological models at the mesosystem level incorporate both elements, providing an organisational level perspective into teachers' ICT adoption in teaching and learning and the adoption of an ICTPD innovation.

4.6.1 Zhao & Frank's ecological perspective in teachers' ICT adoption

Zhao & Frank (2003) propose that an ecological perspective provides a powerful analytical framework to integrate and organise sets of factors that affect implementation of innovations related to ICT (p. 807). According to Zhao & Frank (pp. 808-809), many factors that hinder teachers and schools from adopting ICT can be found in existing teaching practices and school cultures. In addition to individual-teacher factors, ICT or technology is viewed as a factor that either hinders or supports teachers' adoption of ICT. For example, learning new applications and technologies can hinder teachers' adoption due to the need for teachers to continually learn about new applications.

Zhao & Frank (2003) contend that previous research on factors that affect teachers were a laundry list of factors that were done in isolation without contextual factors such as Wilson et al.'s eight conditions. Zhao & Frank's

ecological perspective is a multilevel model that takes into account different factors that influence the adoption of ICT within an ecology (p. 809).

There are four ecological concepts which I have adapted from Zhao & Frank's (2003) perspective, and a fifth ecological concept from Hargreaves (1994). These five ecological concepts are as follows:

1. Schools as *ecosystems* which have hierarchies and are in a state of homeostasis³⁴.
2. Schools as *ecosystems* are made up of organic (e.g., teachers) and inorganic³⁵ (e.g., computers) communities.
3. Teachers are the *dominant species* and school heads are the *keystone species*.
4. Each *species* has a *niche* with specific roles and responsibilities.
5. Innovations such as ICT are *introduced* and *as invading species* are also *disruptive*.

I have chosen five concepts as the most relevant to understanding adoption of ICT in an ecology. Hargreaves's (1994) 'disruption' is an important inclusion as it provides a way of explaining how an innovation disrupts the ecosystem. I elaborate these five elements briefly.

First, the schools as an ecosystem. In Zhao & Frank's (2003) ecological concept, the school is viewed as an ecosystem that is nested within a state or district, which in turn belongs to the national educational system. The school belongs to a hierarchy in the system and is also hierarchical in nature, where there are different species in the ecosystem. The ecosystem is considered to be stable and regulated.

³⁴ An equilibrium maintained by several complex species in a system.

³⁵ Inorganic in this research applies to inanimate objects, e.g., computers (ICT equipment).

Second, the school is made up of communities that interact with each other. These are divided into organic and inorganic communities. In organic communities, for example, teachers interact with each other and other species such as the keystone species (school head), and also interact with inorganic communities, such as computers in computer labs.

Third, teachers are the dominant species - the largest species in an ecosystem. Teachers can establish relationships, interact, and be individualistic or cooperative. School heads are viewed as a keystone species as they hold power and influence in the ecosystem.

Fourth, each species has a niche. Teachers and school heads have specific roles and responsibilities in schools. For example, teachers are expected to teach and manage student learning.

Fifth, innovations are viewed as an invading or introduced species that is disruptive (Hargreaves, 1994). In this research, I apply these to *ICT and innovation*, specifically to the ICT professional development (ICTPD) programme, KPEC. ICT and the ICTPD programme can be viewed to disrupt the status quo of the school, and the school (and teacher) either accepts or rejects ICT or the innovation or both. Teacher rejection of the innovation may be linked to the school context in terms of support and leadership, and may also be linked to external influences such as policies that support the innovation (Fullan, 2001).

By using an ecological perspective, I accommodate levels of complex factors and consider the influence of factors on how innovations are received, perceived, and implemented by schools and teachers.

The next section provides arguments for the use of the ecological perspective in forming the theoretical framework. I discuss the use of the ecological metaphor and its linkages with complexity thinking.

4.6.2 Ecological perspectives and complexity thinking

An ecological perspective is strongly related to complexity theories (see Figure 4.3).

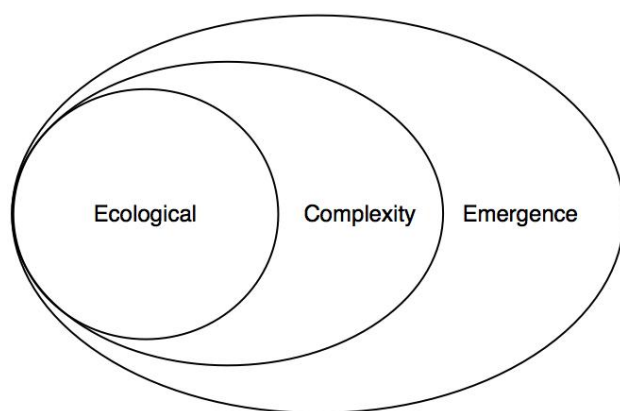


Figure 4.3. The interrelationships between ecological perspectives, complexity thinking, and emergence in this research.

The use of the ecological perspective in education, as Colucci-Gray, Camino, Barbiero, & Gray (2006, p. 229) suggest, includes these two aspects:

1. The notion of complexity: the part and the whole in complex interaction and the emerging epistemology of complexity.
2. Complexity at all levels: the implications for education.

Fullan (2000, pp. 3-5), for example, argues that complexity theory offers a way of understanding change in organisations such as schools, especially for emergent change or themes. Furthermore, Davis & Sumara (2006, pp. 34-35) claim that complexity theory offers: (a) meaning that can only be constructed within a system and not in isolation, and (b) a theory that is situated in a network of relationships that change accordingly. In terms of ICT and adoption, Tatnall & Davey (2003) argue for the need to incorporate complexity to understand how ICT is adopted (as an innovation) in relation to all the human and non-human interactions that may contribute to the outcome (p. 2). More importantly, complexity thinking was useful for generating new categories and helped construct new models in adoption by drawing on elements in grounded theory in the analysis. Findings, in chapters 6 & 7, contributed to the generation of two 'conditional' models of adoption. Further, models of adoption, innovation

and change, such as ACOT (1995), are too simplistic on their own; an ecological perspective plus complexity thinking gives us a broader and multilayered view of ICT adoption, the progression of change, and the influence of an innovation (professional development).

4.6.3 Complexity thinking

The use of complexity thinking assumes an acceptance of ambiguity (Smith & Graetz, 2006, p. 852). The inclusion of complexity thinking in my research enhances my understanding of teachers' ICT adoption, due to the need to: (a) explain interdependent relationships and linkages among species and systems; (b) identify features in the adaptation of the ecosystem that either enable or hinder teachers' ICT adoption; and (c) describe the states that enable or hinder teachers' ICT adoption within the ecosystem and external system.

I have selected and adapted three conditions from Davis & Sumara's (2006) list of conditions³⁶. Davis & Sumara and Smith & Graetz (2006) articulated that conditions should have a dual characteristic, and as such I have constructed my three conditions accordingly³⁷. The concept of duality is especially important, according to Smith & Graetz, in providing "an access point for the practical instigation of edge of chaos conditions and the potential for emergence" (p. 851). Smith & Graetz propose that dualities can either encourage balance or be in constructive tension (p. 853). In other words, dualities within a condition helps to explain the emergence³⁸ of a particular 'action', in this case, between adoption and non-adoption of ICT. They are:

³⁶ Davis & Sumara (2006, pp. 135-136) proposed nine conditions that may be used in complexity thinking and education.

³⁷ I recognise that there are other concepts and elements that relate to complexity thinking according to Davis & Sumara (2006). The selection is based on the context of my research.

³⁸ According to Smith & Graetz (2006), emergence is an approach for explaining traditional notions of causality in complexity thinking.

1. Possibility of adoption and non-adoption.
2. Stability and instability.
3. Feedback loops, both negative and positive.

The application of dual characteristics on the three conditions above provides an approach in describing how the ecosystem changes in relation to factors that support or hinder teachers' ICT adoption, similar to Tearle's (2003) continuum discussed earlier.

In summary, the integration of complexity thinking into the ecological perspective provides another way for me to:

1. Identify factors that support or hinder teachers' ICT adoption.
2. Understand how these factors influence teachers and other stakeholders in the school.
3. Describe the multilevel or network of interactions and non-linear processes in which teachers and schools adopt ICT.

4.6.4 Emergence

Emergence is not only a part of complexity but is also conceptually related to ecological concepts, according to Corning (2002). However, research literature, such as that by Davis & Sumara (2006), Goldstein, Richardson, Allen & Snowden (2007) and Corning does not precisely define emergence. To explain emergence, I start by using a working 'definition', which I have taken from De Wolf & Holvoet (2004):

A system exhibits emergence when there are coherent emergents at the macro-level that dynamically arise from the interactions between the parts at the micro-level. (p. 3)

Further, Corning (2002) suggests that emergence is a descriptive term pointing to the patterns, structures, or properties (p. 8).

I briefly unpack and outline the essential elements of emergence from De Wolf & Holvoet (2004), Corning (2002), and Davis & Sumara (2006) as:

1. Having a micro-macro effect.
2. Interdependent and independent (collective and individual).
3. Patterns that span from the lower to higher levels.
4. Dynamic behaviours, i.e., dualities.
5. Decentralised, i.e., the micro-level or single units are controllable but the whole is not.
6. Recursive, upward and downward causality.

In my research I use emergence as a concept which:

1. Explains the behaviours at the system or macro level that are reflected in the behaviours and relationships at lower levels (in my research, at the ecosystem and species levels).
2. Relates to a sum of different factors and interactions between units and levels, which *trigger*³⁹ the emergence of adoption⁴⁰, for example.

Emergence is a way to understand how adoption may be facilitated and nurtured at different units, interactions, and levels. Further, emergence provides an approach in discussing and developing practical implications for the ecological framework.

Though I discuss leadership as a school factor in section 3.3.2, I did not elaborate on the leadership of emergence as a related concept. I briefly discuss the concept of leadership of emergence in this section as it is referred to in the development of the ecological- complexity perspective in chapters 8 and 9.

³⁹ It is similar to critical mass or 'the tipping point' (Gladwell, 2000).

⁴⁰ I consider adoption as a phenomenon in my research.

Lichtenstein & Plowman (2009), argue that leadership can be seen a dynamic and interactive process where individuals interact and influence each other in leading change. This is contrary to the traditional view of leadership, which assumes that individuals with power and authority control the actions of others. The leadership of emergence, according to Lichtenstein & Plowman focuses on, "the dynamic interactions between all individuals, explaining how those interactions can, under certain conditions, produce emergent outcomes." (p. 617). Lichtenstein & Plowman apply complexity theories to form the basis for leadership of emergence and identified four conditions (or sequences) for emergence to occur, (1) a Dis-equilibrium state, (2) Amplifying actions, (3) Recombination and, (4) Stabilizing feedback. According to Lichtenstein & Plowman these four conditions are necessary in emergence and involves a progression of processes and mechanisms. The leadership of emergence is the disruption of a status quo, the establishment of uncertainty, the encouragement of change via collective action and the stabilisation of the system by integrating local constraints.

The next section extends the use of the ecological perspective on the adoption of an ICTPD innovation.

4.6.5 Tatnall & Davey's ecological model: the adoption of a training innovation

There are certain similarities found between Zhao & Frank (2003) and Tatnall & Davey (2003) in their use of the ecological perspective in explaining innovations introduced within an institution. Tatnall & Davey (2003) proposed an ecological model to understand training⁴¹ innovations within organisations.

⁴¹ Tatnall & Davey (2003) use the term training instead of professional development. In chapter 1, I explained the differences between PD and training. In this section, I refer to the ICTPD or PD as the innovation (KPEC) and use training to refer to the ecological model proposed by Tatnall & Davey (2003).

They define four characteristics, which I have adapted and linked to questions for data collection (see Table 5).

Table 5. Characteristics of ecological model of ICT innovation.

Characteristics	Questions
Co-operation	What factors within the environment support the adoption of the innovation?
Energy and satisfaction	What effort is required to adopt the innovation and did it reach the intended outcome?
Competition	What other activities or projects influence the adoption of the innovation?
Filling a niche	How does the innovation fit the needs of the teachers and school?

(adapted from Tatnall & Davey, 2003, pp. 3-5)

I explain these four characteristics briefly. *Co-operation*⁴² relates to factors that influence how a school receives an innovation (within the school context). It asks whether there are factors that support the innovation in the school, such as the availability of computers and teachers' ICT skills. *Energy and satisfaction* relate to the amount of energy or effort required to adopt the innovation and the satisfaction derived from participating in the innovation. In my research context, it refers to factors such as time and effort required to carry out the activities during the ICTPD programme, what teachers learnt from their involvement, and whether the ICTPD programme has reached its intended outcome. For *competition*, there is a need to consider other innovations in ICT being carried out in the school, such as those mandated by the MOE - for example, the ETEMS programme - which compete with the ICTPD programme for time, resources and activities. In *filling a niche*, I examine whether the ICTPD programme fills a niche in terms of the training needs of the teacher and the school.

The main reason I selected Tatnall & Davey's model is because it specifically addresses factors related to training and innovation. Zhao & Frank

⁴² Considers whether the school as an ecology has the ability to support the innovation, i.e., co-operate in supporting the ICTPD.

sought to explain the process of adoption in an organic approach but did not clarify how ICT adoption progresses in relation to a training programme. I modified Tatnall & Davey's model (2003) with refinements from Zhao & Frank (2003) so that I could use ecological concepts to explain how the species and the ecosystem react in adopting the training programme, i.e., ICTPD programme. In other words, I modified Tatnall & Davey's model in order to understand how the innovation is adopted by teachers, and the processes that influence their decisions to either superficially adopt the innovation or fully adopt it in their teaching and learning.

Further, I add the perceptual concept of *distance* to Tatnall & Davey's (2003) four characteristics, as an approach to further understand the processes which teachers and schools go through in adopting the ICTPD programme. Previous research has used distance as an ecological concept to describe innovation and change, as used by Zhao, Pugh, Sheldon, & Bryers (2002, pp. 482-515). Tearle (2003) and Zhao & Bryant (2006) use this concept to incorporate cultural and knowledge distance between the innovation and the recipient.

I found Zhao et al.'s use of distance to be inadequate in explaining the combination of factors and dynamics of interactions in the system. Thus, I extend their use and developed my own conceptualisation of distance by including *space* (see section 8.2.8); this concept was developed as a result of the findings in chapter 7. By applying distance to my research, I am able to describe the contrast between the innovation, i.e., the ICTPD programme as an invading species, and its adoption by the existing species in the ecosystem and the extent of adoption of the ICTPD programme. To put it another way, the distance between the existing priorities, practices, and cultures and the new priorities, practices, and cultures sought by the innovation affects the adoption of the innovation. Distance, thus, describes the extent of adoption.

In summary, the ecological framework, as outlined here, is used to identify which influences affect the innovation in the research, and to identify whether the innovation continues to progress, or stagnate, or regress. The

multilevel approach taken in the ecological framework is consistent with the implementation of the innovation at the cluster level, the content delivered via the PD process at school, and ICT content being adopted by teachers.

4.7 Summary - ecological framework

I developed an ecological framework with multiple theories and models rather than relying on a single theory. In this chapter, I have described and explained the sum of the parts and the whole that constitute the theoretical framework, from the micro-models that explain teachers' individual factors, to the overall theory that structures the framework. This theoretical framework also includes theories and models that describe multilevel processes and interactions from a combination of ecological concepts, complexity thinking, and emergence. The following figure (Figure 4.4) provides an overview of the integration of perspectives, conditions, concepts, and models within the theoretical framework used to understand teachers' ICT adoption in teaching and learning, and the adoption of an ICTPD innovation. The ecological framework assumes that factors and processes are dynamic, and that adoption and change are not static end points. Instead, it considers that teachers and schools have different pathways to adoption and these pathways intersect and interact at different levels. Adoption emerges from these complex factors, processes, intersections, and interactions rather than as a result of a range of linear causal factors.

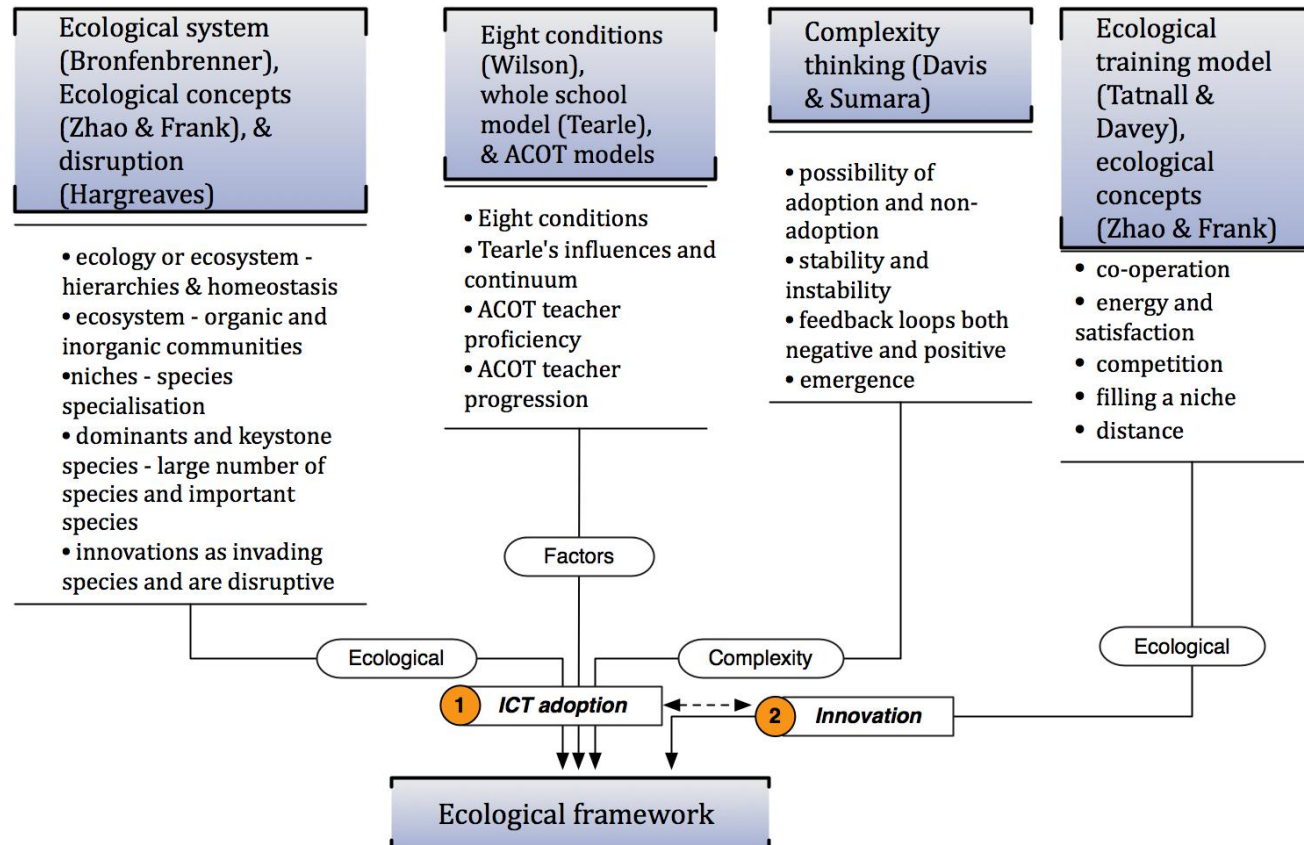


Figure 4.4. An overview of the ecological framework.

In (1), there is a combination of ecological concepts, factors, and complexity used in understanding teachers' ICT adoption in teaching and learning. In (2), the ecological model used specifically deals with training and also takes on ecological concepts from ICT adoption (i.e., Zhao & Frank). The arrow (dotted line) denotes the links or similarities between concepts used in both types of adoption.

The next chapter discusses the design of the case study, and the methods and processes used to gather and analyse data.

5.0 METHODOLOGY

This chapter is divided into two main parts. The first part of this chapter describes and justifies the design of my study and also contains background information on the schools and participants involved in the ICT professional development (ICTPD) programme on which it focuses. The second part of this chapter describes how the data is analysed, and discusses the issues of bias and ethics in my research.

This following section briefly discusses the intersection between the theory, design, and data.

5.1 Theoretical basis

VanWynsberghe & Khan (2007) discuss the range of definitions available to describe methods, research design, and methodology. Their discussions show that methodology can be described as the connection between theory, research methods and data (p. 3).

In the previous theoretical framework chapter, I discussed the use of an ecological metaphor to construct the ecological framework for my research. According to Fleckenstein, Spinuzzi, Rickly, & Papper (2008), using such metaphors in research moulds "our conceptualisation of a phenomenon of study and the methods by which we might plan a project to better understand that phenomena" (p. 390). The ecological framework is used to represent and understand the complexity of factors and themes that relate to the adoption of ICT and the adoption of an ICTPD innovation in schools. As such, the ecological framework informed the research questions and the design of the research methods, especially in the early stages of conceptualising my research. In this chapter, I also discuss how the ecological framework serves to clarify and refine the analysis of my data.

The next section discusses the factors considered in selecting research methods and research techniques in relation to the questions being investigated.

5.2 Philosophical stance

Merriam (2009) points out that a qualitative researcher has to state his or her position in terms of the nature of reality (ontology) and the nature of knowledge (epistemology). I have chosen an interpretive stance, which according to Merriam is where most qualitative research is located. This position as Merriam explains, "assumes that reality is socially constructed, that is, there is no single observable reality. Rather, there are multiple realities, or interpretations, of a single event" (p. 8). Thus, interpretive researchers start out with the assumption that access to reality is socially constructed through language, consciousness and shared meanings.

Apart from multiple realities which are context bound, an interpretive or constructivist epistemological perspective seeks to describe, understand and interpret events, instead of controlling events. Thus, according to Merriam, researchers do not find knowledge, they construct it (p. 9). Higgs (2001) further points out that in the interpretive perspective, knowledge is constructed through a search for meaning, beliefs and values (p. 49).

I have chosen an interpretive perspective as a reaction against the Malaysian MOE mainstream perspective that is primarily, positivist. In the MOE and in Malaysia in general, the world is viewed as linear, empirical, objective and reductionist. In this context, everything in the MOE needs to be measured and quantified to show constant improvement and 'change'. My experiences in working in the MOE suggest that multiple realities, social construction and subjectivity are at the periphery and consequently challenge the high value placed on positivism as the dominant epistemological position in Malaysia and in MOE.

The interpretive perspective fits my worldview and my conceptions of reality. My multicultural and multilingual upbringing, western and eastern education and experiences have influenced this perspective. Further, I believe that knowledge is co-constructed and that multiple perspectives and complexity exist, as well as alternative strategies to solving educational challenges in Malaysia. I believe that positivist or empirical perspectives have not revealed why and how teachers adopt ICT in teaching and learning and how ICTPD innovations are adopted. As such, my research, with its interpretive stance, does not test theory or measure using a positivist approach, but instead seeks to understand the experience of adopting ICT in teaching and learning and adopting the ICTPD programme from the perspective of teachers. I am interested in discovering, using the dual lenses, which factors influence these teachers to fully or superficially adopt ICT.

I also acknowledge that in my research, my understanding of the participants and the context is to some extent that of an outsider. Even though I am not currently a full member of the community (of teachers), I identify and empathise with the participants in my study, as I was once a teacher. Thus, I experienced a tension between being an *insider*, i.e., my understanding of the teachers in my study, and being an *outsider*. The tension stemmed from my task of representing the world of the teachers, that is, the world of the 'other', knowing that my view of the world was influenced not just by my teaching experience but by my later policy and academic training. In describing the world of the participants I understood I would be bringing in some of my own biases and world views. However, I believe, this is all part of the difficulty of taking an interpretive approach.

The interpretive perspective is also congruent with my theoretical framework. My ecological-complexity perspective as outlined in my theoretical framework is based on a organicist root-metaphor as proposed by Kilbourn & Alvarez (2008) who provide a different philosophical view in terms of adoption. Kilbourn & Alvarez (p. 1363) define an organicist as one who, "... actively searches for meaning and understanding in terms of the interconnections and

coherence among things, events, and processes." Furthermore, an organicist deals with both the macro and the micro and looks for ways to understand how hierarchies of one level to another affect each other (with an inherent power relationship). Kilbourn & Alvarez (p. 1363) suggest that this way of thinking is commonly linked to fields like ecology and education.

In the context of my research, I view that organicism, as a root metaphor, is most relevant in that it provides a way of understanding the underlying coherence and integration of a phenomenon whilst uncovering the fragmentation that occurs within that phenomenon. Organicism gives me a way of understanding ICT as a social and complex phenomenon in relation to my research. Though I use the term ecology, rather than organicism, in this research, organicism has influenced the methods, participants and analysis in my research.

The next section discusses the approach I took to carry out my research.

5.3 Qualitative research approach

In this study, I wanted to explore a research problem that has been under-investigated in the Malaysian context. My review of literature revealed little research or evaluation reports available on the outcomes of any of these earlier ICT initiatives outlined in chapter 2. Therefore, I selected a qualitative approach for my investigation of the four schools involved in this particular ICTPD innovation, which would yield rich, descriptive data of teacher's uses of ICT in these classrooms.

I chose case study as an approach that incorporates this theoretical position, the detailed study of teachers and schools in the Malaysian context, and the multilevel perspectives sought in my research. According to Merriam (1991), a case study can be regarded as a method:

The case study offers a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon. (p. 41)

A case study design allows me to investigate the research problem within a tightly defined context, and across a range of teaching context. Further, it provides an opportunity for an intensive study of processes and interactions within a well-defined and bounded context as well as the scope (i.e., offers conditional generalisations) and the precision (i.e., offers specific cases for illumination) to understand the research problem. In case study literature, generalisability is often an issue, especially in the interpretive paradigm. VanWynsberghe & Khan (2007, p. 8) argue that generalisability is limited and contingent on aspects of the study that may be generalisable to other events or to a larger case. In sum, a case study approach matches the interpretive perspective I selected, which assumes that reality is a social construct that emerges from the way in which individuals and groups interact and experience the world.

The literature on case studies, such as Stake (1995) and Merriam (1991, 2009) indicates that there are four important considerations in a case study: (a) unit of analysis; (b) multiple perspectives (representation); (c) triangulation (for accuracy and alternative explanations); and (d) boundaries in each case (spatial or temporal). In my case study, the teacher was the unit of analysis. I selected different teachers (e.g., subjects) and other stakeholders (e.g., school heads) to ensure that various perspectives were solicited. Triangulation was achieved through multiple methods, for example, documents, observations and semi-structured interviews, as well as from multiple data sources within cases, i.e., from multiple teachers within schools. Boundaries, according to both Merriam and Stake (2005), are the detailed descriptions of structures and relationships that are of interest; in my case study, the school was the boundary.

5.3.1 Collective case study

The case study approach I have taken can be described as an instrumental collective case study, as defined by Stake (2003). The case study is *instrumental* because my research focus is on teaching practices. However, in order to understand how there are variations in different contexts, my research

incorporated four school sites. According to Stake, the study of several cases is called a *collective* case study. A collective case study design offers better understanding and theorising due to the specific collection of cases (p. 138). In sum, an instrumental collective case study provides me a way of understanding the complexities between cases in my research.

By using a collective case study, I am able to study how teachers' adoption of ICT in teaching and learning occurs in schools and how various factors influence teachers in different schools. Further, I can explore and discover teachers' and school heads' perceptions in participating in the ICTPD programme with regards to its advantages and disadvantages, to discern and discuss the innovation's most significant features, the factors influencing its adoption and the processes within the innovation.

5.3.2 Selection of cases

The schools were selected due to their involvement in the first cluster based professional development programme in Malaysia, K-Perak E-learning ICT professional development (KPEC ICTPD). Five schools were clustered in the ICTPD programme which started in March 2007 and ended in June 2007.

For my study, I selected four schools which represented the major categories of schools in Malaysia, which are: primary urban, primary rural, secondary urban, and secondary rural. In addition, other characteristics such as geographical location and socio-economic status were also considered in the selection process.

Furthermore, I considered issues related to manageability and time in terms of collecting my research data. Figure 5.1 illustrates the four cases.

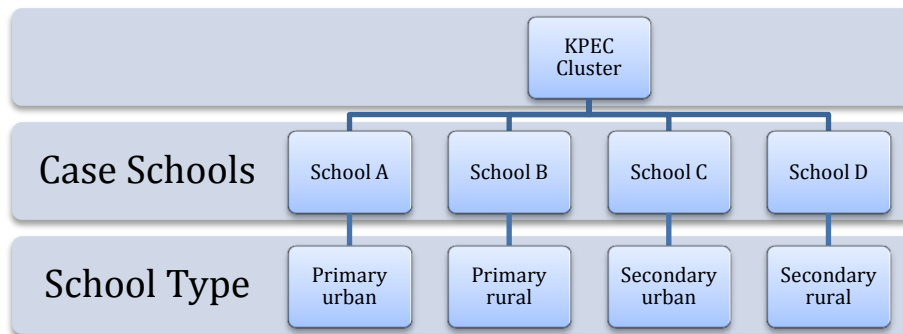


Figure 5.1. Collective case study - each school represents a category or type of school in Malaysia.

In terms of ICT, the four schools selected would have at least one ICT lab with 40 or more computers, coupled with other additional ICT development projects, such as additional ICT suites under the 'Smartising of Schools' project implemented by the MOE (see section 2.3.1.6). Apart from these ICT projects or programmes, the English for the Teaching of Mathematics, and Science (ETEMS) programme provided hardware and courseware for teachers who taught English, Mathematics and Science. In terms of networking, all schools have been provided with 'controlled broadband' through the SchoolNet programme. As a consequence of these schools' involvement in the cluster, some additional ICT⁴³ and some basic maintenance were supplied to these four schools to ensure that the initial cluster would be able to carry out the programme.

In summary, the selected schools were representative of the four school types in Malaysia and were also involved in the KPEC ICTPD, which was a unique programme implemented in Malaysia.

⁴³ K-Perak Incorporated and Innovation New Zealand Education provided the additional ICT hardware and basic maintenance on computers in the ICT labs.

5.3.3 Participants - teachers as the main unit of analysis

Primarily, teachers are the most important species in the ecology and are the main unit of analysis in my research. Each school was asked to nominate teachers who were involved in the KPEC ICTPD programme and its subsequent localisation, i.e., KPEC II. This included teachers who were teacher leaders⁴⁴ (facilitators & mentors at the four schools), as well as classroom teachers. The teacher leaders were KPEC state facilitators who had been trained by Innovation New Zealand Education (iNZed) facilitators from New Zealand (NZ). However, other teachers such as the in-school facilitators and school mentors were not trained by iNZed facilitators.

The teachers involved in my research played two distinct roles; teacher leaders, leaders, who were selected to implement the innovation in school, and teachers, who were on the receiving side of the on-site school programme.

Figure 5.2 illustrates the differences in teacher 'types' involved in KPEC, i.e., the KPEC facilitators and the in-school facilitators. Teachers are *not* illustrated in Figure 5.2.

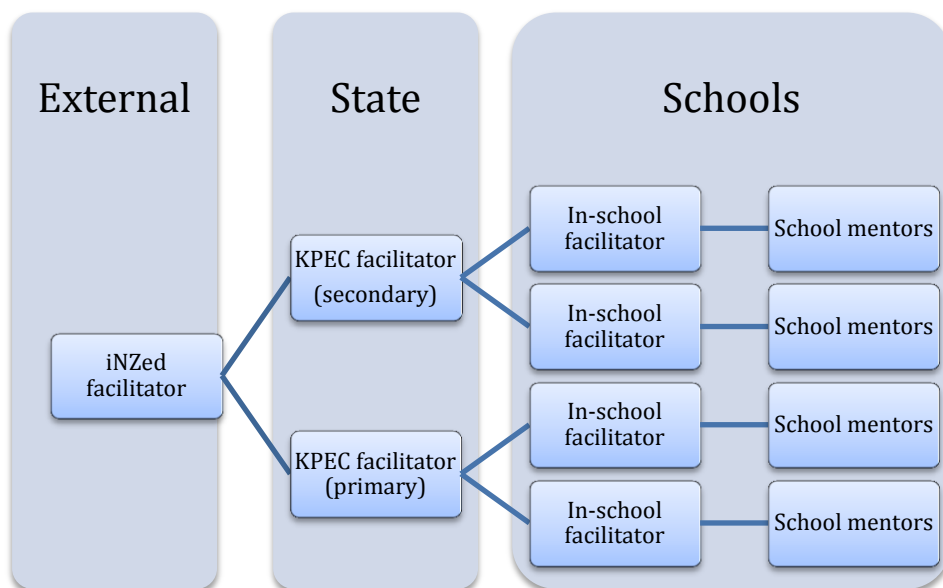


Figure 5.2. The facilitators and mentors involved in KPEC.

⁴⁴ Riel, M., & Becker, H. (2000) define teacher leaders as teachers who place a high value on sharing their knowledge with their teaching colleagues (p.1).

The iNZed facilitators were not included in my research because the programme had ended in June 2007⁴⁵ and I had no access to them. Figure 5.3 illustrates the roles and responsibilities of facilitators and mentors involved in KPEC.

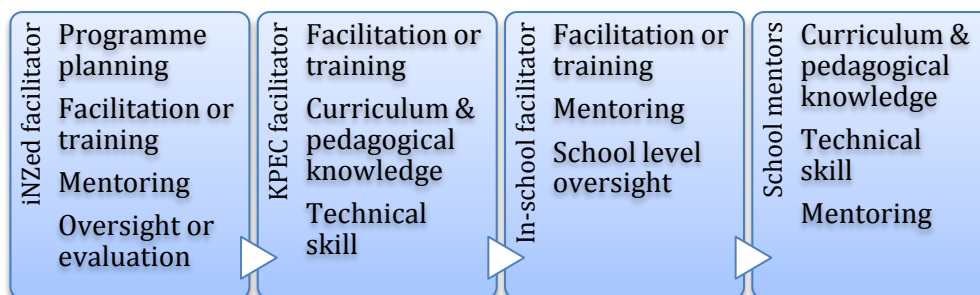


Figure 5.3. The roles and responsibilities of facilitators and mentors in KPEC.

Most teachers who participated were ETEMS teachers (English, Mathematics, and Science) with some teachers from various other subjects (Geography, Life Skills, Religious Studies, and Special Needs). Teachers who were involved in ETEMS had generally been to at least one ICT course and were mandated by policy and monetary incentives to use ICT when teaching these subjects. These teachers had also received a laptop each, with LCD equipped classrooms or labs, and accompanying teacher courseware produced by the MOE. Other teachers in my research who taught different subjects mostly owned a personal laptop or computer and had also used 'shared' laptops in their respective schools. It is essential to note that the participants were already using ICT in their teaching and learning to a certain degree.

Another 'type' of teacher related to ICT in schools is the ICT coordinator. I had included the ICT coordinator in the selection of participants as she plays an important role in Malaysian schools in ensuring that the school ICT

⁴⁵ iNZed facilitators (two facilitators from New Zealand) did not continue to facilitate teachers in KPEC beyond KPEC I.

infrastructure is maintained. Kennewell, Parkinson & Tanner (2000) indicate that ICT coordinators act as a liaison between the school head and the teachers in implementing ICT in schools. Four ICT coordinators participated in my study.

Even though teachers were nominated by their schools to be involved in my research, they could opt out, as three teachers did. In total, 49 participants were involved and 44 were teachers. Of the other five participants, four were school heads and one was the State Education Officer (SEO).

5.3.4 Other participants

The inclusion of other species within the ecological framework provides different perspectives (also triangulation) into teachers' ICT adoption and the adoption of KPEC. According to Vandenberghe (2002) and VanWynsberghe & Khan (2007), the inclusion of other participants can assist in understanding the conditions under which the concept, relationship, or event "got the way it is" (p. 8). Hence, I included other stakeholders involved in teachers' ICT adoption and the adoption of KPEC in my research.

As a keystone species in the ecology, the inclusion of school heads provides an understanding of how school heads support or hinder the teachers' ICT adoption and the adoption of the innovation in their respective schools. The school head plays an important role in determining, for example, the management of ICT labs, equipment, and school policies in teaching and learning. Fortunately, all the school heads⁴⁶ - in Malaysian terms, two principals (secondary) and two heads (primary) - participated in the study.

Apart from school heads, an external stakeholder was also included and interviewed. The SEO was selected as a participant because of two reasons: first,

⁴⁶ School heads in this research applies to school principals and school heads. In Malaysia, they are differentiated according to the type of school, i.e., secondary or primary.

the need for an external perspective on the implementation of KPEC in schools, and second, to gain a policy perspective external of school.

The next section provides the methods used to collect the data to answer the research questions.

5.4 Methods - data collection

Creswell (2002) and Stake (2003) have pointed out that case studies use multiple sources to collect data, including interviews, observations, documents, and artifacts. In my research, mind mapping, semi-structured interviews, observations, documents, and photos form the data collection techniques. Table 6 summarises the data collection techniques used my research.

Table 6. Research matrix

Data collection	Information source	Data artifacts	Notes
Mind maps & Factor sheets	Teacher leaders & teachers	Paper (later digitised)	Excludes: School heads & SEO
Semi-structured interview	Teacher leaders & teachers (pupils/students) ⁴⁷ School heads and SEO	Digital recorder	Digital audio transfer
Observations	Teacher leaders & teachers (pupils/students) School	Observational sheet Physical infrastructure	Volunteer teacher leaders & teachers
Documents	Moe (Malaysia) SEO (State) INZed School	Policy documents Reports Evaluation plans	

⁴⁷ Pupils or students are not directly involved. They are part of both the teacher interviews and observations – evidence of change in classroom organization & practice.

5.4.1 Rationale and protocols

The rationale and protocols for each data collection technique are discussed in the following sections.

5.4.1.1 Mind maps and factor sheets rationale

In my research, mind maps were used to gather data on teachers' motivations on ICT adoption, and to elicit ideas, concepts and processes about teachers' ICT adoption. The purpose of the factor sheet is primarily to gather factors relating to teachers' ICT adoption in teaching and learning.

Meier (2007) proposes that mind maps have practical utilisation in the research process and can be used in a variety of contexts. Similar to concept-maps, mind maps were used in eliciting, representing, and integrating an individual's or a group's knowledge and ideas about a certain theme. I provided a mind map with the main themes and prompt questions (see Appendix D for an example of a mind map).

Mind maps were used as a starting point for the semi-structured interview and focused on the participants' understanding of ICT adoption in relation to the ICTPD programme and what ICTs they used in teaching and learning. Further, mind maps were used to provide additional points of interest for me to pick up on during the semi-structured interview. At the end of the semi-structured interview, teachers were asked to rank order the nodes⁴⁸, according to importance. The purpose of rank ordering was to provide a way of understanding which nodes or points motivated teachers to adopt ICT.

Along with mind maps, factor sheets were used to gather data on the factors that supported or hindered teachers' ICT adoption in schools (see Appendix E). These factor sheets were used to focus the teachers' thinking about

⁴⁸ Not to be confused with Nvivo nodes. Nodes in mind maps are branches in the mind maps.

factors that supported or hindered their ICT adoption, and rank order them according to importance. The factor sheets were also used to provide additional points for the semi-structured interviews.

Mind maps and factor sheets were primarily used for teacher leaders and teachers but were not used for school heads and the SEO. This is because mind maps were used to gather data on teachers' motivations in their use of ICT, and factor sheets were used to gather factors that supported or hindered teachers' ICT adoption.

5.4.1.2 Semi-structured interviews rationale

The purpose of carrying out the semi-structured interviews was twofold; first, to understand teachers' ICT adoption in teaching and learning in the context of their personal experiences and their school, and second, to understand teachers' perceptions on their adoption of KPEC and that of their school. The semi-structured interview allowed for exploration of these two questions in an in-depth way. Bell (2005) citing Moser & Kalton (1977), explains that an interview is, "a conversation between interviewer and respondent with the purpose of eliciting information from the respondent." (p. 135). The ACOT (1995) models were used to form questions about teacher background and experiences in relation to their ICT adoption. Other questions in the interview were based on the ecological model, which, for example, asked about the suitability of ICT in teaching and learning.

One to one interviews were carried out for all teacher leaders, teachers, school heads and the SEO. Even though focus groups had been considered as a method, individual interviews were more likely to make the participants comfortable in voicing their opinions and perspectives. From my experience, Malaysian teachers, if in a focus group, tended to 'groupthink' when they are together and reach a consensus to avoid conflict, and may avoid expressing certain issues due to power relations, as Malaysian schools are hierarchical. The decision to have individual interviews was confirmed to be the right choice as a

number of participants did voice their opinions about, for example, other participants' commitments towards ICT in their schools. Furthermore, individual interviews maintain a certain degree of anonymity and confidentiality that ensure participants have the freedom to express their personal realities.

5.4.1.3 Mind maps, factor sheets and semi-structured interview protocols

At the beginning, participants were informed of their rights as stated in the consent forms they had signed earlier. Before starting, I asked each participant to acknowledge that they had understood the ethics which had been explained to them. I then asked them some basic 'data' questions about their age, how long they had been teaching in their school, what subjects they were teaching and so on.

The mind map procedure was as follows. First, I briefly talked through mind mapping with the participants. Then, I showed them a sample of a mind map and gave them four key features, which were: think fast, keep moving, do not judge, and free association. After that, I gave them a sheet with the main question⁴⁹ (see Appendix D), which I had focused on before the participants started on their mind maps. I also gave each participant a time limit of 15 minutes to complete. The participants were also informed that after the interview, they would be able to change anything on the mind map if they wanted to. Furthermore, I told participants that they would need to rank order the main nodes according to importance⁵⁰ after the interview.

The factor sheet⁵¹ was divided into four quadrants: (a) personal; (b) school; (c) encourage; and (d) hinder (see Appendix F). I briefly explained the

⁴⁹ Mind map question: What motivates you to use ICT in your life and work?

⁵⁰ Ranked 1-6 (1=most important, 6=least important).

⁵¹ Factor sheet question: Factors that you think influenced your use of ICT?

four quadrants and gave examples. Participants were asked to fill in the four quadrants within 10 minutes. For example, one participant wrote, as a factor in the personal quadrant, that using ICT helped in acquiring new ICT skills.

There were different sets of questions for the different 'types' of participants. For example, the teacher leader set was different from the 'other' teachers receiving the facilitation or mentoring, as the KPEC ICTPD programme differentiates them (see Appendix F). The purpose of this was to understand the different roles, responsibilities, and experiences of teachers' adoption of KPEC.

As these interviews were carried out, small changes were made to fine-tune the questions. I started to ask participants questions that I had written on small cards (see sample questions in Appendix G), which I had arranged according to sequence and themes. I also wrote a small number of questions that I had written down whilst participants were doing the mind maps and factor sheets. These questions were related to the research questions but not written in the main question sets (see sample in Appendix I). I did this to take the opportunity for exploring factors and issues related to ICT adoption, and the adoption of KPEC by teachers and other stakeholders.

At the end of the semi-structured interview, which ranged from 30 to 90 minutes, I asked participants to review their mind maps and rank order the nodes, as mentioned earlier.

5.4.1.4 Observation rationale

The main purpose of carrying out observations in my research was to observe how teachers taught their subjects using ICT in their classrooms. I wanted to examine teachers' practices, specifically changes in their practices⁵² (i.e., activities, collaborative group work, student use, and access to e-learning

⁵² Indicators relevant from the NZ ICTPD 'case study' cluster e.g., increased professional & classroom use of ICT (Ham et al., 2001, p.20), were referred to.

materials) when ICT was used. Primarily, I was looking for student centred teaching approaches. Further, observations served to triangulate my data. According to Kane (1995) and Creswell & Clark (2006), observations can be an important strategy in determining what is actually happening, checking against what is perceived to be happening.

A short interview followed the observations to gather teacher reflection on the lesson. The purpose of this short interview was to offer teachers a way of explaining and reflecting on the lesson I had observed. Also, it provided an approach for me to ask questions related to their practices.

5.4.1.5 Observation protocols

The observation sheet had two main sections: one on the classroom (which, for example, focused on the number of available computers) and the other on the actual classroom activity (which, for example, examined the specific use of ICT in teaching) (see Appendix H).

After each observation, as mentioned earlier, I interviewed the teacher for 5-10 minutes, to check my understanding of the teacher's use of ICT in the lesson. I also asked teachers questions from comments I had noted during the observation. There were four general questions asked: (a) on the teachers' view of the lesson (with use of ICT); (b) the reasons behind ICT use in the lesson; (c) the student learning outcomes with ICT use; and (d) the factors that hindered ICT use.

During the course of the data collection period, only six participants volunteered to be observed. The small number of observations was principally for two reasons: first, the data collection period coincided with the end of the school year and thus, many teachers were not teaching classes, and second, teachers were away for courses and examination invigilation. However, I managed to observe at least one teacher in each of the four schools.

5.4.1.6 Document search

The purpose of the document search was to understand the influence of policy documents (letters, directives etc.) at the individual, school, and external levels, according to my ecological framework. Further, documentary analysis offers a way of corroborating data from other sources, according to Merriam (1991). Thus, a document search was carried out in my research to gather documents related to ICT and KPEC. Documents included policy documents (such as ICT or KPEC related circulars) reports, evaluations, and plans from different sources and levels. Documents related to iNZed were also gathered to provide insights into the ICTPD implementation from an iNZed perspective.

5.4.1.7 Document protocols

At each school, I requested access for documents related to ICT and the KPEC programme, which included iNZed documents. All schools in Malaysia are required to have documents filed and organised accordingly⁵³.

Each ICT lab has to have a number of specific documents, for example, the ICT ledger (e.g., number of computers, maintenance etc.) and the ICT usage book (for each computer). For ICT related programmes or projects, all documents (e.g., correspondence and plans) should be located in one main file.

In each school, as part of the KPEC programme, I looked at students' work (i.e., student projects) as evidence of students' learning during KPEC. I also asked teachers about the work that was produced to ascertain teachers' understanding of student learning in KPEC.

⁵³ Part of policy - ISO 9002 (not all standards in ISO 9002 are enforced in schools however).

5.4.1.8 Photographic evidence rationale and protocols

The main purpose of taking photographs was to provide a window into the way schools and teachers value ICT in teaching and learning. In my analysis, photographs gave me a way to corroborate teachers' responses on factors such as the provision of ICT in the schools.

In an effort to conserve paper when gathering documents, I took photos related to my research (such as computers in the ICT lab), focusing on whether the ICT labs were maintained or otherwise. Other evidence, for example, achievements in ICT (trophies or awards), were included. Photos of participants were not taken.

All digital documents and photos were dated and filed in an encrypted disk for security reasons, as part of ethics.

5.4.1.9 Journal observations and notes rationale and protocols

During the course of data collection, I kept a journal for my own reflections and thoughts on the schools and teachers. The purpose of the journal was two-fold: first, to write impressions on the interactions and relationships between teachers, and between teachers and school heads, and second, to note down the 'significance' of the artifacts displayed and documentary evidence presented to me (as evidence of ICT use and innovation implementation - see Appendix J). For example, if a school displayed examination results and achievement in academic excellence on its walls (in the head's or school office), I would note this down and ask the principal during her interview about the school's focus.

Journals were also important because they served to confirm factors or issues related to individual teacher adoption of ICT and KPEC. Some participants would talk more freely during an informal conversation such as talking in the

canteen. One participant, for example, reflected on her use of ICT in teaching and learning after the interview, in informal conversations. Journals, thus, play an important role in enriching the data along with the participants' interviews and observations.

5.5 Transcription and translations

Semi-structured interviews were recorded with a digital recorder and then transcribed. Since the research was carried out in Malaysia, these interviews were carried out either in English or Bahasa Melayu (the national language) and participants had a choice of either language. Translations of these interviews - which also include mind maps and factor sheets - have a number of issues associated, for example, quality and validity is dependent on the ability of the translator, according to Birbili (2000). Birbili suggests that the researcher becomes aware of the cross-cultural differences in words, concepts, and the context in which the translations took place and, most importantly, make explicit the techniques used in the translation process. For the interviews, I translated incidences or responses that were pertinent to my study instead of translating the whole interview. Translations were done for the whole document when required. To ensure translations were consistent, a second native speaker of Malay went through a number of quotes or transcripts I had done.

The next section discusses and elaborates upon the processes and procedures involved in data analysis. This detailed elaboration ensures the factors and themes that emerged from the data in relation to the theoretical framework are explored fully. This is my research audit trail, advocated by Creswell (2002) as an essential element in the qualitative research process.

5.6 Data Analysis

I focused the analysis on my research questions, which were: first, the factors that supported or hindered teachers' ICT adoption in teaching and learning, and second, the adoption of the KPEC ICTPD programme. These factors,

as outlined in the literature review and the theoretical framework, gave me a basis on which to structure the initial variables or factors.

In my research, data from several cases was looked at and analysed in terms of how the data fitted into the context - the factors influencing teachers' ICT adoption and the adoption of KPEC (including the change in practice) across the four case schools. These four cases were analysed using cross-case analysis to examine themes across the cases and find commonalities and differences.

In total, I had collected 44 mind maps and factor sheets, 49 participant interviews, four observations, 989 photos and documents along with my own journal notes (two whole books). All of this data was converted into digital form and put into Nvivo.

In the analysis of the data and the findings, which follows this chapter, various references to literature are made in certain sections. The purpose of including the literature at different points within chapter 6 onwards was to support and develop the building of the ecological-complexity perspective (ECP) and the two models associated with the two innovations. The literature also served to highlight the similarities and differences that were present in both innovations. Glaser & Strauss (1967) state that literature needs to inform all stages of data analysis and the building of new theory or in my case, models. In the coding stage, for example, literature is key for "comparing and contrasting" what is discovered in the data with theories in the related literature and other research in that field. It is an important part of 'sense making'. Further, it is another kind of audit trail that shows the journey from the initial coding to the established patterns and themes to the theory built from the grounded data. In addition, according to Delamont (2007) the use of the literature is to 'sensitise' the researcher to what is in the data, as part of the process of asking questions about the patterns that emerge which are familiar to the researcher. This

ensures that the researcher is not making ungrounded assumptions and thus misinterpreting the data due to the researcher's biases.

5.6.1 Software used in analysis

Denzin & Lincoln (1994) suggest that researchers who face large amounts of qualitative data require an approach to manage and interpret the data collected. I selected Nvivo, a qualitative software package to analyse the data I had collected. I used Nvivo to ensure that I could illuminate in detail the processes I took in determining the emergence of factors in my research. According to Bazeley (2007), Nvivo is a software package that can help a qualitative researcher to organise and make sense of the data collected. I primarily used Nvivo to: (a) identify parts of data relevant to my research; (b) organise these parts into categories; and (c) describe the relationships between categories. Furthermore, I needed a process to successfully reduce the large amount of qualitative data.

5.7 Coding process - overview of open, axial, and selective coding

This short section provides an overview of the processes of open, axial, and coding processes. The purpose of this section is to provide an overview of the coding process, which will be further elaborated upon in the next section through Nvivo.

To clarify, I used elements from grounded theory to analyse and frame my data. However, I did not use grounded theory per se for my research. Strauss & Corbin (1990) outline three steps in analysing data and they are: (a) open coding; (b) axial coding; and (c) selective coding.

In open coding, all the data sources were read and re-read in detail. Key words and phrases were highlighted to create initial codes, and attached notes were made to explain them in some cases. In the next step, I examined the data

as a whole, among teachers in all four schools, to highlight similarities and differences among participants and schools.

In axial coding, the categories and subcategories were linked at the conceptual and descriptive level, according to Strauss & Corbin (1998). At this stage, I thought about the relationships between categories and properties, and the linkages to the concepts or themes, i.e., categories and sub-categories are reorganised by theme, concept, or relationship.

In selective coding, categories were integrated and refined so that central categories or themes were established. In this stage, I applied my ecological framework as an approach to organise the factors from the data according to the two main themes in my research, i.e., teachers' ICT adoption and their sub-categories, and the adoption of the ICTPD programme and their sub-categories. Through an iterative process, concepts (sub-categories), that were not relevant or pertinent were discarded.

5.7.1 Emergence of factors

In relation to my methodological approaches, I use the term emergence in relation to concepts in 'grounded theory', i.e., the relations between data and theory. I use the phrase 'the emergence of factors' to indicate factors that emerged from data. In my research, I combine the factors that emerged from data and factors which I have predetermined from my literature review and theoretical framework. Kelle (2005) suggests that researchers integrate data and theory if they focus on the micro and macro approaches in qualitative research.

In this following section, I elaborate on the coding process, i.e., open, axial and selective coding, in Nvivo. As such, I discuss the steps to code the primary and secondary data, and explain the emergence of factors from the data, as well as some initial themes or factors from my ecological framework.

5.7.2 Primary Data

In Nvivo⁵⁴ I created a case node⁵⁵ for each participant in the research and linked the data to each case. I coded each participant's data, primarily on the semi-structured interviews, and gave attributes of that case. In this way, I could obtain information important to the participant, for example, the background of the teacher and which school the participant was teaching at.

The interviews were transcribed in the language in which the interview was conducted. The transcribed interviews were formatted in Word according to Nvivo requirements. The interviews were then placed in the *internals* folder (sources) of Nvivo, under semi-structured interviews.

First, I highlighted key passages in the transcripts using Nvivo and excluded digressions, repetitions and other irrelevant discourses. In the next stage, I assigned quotes to categories, which I created in 'open coding', e.g., *lack of time*. A category or code in Nvivo, is an abstract conceptual label, which summarises the key characteristics of a passage. This is a time-consuming stage, which involved sorting through the transcripts and then collecting numerous quotes and examples of each existing code and identifying new ones. Many categories or codes were identified from the first transcript and then progressively there were fewer new codes from each successive transcript, as the quantity of new information decreased. Coding was essentially a subjective process.

The subsequent process involved assigning codes to themes (called nodes), e.g., *barriers*, which was repeated for one transcript by a second, independent person or persons, to check the reproducibility of assigning codes to nodes. I checked the codes and nodes with a PhD candidate and also showed

⁵⁴ Nvivo is based on elements of grounded theory and as such uses cases (with many variables) to illuminate similarities and differences.

⁵⁵ Case node - for each case i.e., participant, there is a case node (unit of analysis). Attributes of each case are also attached to each case and cases were cross-cased according to school (set).

them to my supervisors. This step was necessary to ensure that variance is minimised and there is consistency and credibility.

The final stage, selective coding, involved the identification of a core category or general themes, e.g., *innovation implementation*, from which the theory will arise, by making connections between the categories and defining properties. Categories may have a major or minor status, i.e., tree nodes with child nodes and the linkages may go across these different levels. Deliberately seeking out negative cases, which did not fit the theory, and producing explanations for them may extend this stage. For example, under the node of *barriers* (innovation avoidance), there was a case of a teacher who avoided participating in the KPEC programme. This teacher represented a clear negative case, which provided a comparison to other teachers in the adoption of the ICTPD innovation.

This illustrates the way in which the data analysis method had a clear influence on research findings. There were also difficulties of generalising outside of the context in which the data were collected.

From the semi-structured interviews I read, I created nodes from the emergent themes in the data that reflected my theoretical framework (see Appendix K for an example). These free nodes reflected the main unit of analysis (teachers as dominant species), other units (school heads and the SEO), ICT adoption at three levels (individual - school - external), and KPEC as an innovation. Elements or aspects that were related to the research, such as perceived change, were also made into nodes.

In the first iteration, there were over 100 free nodes. I reduced the number of nodes to 78 and consolidated them under: (a) teacher factors related to individual, school, and external levels, and (b) factors related to the innovation.

I was aware that most semi-structured interviews were in the Malay language and that the coding was done in English. I looked at the narratives at the level of meaning instead of literal translation, taking into account the context of the discourse and how it was said. Further, I was aware that translations into English may not convey the intended meaning. I coded and recoded three transcripts to ensure that my coding of the transcripts were consistent.

5.7.3 Secondary data

The mind maps and factor sheets went through a number of processes. The mind maps were first analysed by counting the main nodes⁵⁶ and minor nodes. I then totaled the nodes to examine the number of factors or issues related to teachers' ICT adoption.

After that, I looked at the two themes related to the mind maps (explained earlier in this chapter), teachers' use of ICT in his or her life, and teachers' use of ICT at work. I created a table and put the key words into the two categories, i.e., divided the data according to life and work. Key words are important as they indicate major ideas, according to Meier (2007). I then proceeded to table the rank order of these key words as teachers had rank ordered the nodes in the mind map after the interview. The rank-ordering of nodes gave me a way to understand teachers' priorities in their adoption of ICT.

Factor sheets were used to elicit factors that influenced teachers' use of ICT and to understand the links between personal and professional factors. For the factor sheets, I analysed the factors from four quadrants and tabulated the factors. The tabulated factors, gave me an understanding of factors affecting teachers across schools. Further, I could group factors together and link them to each participant (case).

⁵⁶ Nodes are ideas or keywords. Primary branches for each major idea linked to the topic are considered as main nodes and secondary branches as minor nodes.

The mind maps and factor sheets were analysed without the use of Nvivo. I found it easier to collate the mind map nodes and factors in the sheet using Word. I used manual calculations on paper to tally according to motivation and ICT use. I cross-referenced these with Nvivo, annotated each case and put the data in a spreadsheet using Excel.

The six observations were linked to their respective post observation interviews. These short interviews were transcribed and coded. I coded or marked the six observations manually and cross-referenced them to my journals for triangulation, as I had written notes if participants had come back and discussed their lessons with me. Observations proved valuable in gauging and understanding teacher practices.

The documentary evidence, categorised under *school data*, and photographs, categorised under *environmental*, were filed under *internal sources* in Nvivo. These two sorts of data, including attributes, were cross-referenced with the semi-structured interviews into sets at school level. This ensured that the data could be aggregated, compared, contrasted, and categorised systematically.

5.7.4 Referencing data

I developed through Nvivo, a set of references for the data as shown in Table 7. The purpose of these references is to ensure that participants remain anonymous in data analysis and discussions.

Table 7. Research data-references

DATA	Refers to:
A/B/C/D	School (e.g., School A)
T	Teacher
H	Head of school
I	Interview
D	Documents including photos
JN	Journal notes
O	Observation
Examples:	
HA:I	School Head A, from interview data
JN:A	Journal notes related to school A
Teacher A8:I or (A8:I)	Teacher is from School A, Participant Number 8, from the interview data
Teacher A8(O) or A8:O	Teacher observation
D: 123456	Documents or photos (digital artifact), reference number 123456 (six-digit number)

I will use the conventions in Table 7 in the following chapters to refer to the data.

5.7.5 The factors according to the ecological framework

Instead of using Nvivo to model the factors I found according to my research questions, i.e., teachers' ICT adoption and the adoption of an ICTPD innovation, I opted to manually draw and illustrate these factors. From the data, I grouped the factors and linked them to the levels to which they belonged, as illustrated in Figure 5.4.

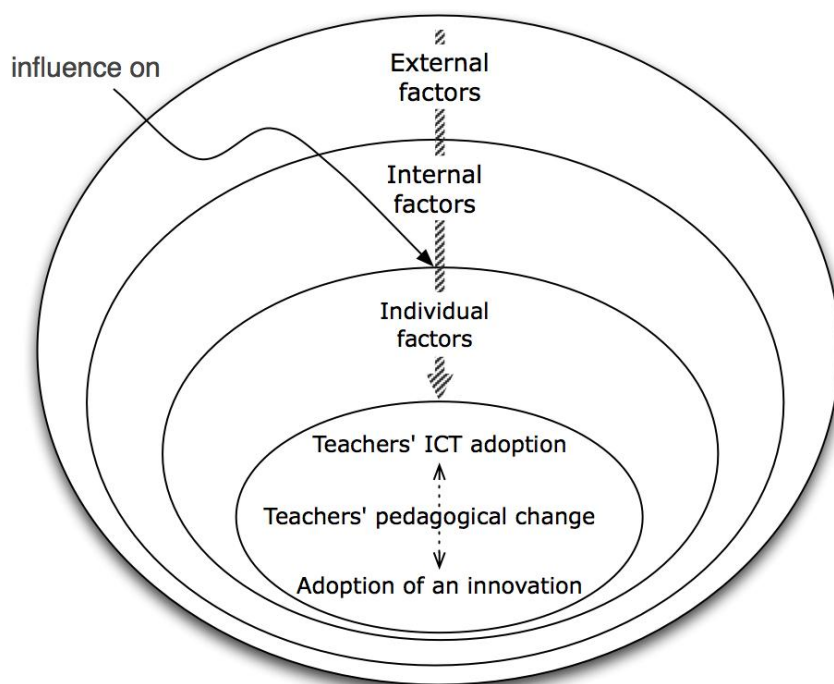


Figure 5.4. External, internal, and individual factors that influence teachers' ICT in teaching and learning and the adoption of an ICTPD innovation.

This linear model became the starting point towards my understanding of the ecological framework, which is based on complexity thinking in my research. It provided a framework in which I could populate the model with factors I had found.

In summary, through Nvivo, I illustrated how the data was analysed using open, axial, and selective coding. The combination of categories from the theoretical framework and the factors that emerged from the data ensured that all themes or factors were examined thoroughly.

5.8 Validity and reliability

Lincoln and Guba (2005; 1985) argue that validity and reliability in qualitative research is based upon trustworthiness. Trustworthiness constitutes four key elements, (1) credibility, the confidence in the 'truth' of the findings, (2) transferability, the findings can be applied in other contexts, (3) dependability,

the findings are consistent and can be repeated, and, (4) confirmability, the degree to which the findings of a research study are created by the participants and not by the researcher's bias, motivation, or interest. According to Guba & Lincoln (2005) credibility and triangulation are essential in a qualitative study if a researcher is to understand the participants and to see whether the information is correct and carries the intended meaning. In my research, I employed various strategies to ensure credibility and plausibility of the data.

According to Lincoln and Guba (1985) and Creswell (1997), to establish credibility, a number of techniques can be applied, namely, prolonged engagement, persistent observation, triangulation, member checks, and negative case analysis. Prolonged engagement relates to adequate time spent for field research; I spent eight weeks to carry out the field research, which was sufficient time for me to understand the social setting and phenomenon of interest. During this time, I talked to a number of participants, developed relationships and trust with the teachers in the schools. The rapport and trust I believe facilitated understanding and co-construction of meaning (also discussed in section 5.9). Through prolonged engagement, I had a range of understandings of the context and the social interactions that occurred between teachers and school heads within schools.

I carried out persistent observation by observing the contextual factors that were essential aspects of my research. It provided me the depth I required to understand and identify the salient factors in the schools related to teachers' adoption, that were relevant to my research. I used a journal to account for these observations. For example, I observed the interactions between the school head and the teachers in the school during assembly.

Triangulation is primarily based on the use of multiple data sources (Creswell & Clark, 2006; Merriam, 2009). I used triangulation to ensure that a rich, broad, robust and well-developed account of the phenomena is gathered. Relying on a single method cannot highlight the detailed intricacies of the study. I interviewed teachers, school heads and other participants related to the innovation. I also used a number of methods to collect my data, ranging from mind-maps to semi-structured interviews. Further, triangulation provided a way to understand valid, consistent and varied construction of realities that emerged from the data, as required by my philosophical stance.

According to Guba & Lincoln (2005), triangulation is necessary in verifying research findings to ensure trustworthiness and alternative explanations. Triangulation in the data was achieved through the methods used in this research. The mind maps and factors sheets served to triangulate the data from the semi-structured interviews. The semi-structured interviews had similar questions (under different themes) to clarify participants' understanding of a certain issue. Documentary evidence, which includes photographs, contributed to further ensure that findings made were credible. In one school for example, the photographic evidence supported teachers' views about the level of ICT commitment teachers received from the school head. Teacher observations captured the complexity and reality of teachers' practices. The observations verified findings and supported explanations, such as teachers' actual pedagogical approaches in relation to their pedagogical beliefs in teaching and learning in ICT.

Another aspect of qualitative research is bias. Bias (discussed in section 5.9) is also recognised in this research to ensure a reflexive process, i.e., as much as possible, the researcher's bias should be minimised in influencing the participants, the data collected, and the analysis of the data. To enhance trustworthiness, I carried out participant confirmation or member checking (Creswell, 2002, p. 196) via email. According to Creswell, member checking

ensures that participants confirm the accuracy of the data (descriptions or themes). In other words, transcripts are sent to the participants for them to comment and amend. Member checks are used to ensure the validity of an account and according to Lincoln and Guba (1985), essential for establishing credibility. Member checks were carried out to provide an opportunity for participants to correct errors, challenge interpretations and give other information that are relevant. However, though an essential process, the participants in my study did not challenge interpretations nor offered additional information; they merely confirmed and agreed with my accounts. I believe that Malaysian teachers were not familiar with this research process.

Confirmability, according to Lincoln and Guba (1985), is also another aspect of the qualitative research process and is related to the credibility of my findings. In my research, confirmability was carried out through documenting the checking and rechecking of the data by discussing my analysis with my supervisors and other PhD students. Further, I actively searched for *negative cases*, which provided a contrast to the other data I gathered. As part of this process and to minimise the researcher's bias, an audit is conducted.

I used peer debriefing as an approach to ensure the credibility and accuracy of an account. Researchers use a cross-checking procedure, by coding data and meeting periodically to discuss emerging findings to enhance the consistency of analyses. Creswell (2002) explains that this is a process in which the researcher locates a person or persons, who reviews and asks questions about the qualitative study (p. 196). Peer debriefing with academic supervisors and two doctoral students (with appropriate knowledge on the research area) was undertaken throughout the research process. This engagement with peers enabled me to analyse, make explicit, and defend findings. Further, peer debriefing provided an approach to discuss alternative interpretations and analysis. Regular discussions with a critical friend (also in doctoral study at Victoria) provided an opportunity to outline, explain, debate, and defend the

research process, interpretations, and constructions. Further, I had discussed my interpretations and analysis with my supervisors to ensure that other understandings and views were incorporated. As a consequence, if consensual validation of interpretations was not achieved, I re-evaluated and considered alternative interpretations and constructions.

The analysis of the negative or deviant case proved significant. There was one teacher (Teacher D11) and one school (School B) that became the two negative cases in my research. These two cases allowed me to compare and contrast patterns and explanations that emerged from my data. Further, these cases allowed me to analyse and refine my explanations of the majority of cases in my research.

A research audit, as earlier mentioned in this chapter, is a necessary part of the process as the chain of evidence is both systematic and accessible (Creswell, 2002). Further audit trails, such as notes or annotations in Nvivo, established a 'train-of-thought' to ensure that, during the research, insights which emerged were explored (see section 5.6).

The next section discusses the researcher's bias and ethics.

5.9 Role of the researcher

In this research, I was aware of the role of the researcher, as I am a technorealist and believe that there are uses for ICT in teaching and learning. However, I believe that ICT is the means to an end in education and not the end in itself. In other words, ICT is framed in the context of school improvement or change, as I have suggested in my literature review chapter. My own construct, as a 'technical expert' in ICT and as the international officer for ICT projects for schools at the MOE offers a unique perspective into understanding teachers' ICT adoption and the adoption of an ICTPD innovation. In sum, I had my own agenda to fulfill.

During the data collection, I was aware of the notions of 'power' and status I brought as a researcher. I did not inform the teachers that I had been an officer from the Malaysian Ministry of Education (MOE), which would carry a certain degree of coercive 'power' and status. I believe that I was perceived to be 'neutral' in terms of power and status during the fieldwork. As such, it was easier for me to negotiate and build trust with the teachers involved. Further, I believe that teachers perceived that I had a strong ethical stance. In each school, I began by 'walking and talking' to teachers around the school and explained to them what I was doing and why. They believed that they would not be penalised in any way in participating in my research. The explanations I gave about their rights outlined in the consent letter and the ethics form proved essential for this trust to occur. Once trust and respect developed, the teachers considered me as an insider, as shown in the data in section 7.6.2.1, where the teachers openly discussed their issues about having foreigners in their schools and the issues they had with their schools.

In collecting the data and its subsequent analysis, I found that my experiences and assumptions were brought to the forefront, as an insider. I was a teacher of English and ICT in a secondary school for four years and understand the routines and power play that occurs in school. I had empathy for the teachers involved in my research. I understood many aspects and limitations put on them in terms of the demands put on them by the school head and other stakeholders in the school. However, this gave me deeper insights into the subtleties of being a teacher in the school environment. In data analysis, I acknowledge that I cannot claim to be completely neutral; I believe outlining my biases in my research I can claim certain a degree of validity.

In summary, I have reflected upon the dualities and the tensions of insider and outsider roles I took upon during my research have subjectively 'define' my understanding of the data and its analysis, which I have discussed in this section.

5.10 Ethics

As a part of ethics, I obtained ethics approval to carry out my research from the University of Victoria research committee (ethics) on 4th August 2008, reference number AARP SEDS/2008/27 (RM number - 15783 - see Appendix M).

Access to the schools and participants was negotiated from the MOE (as the central agency); through the Economic Planning and Research Department (EPRD). Before approaching either department, initial permission was sought from the Prime Ministers' Department (Research Unit of the Economic Planning Unit or EPU). I sent a form and letter with a copy of the proposal to the EPU, and they in turn referred to the MOE in order to approve the research. This additional step is required as this research is from an overseas university and must first be vetted. The approval letter was issued on 29th July 2008, reference number UPE 40/200/19/2314. This process is top-down due to the structure of the bureaucracy and the researcher cannot diverge from it.

The negotiation with the MOE and, thus, the State Education Office (SEDO) (see approval letter - Appendix N) meant, however, that the principals, heads, and teachers involved were co-opted into the research. This was due to the need for the SEDO to inform the schools and send consent letters (see Appendix O). However, participants were able to opt out of participating in the research. Access to documents and other materials was also negotiated with the schools accordingly.

The participants in my research were able to review the transcripts of the interview, as stated in the consent letter. Sixteen teachers wanted the transcripts, which I sent via email; only four replied. These participants did not have any further comments on their respective interviews.

5.11 Summary

The use of the ecological metaphor and framework influenced the design of the methods and the analysis of the data. Elliot & Luke (2008) quoted Kemmis (1980), who aptly stated, "Case study cannot claim authority, it must demonstrate it" (p. 136). In this chapter, I have described the justification for the use of case study in my research, the data I needed to collect according to the theoretical framework I used and the processes I had taken in analysing the data.

As explained and elaborated upon in this chapter, the research process has to be made explicit in order to provide a detailed explanation in relation to: (a) the selection of participants; (b) the data collection methods; (c) the methods and approaches taken in analysis; and (d) how conclusions were made. An extensive appendix is provided as supporting evidence to illustrate the participants, fieldwork approaches and analyses.

In the next chapter, the first set of research findings is reported. Structured under the factors following the ecological framework, i.e., individual, school, and external factors, this chapter reports on the influences of these factors on teachers' ICT adoption in teaching and learning.

6.0 TEACHERS' ICT ADOPTION

In this chapter, I identify the factors that influence the adoption of ICT based on the perceptions of the teachers in the case study schools. The factors were identified in a multilevel perspective, in relation to research question 1 and the two sub-questions:

1. What factors support or hinder teachers in the cluster schools in adopting ICT to support teaching and learning?
 - a. What factors within the schools and outside the schools have influenced teachers' adoption of ICT?
 - b. How have the school context and the teachers' professional background influenced the adoption of ICT?

This chapter is arranged to respond to research question 1 in three parts: (a) teachers' individual factors; (b) school factors; and (c) external factors. This inverse arrangement is aimed at focusing first on the main unit of analysis - the teachers in the research schools.

The factors presented in this chapter are linear; the ecological framework used in this research outlined the three levels of factors according to the research questions. A summary of these linear factors is shown at the end of this chapter. I further discuss the similarities and differences between the findings in this research and previous research.

I will discuss the transition from linear factors (see section 6.7) to complex factors and interrelationships using the ecological-complexity perspective of chapter 8. This discussion will provide a micro (species), meso (ecosystem), and macro (system) level understanding of teachers' ICT adoption through three conditions in complexity thinking which suggest that linear factors and stages of development only partially explain the complexities in adoption.

Before discussing the linear factors in response to research question 1 and its sub-questions, I briefly discuss the four schools involved in my research. The purpose of discussing the four case study schools in this chapter is that the information described is directly relevant to teachers' ICT adoption in teaching and learning.

6.1 The case study schools

My research was carried out in four schools involved in the first KPEC cluster (KPEC cluster No.1). The four schools are designated as School A, B, C and D which follows the school level (primary - secondary) and context (urban - rural) to ensure anonymity. I offer a short summary of the case study schools.

6.1.1 School A (urban primary school)

School A is located in an urban context. It is a primary school located in a suburb and has a population of about 1,100 pupils. It is a public national school and being in an urban environment, there are high expectations of the school as parents are mostly middle-class and well educated. This school has a reputation for academic excellence, as evidenced by its receipt of eight excellence awards between 2007-2008 by the State Education Office (SEDO).

The school also has a reputation (in the state) for being innovative in ICT. It has participated in many ICT projects of its own motivation, without needing to be assigned a programme. For example, the school participated in a national ICT project under MSC and won an APICTA (Asia Pacific ICT Awards) merit award in 2006 for their Self-Access Learning Centre (D: 164060).

According to the school head (HA:I)⁵⁷, the involvement of the community and political affiliations has helped develop this school into a leading ICT school. This school has two computer labs and an access centre (see Sections 2.3.1.1 and

⁵⁷ Refer to section 5.7.4 for all data references.

2.3.1.6 respectively) under the MOE and was building its own media lab from donations. It has two Internet lines, in addition to SchoolNet (see section 2.3.1.4). The management of ICT was important for this school and it had appointed two ICT coordinators and two ICT technicians to ensure that all the computers in the school were being maintained.

6.1.2 School B (rural primary school)

This school, although categorised as rural, is in the outskirts of the main town. This primary school is clustered together, in a small area, with the District Education Office, and the District Teacher Activity Centre, as well as another primary school. Thus, the school actually has access to training facilities, resources, and support at its doorstep.

The school is fairly large, with about 1,100 pupils. It also has residential halls for rural children from the surrounding villages to reside and study at the school.

In terms of ICT infrastructure, there are two computer labs and one access centre. However, there seems to be intermittent problems connecting to the Internet, as it is dependent on SchoolNet.

6.1.3 School C (urban secondary school)

School C is located in town in an urban setting. Rural villages surround this very small town but the school is categorised as an urban secondary school. The school has a population of about 1,200 students. It is the only single-sex school in the area. All other schools are co-educational schools. This school is near two highly prestigious schools - one, a boarding school for elites and the other an old missionary school. School C has had excellent results in the public examinations. It is, however, unable to compete academically with the other two schools mentioned, as both have near perfect exam results.

The school's ICT infrastructure consists of two ICT labs. SchoolNet provides network connectivity. The school had the most detailed documentation on the KPEC project. It is through this school's documents that the implementation of KPEC and its relationships between other agencies are seen through letters, meetings, and plans.

6.1.4 School D (rural secondary school)

In stark contrast to School C, School D is a rural secondary school in a very small village. The school is relatively new, built in 2002 using the 'Baling'⁵⁸ model, which was developed under World Bank funding (Ministry of Education Malaysia, 2006). It has a student population of 1,100 and most of them are from families that are either involved in fishing or manual labour (the rural poor).

In terms of public exam performance, the school has achieved about 60 percent passes in PMR and SPM. The principal recounted to me (HD:I) that rural students are less able and thus do not perform as well as students in towns and cities. However, according to this school head, teachers are continually trying to improve the students' academic performance.

All the facilities and ICT infrastructure are fairly new, if compared to other schools in this research. However, unlike School C, this school has only one computer lab and one access centre. It has three wireless access points throughout the school, which uses the SchoolNet connection.

The school, although constrained by the community that surrounds it, has initiated a plan to obtain recycled computers from businesses around the area. The principal has already secured a number of second-hand computers and will use them to add to existing numbers (HD:I).

⁵⁸ Comprehensive and integrated school building design.

6.2 Teacher demographic data

As an overview, the teachers in these four case schools are of three types: (a) teachers trained in teacher colleges, with Diplomas in Teaching (Dip. T.S), (b) teachers trained in universities with Bachelors of Education (B.Ed), and (c) teachers who have Post-Graduate Certificates Of Education (PGCE). All teachers in secondary schools require a degree to teach, with a minimum of a PGCE.

In this research, there were 44 teachers interviewed, of whom 24 were primary teachers and 20 were secondary teachers. Non-teacher participants included four school heads and one SEO, making the total number of participants 49 altogether. Of the 44 teachers, 21 were diploma holders, 16 had degrees, and 7 were PGCE holders. There were 26 female teachers and 18 male teachers who participated in my research. Figure 6.1 illustrates the breakdown of these teachers' professional backgrounds.

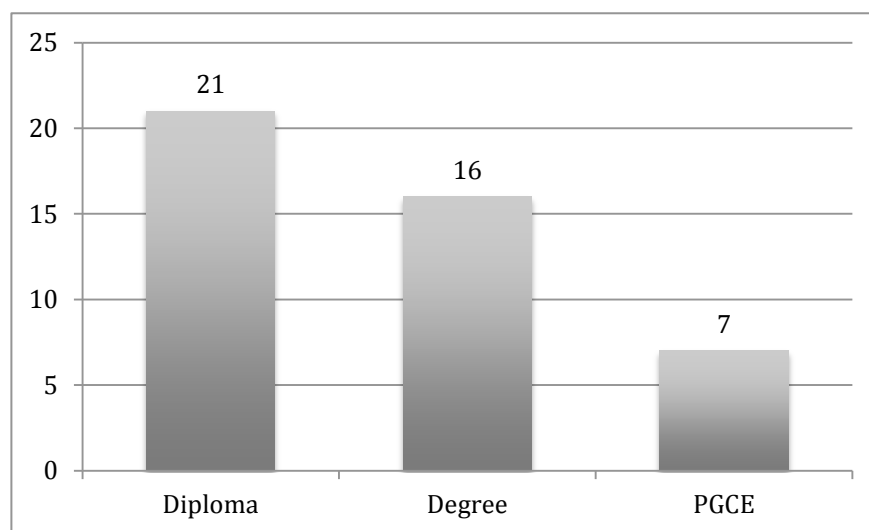


Figure 6.1. Teachers' professional backgrounds.

In terms of teacher placements in either rural or urban schools, 25 of the teachers were in urban schools and 19 were in rural ones. The teachers varied in regards to the subjects they taught. Most were from the core subjects: English (10 teachers), Mathematics (9 teachers), Science (7 teachers), and other subjects (18 teachers). In terms of ICT training, 20 teachers had attended in-service training (INSET) courses, while 24 teachers had learnt ICT in various other ways.

All the professional development data was mined from semi-structured interviews.

All the teachers (n=44) involved in this research had the following features: possessed basic ICT skills; were currently using ICT in their schools (e.g., school administrative work); and had a positive attitude towards ICT.

6.3 Definition of teachers' ICT adoption

In the literature, there are numerous definitions of what ICT adoption entails, such as those offered by Rogers (1995), Sandholtz, Ringstaff, & Dwyer (1992a), and Somekh (2008). In this research, teachers' ICT adoption generally refers to *teachers' ICT adoption in teaching and learning*. I examine how teachers adopt ICT in teaching and learning, and look for changes in teachers' teaching practices (pedagogy).

However, the following section (6.4.1) deals with teachers' initial ICT adoption prior to teaching and learning. From section 6.4.2 onwards I refer to teachers' ICT adoption in teaching and learning unless noted.

6.4 Factors influencing teachers' ICT adoption: individual level

The purpose of this section is to describe the individual factors that influence teachers' adoption in teaching and learning. In the data, I identified three main factors: (a) teachers' personal motivations for adopting ICT; (b) teachers' professional motivations and background; and (c) the influence of their background and professional development on the teachers' confidence in ICT. These three main factors have a number of associated sub-factors, which are also outlined.

The ACOT (1995; 1992b) models used in this research indicate that personal factors and professional factors form the initial influences in teachers' ICT adoption. Wozney, Venkatesh, & Abrami (2006) and Mueller, Wood,

Willoughby, Ross, & Specht (2008) have further shown that there is a relationship between personal and professional factors, such as motivation in teachers' ICT adoption. Thus, I start by discussing these factors and relationships.

6.4.1 Personal Motivations

In terms of personal motivations⁵⁹ for teachers' ICT adoption, the interviews showed that personal characteristics influenced initial adoption, like trying new things, finding new knowledge, and keeping up-to-date with technology:

Researcher:

You mentioned that you were motivated to use ICT and the Internet; what do you use them for?

Teacher:

I really wanted to learn more about ICT. Everyday I bring the laptop and I look for new programs to learn, especially from friends.... I learnt how to use email and also subscribe to the Internet at home. (C4:I)

The *initial* adoption of ICT among the 44 teachers was based primarily on personal motivation and in 12 cases they had learnt ICT on their own, not from formal training. Ten teachers had learnt from friends and two had learnt from family members (spouse), as demonstrated by the following comment: "In terms of ICT, I learnt from my husband because he's my expert consultant." (C4:I). Furthermore, it was evident that 40 teachers had learnt to use ICT early on when they were at school or at university, and not in formal classes but from friends or classmates. They cited the need to adopt ICT for personal reasons due to their own learning needs as students. Their use of ICT was related to learning basic word processing applications such as Microsoft Word, and PowerPoint to type assignments:

⁵⁹ Personal motivations are part of teachers' individual factors, as shown by ACOT (1995) research.

At college I had to learn to use the computer, we couldn't use the typewriter. The diploma course required us to use the computer so I learnt from friends...we helped each other to learn because of our assignments. (A11:I)

Personal learning as a motivation continued to influence these teachers' ICT skills in adopting new technologies and web applications. In my research, 17 teachers had high levels of Internet skills⁶⁰, as shown by their use of the web, email, communication (Skype⁶¹ & Instant Messaging or IM), and social networking (Facebook⁶² & MySpace⁶³) in their lives and work. Among the 17, five cited personal communication as a strong motivator, to connect with friends and family either by using Skype to talk or emails:

I learnt Skype because my husband is away a lot, so we Skype or sometimes chat on Facebook, and even my children join in. (C8:I)

In sum, personal motivations were a contributing factor in teachers' ICT adoption in teaching and learning.

6.4.2 Professional motivations

Professional motivation was also a factor contributing to these teachers' ICT adoption in teaching and learning. Professional motivation as a factor is characterised by the teachers' use of ICT in school, both in administrative work as well as teaching and learning in classrooms.

⁶⁰ According to Norton's (2007) definition, cited in the K-Perak evaluation report. The use of web-enabled or Web 2.0 technologies (see Appendix A - Glossary) are considered to be a higher-level ICT skill.

⁶¹ Skype - free communications software (www.skype.com).

⁶² Facebook - social website (www.facebook.com).

⁶³ MySpace - blogging website (www.myspace.com).

6.4.2.1 Subject driven

Of the 44 teachers in the study, 26 teachers taught English for the Teaching of Mathematics and Science (ETEMS) and 18 teachers taught various other subjects, as Figure 6.2 illustrates.

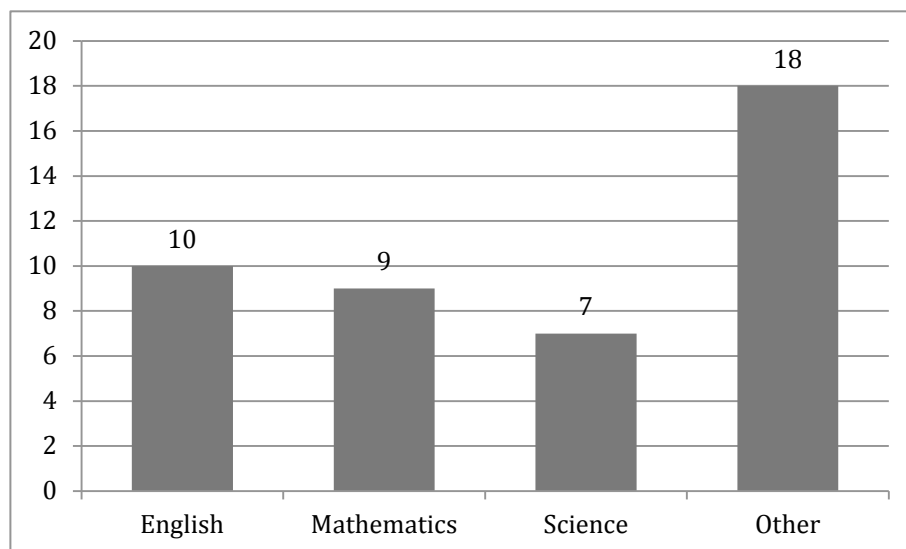


Figure 6.2. The number of teachers according to subject areas.

The 26 ETEMS teachers were professionally motivated to adopt ICT because of the subjects that they were teaching, as this quote illustrates:

I was motivated to teach [Mathematics] using ICT, because I was required to do so. I also did other schoolwork with the laptop. (B3:I)

Teachers under the ETEMS programme were required to teach their subjects using ICT. The data showed that 18 teachers in other subject areas, such as Music, Religious Education, Lifeskills and English for Science and Technology (EST), cited professional motivation as a contributing factor for adoption, as illustrated by this quote: "it is my responsibility, I have to do it [use ICT]. What I do is to improve my teaching in the subject [Lifeskills] even though some people might not think it is important" (C4:I).

6.4.2.2 Work efficiency

Twelve teachers were professionally motivated to adopt ICT due to 'efficiency'. ICT is perceived to help them do work more 'efficiently', and to lighten their burden in doing school administrative work - such as keying in monthly tests or examination marks - as this quote reveals: "filling in marks in school or writing letters is much easier [using ICT] than doing it manually by hand." (C4:I).

6.4.2.3 Self-development

Related to professional motivations was teachers' self-development. Teachers in primary schools have the opportunity to be promoted to a higher salary scale if they acquire a degree, as most primary school teachers are college trained. One route is via distance learning through Open University Malaysia⁶⁴ (OUM). Seven of the primary school teachers from urban and rural schools were engaged in this type of learning. To advance themselves, they had learnt new web-based ICT skills by themselves or from colleagues, as they were required to use the online learning system to participate in courses and submit their assignments, "I had to interact on the online discussions. Then all the resources and information were also online." (A10:I).

6.4.2.4 Communication with others

Apart from these professional motivations, the need to communicate for professional work also emerged from the data. Five teachers cited specific uses of communicative tools⁶⁵ such as Skype, but two teachers in School A had adapted Skype and IM, using them to communicate with their students who would contact them at a certain time after school with questions about homework and other school related work:

⁶⁴ An online distance learning degree for primary teachers, which uses a Learning Management System (LMS).

⁶⁵ Also refers to web enabled technologies that focus on communication and social interaction (e.g., Facebook - www.facebook.com).

If students want to email me or use Yahoo Messenger or Skype, they can install and ask their parents. After school hours, during the evenings, I open Yahoo Messenger and reply to messages if there are any students online at the time. These are Standards 1 to 3 students⁶⁶, no less! (A15:I)

This situation was possible in School A because it is located in a middle-class urban area and, typically, households have computers and the Internet (A15:I). However, these two cases are exceptions. They showed that the need to communicate with students could motivate teachers to adopt new web-based ICTs and use these technologies in their work in school.

6.4.3 Teachers' background

Teachers' background as a factor is traced to the ACOT (1995) model. ACOT researchers suggest that adoption was influenced by the teachers' age and personal experience, along with their professional background, which included their initial professional training.

6.4.3.1 Age and experience

The age of teachers in my research, was on average 36 years old; the youngest teacher was 26, while the oldest teacher was 47. On average, the teachers' experience in school was 10 years; eight teachers had less than four years experience, 26 teachers had 5 to 15 years experience, and 10 teachers had 16 to 25 years experience. Most teachers who had adopted ICT (23 out of the 44) had an average of 10 years teaching experience.

The data showed that older, more experienced teachers, with an average age of 37, had adopted ICT. However, three out of the 10 older teachers, at 40 years of age and above, viewed that some older and more experienced teachers did not want to adopt ICT because they found it difficult and quoted that older

⁶⁶ Students from the age of seven to nine.

teachers, "do not want to do it, they just do not want, too much for them." (B6:I). Directly opposite, one teacher expressed that younger teachers (ages below 30) were as reluctant to adopt ICT, as this quote showed: "Maybe they [younger teachers] have less awareness or motivation [to adopt ICT], for these people, they want everything to be easy" (B7:I).

The data indicates that there was conflicting evidence and therefore age and experience did not emerge to influence teachers' ICT adoption, whereas previous research, such as from Eteokleous (2008), which found that younger teachers with less experience are more likely to adopt ICT, and vice versa.

6.4.3.2 Professional background

Teachers' professional background, in this context, relates to teachers' ICT adoption in relation to their professional training at university or college.

6.4.3.2.1 Starting points for teachers' ICT adoption

The data from teacher interviews showed that 13 teachers adopted ICT during university or college. These teachers learnt from friends, and one quote which exemplified this was, "When I went to college, I learnt ICT from a friend who happened to be an expert who wrote books" (D1:I). However, there were only four teachers who recalled learning ICT formally at college or university because ICT was part of the course or degree, as demonstrated by this quote: "I learnt ICT every semester because my degree was in technology but with education as a minor" (C3:I). Thus, the majority of teachers in this research did not adopt ICT due to a requirement in their diploma or degree at college or university. Instead, these teachers adopted ICT because they perceived it as a necessary skill for studying, i.e., a means to an end.

6.4.3.2.2 Influence of professional training

The professional background of these 13 teachers varied depending on whether they were trained as primary or secondary teachers, as mentioned

earlier in this chapter. Only three participants had ICT related degrees, and only one of these related to education (multimedia in teaching and learning - C3:I). These three participants differed from the other teachers in my research schools. Their professional background had influenced their respective school heads to select them as either ICT coordinators or ICT teachers in their schools.

6.4.3.2.3 Pedagogy and professional training

In terms of pedagogy or teaching practices related to ICT, not one teacher recalled being taught how to use ICT in teaching and learning, even in the one case where the teacher learnt to use multimedia applications in schools (C3:I). This finding is important as it showed that ICT pedagogy was not taught at university or college.

In summary, teachers' professional background as a factor in this research appears to have influenced a very small number of teachers to adopt of ICT.

6.4.3.2.4 In-service training

ACOT researchers (1995) suggest that teachers' participation in professional development courses while working at school has an influence on their adoption of ICT. Professional development in the context of this research refers to in-service training or courses⁶⁷ (INSET) in ICT, which teachers attended while at school. As outlined in chapter 2, ICT training courses in Malaysia are carried out off-site, i.e., outside school, and may take one to 14 weeks, depending on the type of course.

As suggested in the previous section, professional background - either training at university or college - did not influence many teachers to adopt ICT.

⁶⁷ In-service training is a term used in Malaysia, adopted from UK. It refers to national or state initiated training programmes or courses. Training programmes or courses are used interchangeably in this research.

In my research findings, teachers' professional development (PD) emerged as an important factor in teachers' ICT adoption in teaching and learning. For all teachers in this research, their basic ICT skills and motivation to use ICT in teaching were traced to their participation in INSET courses related to ICT. There were two main INSET courses mentioned by the teachers, first, the *Bimbingan Perguruan Professional dalam Teknologi Maklumat dan Komunikasi* (BPPT) training, and second, ETEMS training.

6.4.3.2.5 BPPT

The BPPT programme, a national programme that started in 2004, trained about 100,000 teachers in ICT (Prestariang Technology, 2006). It was a two-week, off-site training programme that taught teachers basic ICT skills, including using the Internet, and a basic approach in using ICT in teaching and learning. However, not all teachers in my research schools had the opportunity to attend the BPPT course, since it ended in 2006. Even though only eight teachers recalled learning about ICT and its use in teaching during this course, it was a significant reference, as other courses were not cited as often as the BPPT course. The importance of the BPPT course and its influence on teachers' ICT adoption is demonstrated by these two quotes:

The BPPT course was for all teachers and it was there I learnt to use ICT and the Internet. (A7:I)

I was in school for three years when I went for the BPPT course. It was a complete course about ICT...The teachers who went for this course started from basic applications like Word, Excel and PowerPoint. It was there I learnt ICT. I also learnt to build a website. I think all teachers went for that basic course. (C3:I)

The eight teachers mostly recounted how they had learnt to use ICT in the classroom from BPPT. However, not one of the eight teachers recalled learning new teaching practices and learning approaches in relation to ICT, despite claims

by Prestariang Technology⁶⁸ to have taught teachers new teaching practices in ICT, according to their BPPT report for the MOE (Prestariang Technology, 2006). In other words, BPPT focused on providing technical aspects of ICT, i.e., taught about ICT use in classrooms, such as the use of applications, rather than pedagogical teaching practices.

6.4.3.2.6 ETEMS

The next type of INSET programme called ETEMS (see section 2.3.1.5), was carried out in 2003 and it was a two to three day training programme for all English, Mathematics and Science teachers in Malaysia. They learnt how to use the laptops they were given, how to set up the LCD projector, and simple troubleshooting procedures. They also learnt how to use the teaching courseware (from the MOE) in their classrooms (Hassan, 2004). Even though 26 of the interviewed teachers were ETEMS teachers, only five teachers recalled the ETEMS training as giving them basic skills in using ICT in their classroom. For these five teachers, the ETEMS course was where they learnt ICT, as this quote illustrates: "I learnt to use the laptop, how to insert the CD courseware, use the Internet and things like that [during the ETEMS course]" (A15:I).

6.4.3.2.7 Others

Other courses or INSET programmes mentioned were the Computers-In-Education course (CIE), by only one teacher, and the Microsoft Teacher Professional (MTP) course, also by one teacher. The teachers' recall of these INSET programmes show that teachers remembered recent INSET programmes that they had attended and that these courses contributed to their ICT confidence (as defined in this context - see section 6.4.4).

It is important to note that in-house training courses, i.e., school initiated ICT courses which are one day events (mentioned by five teachers), seem to have

⁶⁸ PD Provider

been ineffective in terms of influencing further ICT adoption by other teachers in the schools. This teacher's comment is reflective of the five teachers' views in my research: "We did in-house courses, but [it was] not very effective as the attendance was poor." (A5:1). This suggests that school initiated ICT training is less likely to encourage teachers to adopt ICT in teaching and learning.

Overall teachers' involvement in INSET courses contributed towards their adoption of ICT because it provided them with basic ICT skills and an initial understanding about adopting ICT in their classrooms. National initiated courses such as BPPT, are more likely to influence teachers than school initiated ones. This suggests that teachers are used to formal and structured INSET courses.

6.4.4 Teachers' ICT confidence

Apart from professional backgrounds and teacher INSET courses, teachers' ICT confidence was another factor that influenced their adoption of ICT. ICT confidence was mentioned as a factor that increased teachers' use of ICT in the KPEC programme (Norton, 2007, p. 25). The KPEC report stated that ICT confidence was: "Teachers' personal use of ICT and about their use with classes for teaching and learning" (p. 25). Furthermore, the report mentioned ICT capability, in terms of teachers' skills in ICT and curriculum delivery, increased use of ICT in teaching and learning, as well as ICT use in administrative work.

Though there is extensive literature on ICT confidence, its definition varies according to context and the research. In the United Kingdom, discussions on ICT confidence are related to ICT capability⁶⁹. According to Kennewell, Parkinson, & Tanner (2000), ICT capability includes ICT skills, processes and strategies, subject and pedagogical knowledge and self-confidence, and the opportunity to use ICT. Researchers from the United States, such as Kessler &

⁶⁹ In the UK, ICT capability is the term used to describe teachers' capability in ICT (used in their national standards by the British Educational Communications Technology Agency).

Plakans (2008, p. 270) indicate that ICT confidence is related to ICT skills and a positive attitude towards ICT and teaching. Thus, teachers who have confidence use ICT more and in different ways in classrooms. Researchers from the Netherlands differ slightly, such as Drent & Meelissen (2008) and Tondeur, van Braak, & Valcke (2007), who associate positive computer attitudes and beliefs to ICT confidence.

However, in this context, I define teachers' ICT confidence⁷⁰ as a teacher's perception that he or she is able to use ICT effectively in teaching and learning. Thus, a teacher with ICT confidence will demonstrate assuredness in using ICT with better ICT skills, positive experiences, and teaching practices. Teachers' experience in using ICT is partly related; the frequency of ICT use in teaching and learning, and the positive reinforcement they accumulate when ICT is used in teaching and learning, can contribute to ICT confidence. Even if a teacher's current practice in ICT is teacher centred, it nevertheless contributes to their ICT confidence.

Further, it must be noted the teachers who participated in this research were selected from KPEC. These teachers were selected by Innovation New Zealand Education (iNZed) facilitators because they, especially the facilitators and mentors, were perceived to have the ICT skills and the confidence to use ICT in teaching and learning, (see section 5.3.3).

6.4.4.1 ICT confidence and ICT skills

ICT confidence, in this research is partially reflected by the ICT skills that the teachers possess. As teachers' ICT confidence was not measured directly, ICT confidence here is inferred from the available data⁷¹. Twenty-nine (out of 44)

⁷⁰ Based on the Oxford English Dictionary (online at: <http://dictionary.oed.com/>) definition of confidence, which incorporates mental attitude, assurance arising from reliance (on oneself).

⁷¹ Semi-structured interview, in response to: Do you think you are confident in using ICT and in what way?

teachers said that they were confident in using ICT in teaching and learning. They defined their ICT skills in two ways: first, their use of ICT personally, and second, the use of ICT in their classrooms (with students), as demonstrated by the quote below:

I think I'm well versed and confident in using the computer personally. I'm confident because I can help my students create presentations using PowerPoint. (C7:I)

The quote above shows that personal use of ICT can lead to classroom use and thus contribute towards teachers' ICT confidence, as similarly found by Christensen & Knezek (2008). Most of these teachers related their ICT confidence to their knowledge and use of Microsoft Office applications, most often Word and PowerPoint. All 29 teachers also cited the use of web-browsers, email, the LCD projector, and troubleshooting simple problems. These teachers may have identified the use of applications as a demonstrable action of their ICT confidence.

For teachers in my research, their ICT confidence is rooted in their ICT skills and the ability to teach the ICT applications that they use in the classrooms, which corroborated with the KPEC reports. It can be *inferred* from this quote that personal and professional motivations have a role to play in building teachers' ICT skills and confidence: "I use ICT a lot now and quite often too...whether for school to do work or for personal reasons to find things like cooking recipes" (C5:I).

There were minor differences between male and female teachers' conceptions of ICT confidence in relation to the software applications they used. Teachers who participated in this study were mostly female; 26 female teachers as compared to 18 male teachers. Female teachers tended to define ICT confidence by software references and cited web-based applications like Skype, Yahoo Messenger, and Facebook, whilst male teachers referred to applications

such as Authorware⁷² and Hot Potatoes⁷³. This minor difference in software applications show, that *female* teachers tended to refer to *social* or communication type software or applications, and *male* teachers were more inclined towards video and *multimedia* software or applications.

Other subtle differences emerged in gender perceptions of confidence⁷⁴ in ICT. Male teachers⁷⁵ tended to articulate, in their interviews, that they were confident, compared to female teachers who were more conservative with their answers. This finding is similar to research done by Jamieson-Proctor & Finger (2008).

6.4.4.2 ICT confidence and ICT ownership

In building teachers' ICT confidence and skills, ICT ownership is seen as an important indicator, as research from BECTA (2005) and Haydn & Barton (2008) showed. For 25 teachers, ICT ownership made significant contribution to their ICT skills and contributed to their ICT confidence. There were two types of ICT ownership, personal (bought) and professional (given). Twelve teachers had bought their own laptop or computer, while the other 13 were assigned a laptop from school through ETEMS.

In my research, there was a strong link between ICT ownership and its contribution to the ICT skills of the teacher. The impact of ICT ownership is illustrated by one teacher (A4). This teacher learnt to use ICT because she had been given a laptop under ETEMS. She mentioned that she would not have used ICT in her classroom if she had not acquired the necessary ICT skills, i.e., learnt

⁷² Adobe Authorware (<http://www.adobe.com/products/authorware/>) is a visual authoring tool for creating rich-media e-learning applications.

⁷³ Hot Potatoes (<http://hotpot.uvic.ca/index.php>) can create interactive multiple-choice, short-answer, jumbled-sentence, crossword, matching or ordering and gap-fill exercises for use on the World Wide Web.

⁷⁴ The research question: How confident are you with ICT? (Sub-questions - In what way - explain).

⁷⁵ Male teachers were either ICT coordinators in Schools A, C & D, or held ICT support roles in Schools, A, B and C.

how to use Word, PowerPoint, and the Internet (A14:I) as a result of laptop ownership.

There were minor variations in terms of the motivation for ICT ownership. The variation stemmed from the reasons behind acquiring laptops or computers, whether it was motivated by self, related to personal reasons, motivated by work in the school, or related to subject and curriculum requirements. For teachers who were motivated by personal reasons, their ICT skills were more likely to be acquired from learning by themselves or a family member. Once these teachers had the skills, confidence grew and transferred to the school, as explained by this teacher:

I bought the computer and learnt myself. At first I didn't use it much and only when I needed to but after a while, I used it for presentations for work and for the Internet. (B8:I)

Professional motivations coupled with ICT ownership (laptop from school) influenced teachers to learn ICT, because they were required to teach using the school laptop and the teaching courseware. In one particular case, the teacher recounted that she had to use the teaching courseware with the school laptop and learnt ICT from attending the ETEMS course and from colleagues (A14:I). With these teachers, ICT skills and confidence grew from professional motivations.

The next part of the discussion focuses on school-based factors in relation to ICT adoption.

6.5 Factors influencing teachers' adoption of ICT: school level

At this level, teachers' ICT adoption was influenced by three factors: the curriculum or the syllabus (term is used interchangeably in this context), examinations, and the perceived lack of time. Similar to the previous section, related sub-factors are also identified.

The interrelationship between the curriculum, examinations, and time are constant features in Malaysian schools, as mentioned in the KPEC report (Norton, 2007).

6.5.1 Curriculum

The most cited reason that hindered teachers' ICT adoption was the curriculum. Twenty teachers mentioned that the curriculum or syllabus was a factor that determined whether ICT was used in their teaching and learning. For 20 teachers, the requirement to teach according to the specifications in the curriculum was a factor that hindered the adoption of ICT in their classrooms, as similarly found by Norton (2007, p. 111) in the KPEC report. Because the content of the curriculum needed to be delivered and covered within the school year by the teacher, as mandated by MOE policy, 18 teachers felt pressured to teach all topics within the curriculum or syllabus. These teachers viewed that they could move through the curriculum quickly by using traditional 'pen and paper' techniques, as illustrated by these two quotes:

Researcher:

Why do you think you seldom use ICT in your teaching?

Teacher:

Because we need to focus on finishing the syllabus. We have to go through quickly and ensure that all the students understand the topics. (C8:I)

Teacher:

Because we need to concentrate on the syllabus, and then we do more exercise on paper, not on computer. (A5:I)

The pressure to complete all topics in the syllabus was driven by the external assessment of learning, i.e., the public examinations that the educational system is based on. Five teachers also mentioned the curriculum or the syllabus as a factor in relation to the examinations, as shown by this quote:

Researcher:

What do you think the main constraint was?

Teacher:

The main constraint is time because of the syllabus. We have to finish it by the end of the year. We have to finish it before the exams. (B3:I)

As noted by some of the participants, the performance of teachers is measured against the performance of their students in the exams. Teacher B8(I) who taught Mathematics, for example, discussed the pressures from parents' expectations of student performance in examinations and how the school gauged teacher performance against the results. Thus, teachers are more likely to concentrate on the curriculum, as it is linked to examinations and their performance as teachers.

Twenty teachers also cited the lack of time to teach as a reason for not using ICT in teaching. They perceived the use of ICT as inefficient and wasting valuable teaching time, as demonstrated by these two teacher's experiences:

If you go to the classroom you want to set up the LCD projector, it'll take about at least 15 minutes. If one period is only 40 minutes, it takes 15 minutes to set it up, another 15 minutes to tell the students what to do, that's it, not enough time. (D13:I)

I have no time to do this [use ICT in teaching]...I have no time, with the number of periods I have, extra classes and all. (D8:I)

The need to teach to the curriculum, the need to ensure that the students are prepared for public examinations, and the inefficiency of ICT were perceived by teachers to have hindered the use of ICT in teaching.

6.5.1.1 Curriculum space

The curriculum factor also influenced teachers in another way. The curriculum affected ICT adoption because teachers determined whether or not ICT fits according to the topics taught. Thirteen teachers in the case considered curriculum 'fit' or 'space'⁷⁶ before deciding to use ICT. Teachers who used ICT chose to do so when there is a need for it. Teachers used ICT to help them teach a topic that is considered difficult to teach without the use of ICT, as shown by this quote:

I will use a teaching courseware to teach in the class when it comes to certain topics [in Math], when I find it more effective to let the students get a clearer picture especially involving the three-dimensional... (D5:I)

In some subject areas teachers perceived to have spaces within the curriculum for them to use ICT, for example in English, as this quote illustrates:

I use ICT a lot in English. When I do, I tell my students to explore the Internet and go to the English club website, from there, for example, I tell them to use the Starfall activities. There are a lot of activities in English, reading, writing and matching. They enjoy the games, as they can learn from there. They can read. They can make sentences. (A8:I)

The quote above also illustrates that the teachers used ICT if there were resources within their subject that backed up the use of ICT in their teaching. These resources, either from the Internet or software, emerged as essential, as ICT was perceived as a resource for their teaching.

6.5.1.2 Frequency of ICT use in teaching

The frequency of ICT use in teaching indicates teachers' level of ICT integration and ICT confidence. The KPEC evaluation reported that teachers used

⁷⁶ Curriculum space refers to whether a topic or content area and its related activities in the curriculum is suitable for ICT, as suggested by Loveless (2003).

ICT more frequently since they participated in KPEC and used it for problem-solving, information processing, and collaboration (Norton, 2007, p. 6). However, the data from this current research shows that teachers' understanding of ICT use is superficial and their reported frequencies was higher than actual use.

The data shows that frequency of ICT use, as understood by 18 teachers in this research, refers to the number of times that ICT is used, primarily as a teaching aid⁷⁷, as demonstrated by this quote:

You could say I use it [ICT] all the time. I use it as a teaching aid to teach my subject under ETEMS. (C7:I)

The quote shows that this teacher considered her use of ICT as part of their teaching routine as mandated under ETEMS and ICT subject specific policies (e.g., teachers of English, Mathematics or Science subjects have to use ICT at least once a week under ETEMS). Teacher C7 self-reported high use of ICT is related to her use of her laptop to project PowerPoint presentations or the teaching courseware through the LCD projector.

Further, the reported frequency of ICT use by teachers can be misleading, i.e., teachers tended to report higher frequencies than actual use. These 18 teachers initially said they used ICT frequently (as illustrated by Teacher C7 previously) but when probed on how and why they used ICT, the numbers (in terms of frequency) fell. The following quote is indicative of this group of teachers:

Initially

Researcher:

How many times [do you use ICT]?

⁷⁷ A teaching aid is a tool used by teachers.

Teacher (Mathematics):

I use ICT once every two weeks.

Later

Researcher:

How many times [do you use ICT] with your Standard 6 [Examination class] to teach Mathematics for example?

Teacher:

Presentation like that... [PowerPoint or Courseware or Internet Activities]

Researcher:

Yes, presentations, how times a year?

Teacher:

This year, it's the exam year, so maybe 10 times this year.
(B8:l)

Among these 18 teachers, the differences between their initial and subsequent responses on the frequency of ICT use can be traced to their need to cover the curriculum for the examinations. Similar to Teacher C7 in the previous paragraph and with the other teachers in this group, teachers' self-reported 'high' use of ICT reflects their involvement in ETEMS (and KPEC) rather than actual use. Further, this implies that these teachers' use of ICT in their teaching and learning is superficial because ICT is perceived as a tool (e.g., for teaching ETEMS) and not integrated into the lesson.

In summary, it appears that the teachers in this research did not frequently use ICT due to curricular constraints in relation to examinations. Their use of ICT has remained superficial.

6.5.2 Teachers' practice

Teaching practices of the teachers was a factor that influenced the use of ICT in teaching and learning. Sandholtz, Ringstaff, & Dwyer (1992b) suggest that the first order level of ICT use and adoption closely reflect the way teachers previously taught. In terms of the teachers in this research, their knowledge of

teaching came from professional training but, as indicated earlier in this chapter, this did not include knowledge about pedagogy.

6.5.2.1 Current practices

Taking into account professional training and curriculum constraints, teachers assumed a traditional approach to deliver the content of the curriculum within the school year. Thirty teachers viewed 'chalk and talk' as the most efficient approach or teaching practice to deliver the curriculum, as exemplified by this quote:

It's normal, like using the textbook or *chalk and talk* for Math because I need to explain by example. (D5:I)

Even when ICT was used to teach, teachers' approaches mirrored previous or current practices, as shown by this quote:

Previously, we used chalk and talk but now teachers show at the front [PowerPoint slides using the LCD projector] then give some explanations and directions so that the students understand better. (C8:I)

Teachers viewed that ICT use had replaced 'chalk and talk', which they understood as 'traditional', and replaced it by 'PowerPoint and talk', which they viewed as a 'newer' approach. The quote above shows that teachers also perceived that the use of ICT is an improvement.

6.5.2.2 Lack of pedagogical knowledge in ICT

In this research, I asked the teachers to discuss their teaching practices and give examples of the practices they used in integrating ICT. The questions regarding practices were related to the KPEC report, which claimed that teachers' practices had changed due to KPEC (Norton, 2007, p. 24). KPEC chose to facilitate teaching practices that were constructivist in nature, by introducing processes like Reflection-On-Action (p. 20) and ICT challenges (p. 18). Nearly all

the teachers interviewed were unable to offer an explanation of constructivism, except for one, who attempted to explain what constructivism meant, as understood by her:

Researcher:

Just now you talked about constructivism. What do you understand by it?

Teacher:

For myself, I know it is student centred where it is focused on the student, and the teacher as a facilitator, facilitates. For example, I give the students one theme like the human body and they pick one part of the body and then discuss in their groups and find information on that body part. Eyes, for example. Then she will find a picture with functions or parts of the eye. So, she will use a scanner to scan the picture and then she uses Powerpoint to present to the others. If there are five in a group, all five will present different parts of the body. (C9:I)

The explanation above illustrates that this teacher understood constructivism in terms of facilitating student learning. The other 43 teachers, when asked about teaching practices⁷⁸ (and examples of), answered by discussing classroom organisation and the teaching process, as explained by this teacher:

An example of my teaching practices when I used ICT. What I do is I first give an instruction on what they need to do step-by-step [using ICT] and then students will do work in groups. (C5:I)

Teachers' practices were teacher centred and reflected the focus on managing teaching rather than managing learning, as shown by this quote:

Ok, I start with discussing the topic, everyday lives, what students say it is. Then I do induction, I tell a story related

⁷⁸ Researcher first asked about constructivism. If the teacher did not understand what constructivism meant, the question is rephrased to teaching practices in ICT.

to the topic. Then I ask which students are good in ICT and they sit with the less able ones, in groups. I then split the class into two so that it's easier for me to manage my class. (C4:I)

The quotes above exemplified that constructivist approaches were not evident and that there was an absence of pedagogical knowledge in using ICT. Traditional practices were still instructivist with teacher centred approaches: "Approach is the same, chalk and talk is better" (A2:I). Thus, for these teachers, previous 'traditional' teaching approaches were grafted onto ICT. Teacher practices in ICT still followed the behaviourist-empiricist perspective, as suggested by Kirschner, Wubbels, & Brekelmans (2008), where learning occurs by transmission of information.

However, the combination of ICT with traditional approaches was generally perceived by teachers as an 'improvement' over lessons that did not use ICT. For 11 teachers, they believed their teaching practices were 'better' because they replaced the textbook, the exercise book, or some other teaching resource with ICT, as this quote shows:

During induction (lesson), I explain the topic, then they do the exercises...meaning the student will do the exercises from my PowerPoint or Excel. They can answer the exercises straight away and find out the answers straight away. (C1:I)

This teacher viewed the use of ICT as a resource or utility and used it with teaching practices that she had used previously.

To further understand the teaching practices used in the classroom, teacher observations were carried out in all four schools. The observations of four teachers reflected the discourses the 44 teachers had on teaching practices in ICT. One observation stood out as a clear example of the current understanding of teaching practices in ICT. This teacher was teaching Mathematics, in his early thirties, and has a degree from a local university. Highly motivated and confident in ICT, this teacher was assigned to manage two

computer labs in School A. During the observation, this was the approach the teacher had taken, which was similar in all four observations:

The teacher used a web site with questions and answers projected on the whiteboard. The students sat gathered in the centre of the computer lab, away from the computers and answered Math questions when asked by the teacher. The teacher then repeated the process until everyone answered. After that, he handed out a printed exercise (PDF from the website) for students to practice what they had learnt. The class ended with the students handing in their work. (A2:0)

During the post-observation interview, the teacher firmly believed, without hesitation, that he had the 'recipe' (his own term) for teaching Mathematics using ICT. He steadfastly held the view that the lesson was a success and that he had used ICT to teach that Mathematics topic well. He explained that he used his previous experience in teaching Mathematics as a point of reference and that the teaching practice was based on what he had learnt at university.

This observation shows that teachers in these schools perceived that their teaching approaches were appropriate according to their subject and teaching experience. I link these teachers' perceptions to the lack of pedagogical knowledge, which has emerged as an important factor. This indicated that there are gaps in teachers' professional training and is an important consideration for future training, as pointed out by Koehler, Mishra, & Yahya (2007) and Law (2008). Furthermore, Loveless, Devoogd, & Bohlin (2001) argue that appropriate pedagogy in ICT is part of a teachers' professional knowledge repertoire, apart from knowledge on how to teach a subject, i.e., subject pedagogy. In sum, as defined in this research, the lack of pedagogical knowledge stands as a factor that hinders teachers' ICT adoption in teaching and learning.

6.5.3 School leadership

The role of leadership in ICT in these schools emerged as a factor, as indicated by previous research done in this area, such as by Dexter (2008),

Hallinger (2001), Miller et al. (2003) and Riel & Becker (2000). Literature suggests that school leadership affects ICT and change in schools (Fullan, 2000, 2001; J Tondeur et al., 2008). According to Eteokleous (2008), in centralised school systems like Malaysia, the role of the head or principal of the school in supporting ICT is pivotal.

School leadership in these case schools refers to the head⁷⁹ of the school. The school leadership, as a factor, can either support or hinder ICT adoption. The data collected on school leadership was from two perspectives, one from the school heads, through interviews, and the other from the teachers in the schools, also from interviews. Furthermore, I also referred to other data sources such as my journal (informal talks with teachers, deputy heads, and department heads), the interview with the SEO, and documentary evidence (school reports and documents on ICT activities). The SEO succinctly described the role of the school leader in ICT:

If the teacher is interested [in ICT] and is not supported by the head or principal, of course it won't happen. (S:I)

6.5.3.1 Teachers' views of school head support in

ICT

The teachers' views of their school leaders' support in ICT were based on their experiences of ICT adoption in their respective schools. By using Nvivo's matrix coding query⁸⁰, I ascertained that 23 teachers responded positively or negatively in terms of their views of their school head. Teacher responses and teacher numbers⁸¹ are shown in Table 8.

⁷⁹ In Malaysian schools, school heads are divided into two types, principals for secondary schools and heads for primary schools. In this research, I use the term school head to cover both types.

⁸⁰ Cross referenced coded responses (Query): Teachers > Schools > Leadership.

⁸¹ Teacher numbers may not necessarily correspond to responses. One teacher may have more than one response.

Table 8. Teacher responses on school leadership.

School	Positive responses	Negative responses	Teachers
A	5	0	3
B	1	6	4
C	0	8	8
D	3	5	8

Teacher responses on support from school leaders were generally negative. There were 18 teachers, across the four schools, who had negative views. These two quotes are good examples of the negative responses:

The school head doesn't really encourage teachers to use ICT. (C1:I).

Actually, I think it's the school leaders' role to encourage teachers to use ICT. Truthfully, teachers cannot do that, only the head. If the head doesn't see it as important, what do you expect? (B5:I)

The first quote is illustrative of the eight negative responses from teachers who did not receive support from School C's head (similar responses in School B). The smaller numbers of negative responses from Schools D and A show that these school heads supported ICT to some degree, depending on their views of ICT (see section 6.5.3.2). The second quote illustrates that teachers perceived that they needed support from their school heads in ICT; the lack of support implies that ICT is not important in their school.

The data suggests that teachers recognise the importance of school leaders' support *in ICT* and that encouragement of teachers' ICT adoption in teaching and learning needs to be supported by action.

6.5.3.2 School heads' views on ICT support

The interviews with the school leaders were highly important for my research, as it gave a perspective on how ICT was implemented in their schools. In School A, the head clearly supported ICT and encouraged innovations and projects related to ICT. The head proclaimed that her school was a 'cyber-school' and that she led other heads in the district in ICT (HA:I, JN:A). In contrast, School B's head avoided programmes associated with ICT and would concentrate on administrative roles, rather than a leadership one (HB:I, JN:B). School C's head's stance differed markedly as the head was primarily concerned with the status afforded to the head (as senior head) and the school (prestigious single-sex school). The head leveraged on ICT when it suited and built a reputation for supporting projects that benefited the head and the school (HC:I, JN:C). In the case of School D, this head displayed an understanding of the roles that ICT can play in the school and was realistic in terms of what can be carried out with the ICT infrastructure available in the school (HD:I, JN:D).

The difference in terms of commitment from the school leaders can be attributed to their knowledge of ICT. Outside of the interviews, school heads from School A and School D mentioned how they learnt and used ICT to manage their schools (JN:D). School A's head, for example, mentioned that she went for ICT courses to update her knowledge on ICT (JN:D). Further, my observations of Schools A and D offices revealed that these two heads had a computer on their desk and used it for administrative purposes. This observation indicates that these two heads had a basic knowledge of ICT. Conversely, School B and C's heads did not mention their personal or professional use of ICT nor did they have computers in their offices (JN:B & JN:C and interviews).

The lack of ICT knowledge, as demonstrated by the heads of School B and C, shows that school heads need more support in building their knowledge of ICT. Furthermore, not one of the school heads discussed the links between ICT and teaching and learning. Recent research shows that school leadership needed not only a basic knowledge of ICT but a knowledge of instructional leadership in ICT (Dexter, 2008).

The data shows that the role of the school leadership also appeared to have an impact on further ICT adoption in their schools. The lack of encouragement and support from school heads, especially in School B and C, had stagnated teachers' ICT adoption in teaching and learning. For example, teacher B5(I) expressed that the rate of adoption of ICT by teachers in her school had significantly dropped because the school head did not support her teachers' use of ICT. Similarly, teacher C8(I) expressed the same opinion.

It seems, however, the rate of ICT adoption by teachers can be constrained even with the support from the head. In School A, for example, teachers' ICT adoption had reached a plateau (A6:I). The head of School A provided personal one-to-one training for her teachers to encourage them to adopt ICT, " I show the teacher, if the teacher still can't do it, I coach the teacher some more...hopefully the teacher realises that it needs to be done" (HA:I). In spite of her efforts, so far only 18 out of 40 teachers have adopted ICT, according to the school's teacher leader (A5:I). The previous quote illustrates that school leadership also requires support in encouraging teachers' ICT adoption in schools.

6.5.4 ICT infrastructure and support

The research literature suggests that ICT infrastructure and support are key factors in the adoption of ICT (Drent & Meelissen, 2008; Lowther et al., 2008). ICT infrastructure, in this research, covers ICT facilities (availability of computers labs), ICT hardware (computers - desktops and laptops), software (operating systems), networking (wired - Ethernet or wireless - routers), and connectivity (broadband). ICT support is related to how ICT is being supported in schools, and refers to the availability of ICT coordinators and ICT technicians in the schools.

In this research, ICT coordinators are teachers who are appointed by the school heads. ICT coordinators are in charge of computer labs and their

maintenance. Essentially, they determine how well ICT labs are run in a school. Along with ICT coordinators, ICT technicians are lab-based personnel that troubleshoot and help teachers when classes are being carried out.

Before discussing ICT infrastructure and support, I have provided an overview of each school's ICT profile. Table 9 is a summary of the schools involved; it was created from multiple data sources, i.e., from schools documents, observational photos, and journal observations and notes.

Table 9. ICT Profile of Schools.

Table 9 gives a profile of the schools involved and the ICT provision in each school.

Factor	School A	School B	School C	School D
Type	Urban primary	Rural primary	Urban secondary	Rural secondary
ICT labs (no. of computers) / student population	2 (44) / 1,100	2 (44) / 1,100	2 (44) / 1,200	1 (22) / 1,100
No. of access centres* (no. of computers)	2 (24)	1 (12)	1 (12)	1 (12)
ICT coordinator/manager	Yes, 2	Yes, 1	Yes, 1	Yes, 1
ICT technician	Yes, 2	None	Yes, 1**	None
Networking	2 broadband lines & 3 wireless points	1 broadband	1 broadband & 2 wireless points	1 broadband & 2 wireless points
Outside support	Yes, community	None	None	Yes, business

* Access centres (see section 2.3.1.6) ** Untrained technician

6.5.4.1 ICT provision

Overall, teachers voiced concerns about ICT provision, which consists of facilities, support, and access in their schools. Teachers in all four schools linked the impact of this provision to their adoption of ICT⁸² in teaching and learning.

⁸² This data was analysed via the matrix-coding (query) feature in Nvivo, which enables data to be crosschecked in terms of codes, teachers and schools.

This quote shows the impact of ICT provision, in terms of access to ICT labs on teachers' ICT adoption in teaching and learning:

The computer labs are usually fully booked. I try to bring my class into the computer lab as much as I possibly can. Though I do have a set schedule to go into the computer lab, it's not enough. (A7:I)

Forty of the 44 teachers were concerned with *insufficient* ICT provision. The number of teachers who voiced this concern at each school was as follows: School A - 13 teachers; School D - 10 teachers; School B - 9 teachers; and School C - 8 teachers. These two quotes demonstrate the inadequacy of ICT provision felt by the teachers:

Currently no. Not adequate at all. (D12:I)

From a computer facilities perspective, most teachers complain that there is not enough. (C1:I)

Only four teachers viewed their school's ICT facilities and support as being sufficient, as shown by this quote:

Yes, enough. We were given one computer lab with 21 computers and we also have 17 laptops given by the ministry. Then we were given 5 laptops from the state government and some teachers bought their own laptops. (A6:I)

Despite the quote from the teacher above, the prevalent teacher voice affirmed that ICT infrastructure and provision was *insufficient* to cope with teachers and student/pupil needs, as explained by this teacher:

Actually, we have to bring the students into the labs twice a week but we don't have enough computers, we don't go in as much and this impacts on the effectiveness of the ICTL program. (A2:I)

Three teachers in the study defined the inadequacy of ICT provision in terms of the ratio between computers and the number of students in the school, "look at the number of computers...the ratio is far too small, you have over 1,000 students and we have only one lab with 42⁸³ computers, can you imagine. It is our biggest constraint." (D6:I). The quotes above show that the lack of ICT facilities has hindered the adoption of ICT in these schools.

6.5.4.2 ICT coordinator

Research on the implementation of ICT in schools in relation to ICT infrastructure and support has purported the importance of having an ICT manager or coordinator in the school, as suggested by Kennewell et al. (2000). The school ICT coordinator manages the maintenance of computers in the computer labs in these schools. This important role is based on appointment by the school head (Hassan, 2004) and is considered to be an extra responsibility for the teacher, as it does not come with remuneration or status.

Within the four research schools, Schools A and D had ICT coordinators who were committed to the responsibility given to them. They showed me their computer labs and talked about how they managed them, and told me how they would like to have more ICT in these labs (JN:A & JN:D). As mentioned by Tearle (2003), the selection of the ICT coordinator is important in managing ICT infrastructure, as illustrated in School C. The lack of commitment by the ICT coordinator had an impact on the school's computer labs. The ICT coordinator refused to be interviewed and it was only when I was shown the computer lab by another teacher that the coordinator informally talked to me about issues concerning the maintenance of the computers (JN:C). Photographic evidence showed that the computers in School C's labs were in a state of disarray (D:064568 - see Appendix P). The issues School C's coordinator was concerned with were primarily focused on obsolete computers and their upkeep. The state

⁸³ Teacher D6 did not accurately quote the actual number of computers in School D (as per Table 9).

facilitator from School C (C8:I), who had brought me to the lab, later questioned the selection of the ICT coordinator. Teacher C8 and C6 pointed out that the previous ICT coordinator (Teacher C1) had done a good job of maintaining the two labs. This reinforced Tearle's argument that the appointment of the ICT coordinator must be made carefully so as not to jeopardise the schools' ICT facilities.

6.5.4.3 ICT maintenance

The issue of maintenance raised by School C's ICT coordinator was warranted. The lack of useable computers in the computer labs was an on-going issue in all four schools. Twenty-five teachers expressed the issue. As one teacher said:

In the computer labs, I believe if there're 40 computers, you'll be lucky to get 20 of them working properly. In this school, there's Lab A and Lab B, one has 20 (Lab B), if I bring students in, check the computers, nearly all can't be used, all of them not working. The other lab (Lab A), as I said, only half of them can be used. From the hardware perspective, from the maintenance perspective, there are real problems. (C4:I)

The heads and principals of these schools recognised that the maintenance of computers was an on-going problem: "when the computers break down... we get them back worse than when we sent them for repairs." (HD:I). In the four schools the availability of computers had hindered teachers' use of ICT.

The number of working computers and other ICT equipment in the labs further influenced teachers' use of ICT in all four schools. Fourteen teachers in all four schools had issues with the state of ICT equipment in the labs, such as the lack of working computers and network availability problems. A teacher recounted her experience: "I got really frustrated. I went in the lab with high expectations, with the students and all ready, and then problems with the computers, many of them had broken-down" (C2:I). She further stated the

problems with the network: "We wanted to search for information and went on to the Internet but our school network was down, it's often down" (C2:I). These issues affected teachers' views on the usefulness of using ICT to teach their subjects: "Every time I want to use ICT, when the computers aren't working, I feel as if it's not worth the time and effort" (B4:I). The issue of working computers, related to ICT maintenance, emerged as an issue in all four schools (to a lesser extent in School A - due to better maintenance - explained in the next section). Teachers considered the condition and availability of (working) computers in their schools before using ICT for their teaching.

6.5.4.4 ICT support

Another facet of ICT infrastructure was ICT support for teachers. ICT support, in this context, relates to the support teachers receive from the ICT technicians when they encounter problems in the computer labs. The data in Table 9 (earlier in this chapter) shows that School A has the best support in ICT by providing two ICT technicians in the school. Six teachers in School A had mentioned the support from the technicians in their interviews: "now we have the ICT technicians, if there are problems, they will repair them, teachers don't know how to do that." (A11:I). The lesser support received by six teachers in Schools B, C and D appears to have hindered the use of ICT, as this teacher explained: "When I use the computers in the lab, a few computers may not work and I have to call the ICT technician. We only have one and I have to wait for the technician to come. This disrupts my lesson." (D2:I).

Furthermore, in School D, the ICT technician was not trained to troubleshoot ICT problems and help teachers with ICT during class, which compounded the issue according to the school head (HD:I).

6.5.4.5 Access to computer labs

The prioritisation of subjects in relation to access to computer labs was another school factor that influenced the use of ICT by the teachers. Schools in

Malaysia are required by the MOE to prioritise certain subjects in the curriculum in relation to ICT. These are categorised into two types of subjects: ICT based subjects, such as ICT Literacy (ICTL), or subjects that have ICT components (curriculum integration) built into them, such as English, Mathematics, and Science (ETEMS). Other subjects, such as Religious Education, do not have any ICT components and as such are not prioritised. Subject prioritisation affected 18 teachers because it limits teachers' access to computer labs; the schools' schedule for the use of the ICT lab is laid out over the year according to subjects, as demonstrated by this quote:

Teachers have to book the ICT lab before going in because the ICT labs have their own special subjects like computer literacy (ICTL), which has a set timetable and period. So for us, if we want to bring the students in, we have to book.
(C8:1)

Nine subject-prioritised teachers recognised the problems of access by other teachers in the school, "Other classes fight to get into the lab, other subjects that don't really use ICT but want to integrate ICT" (B4:1). This created tensions between subject teachers, especially with those who were motivated to use ICT. One teacher said: "Actually, Religious Education and National Language [*Bahasa Melayu*] teachers want to go in the labs too" (B2:1)." This suggests that other teachers, teaching non-prioritised subjects, have limited access to computer labs even though they are motivated to use ICT.

In so far as school factors are concerned, I have shown that ICT infrastructure and support have influenced teachers' ICT adoption in teaching and learning. ICT maintenance and the role of the ICT coordinator, in addition to ICT access and subject prioritisation, have either helped or hindered teachers' use of ICT in teaching and learning.

6.6 Factors influencing teachers' adoption of ICT: external level

The external factors that influenced the teachers' adoption of ICT in their schools were the school's wider community, i.e., context and the MOE policies. In terms of the data on external factors, the number of responses from teachers was

smaller, with only seven responses. I attribute the smaller numbers to: (a) the 'distance'⁸⁴ between the teacher and these external influences, and (b) the open-ended question⁸⁵ used to elicit factors in the interview. These factors indirectly influence teachers' adoption, as they exist outside of the school.

6.6.1 Context: community involvement and socio-economic status

For four teachers, the school community had an indirect influence on how they used ICT in relation to their school. The community factor was viewed in two different ways - (a) community involvement in ICT, and (b) the social context of the community, i.e., the socio-economic status (SES) of the community. The first community factor affected two teachers. One stated that their school had close support of the parents in terms of acquiring political and financial support (A12:I), and the other viewed that the community involvement was detrimental to ICT as parents sought academic performance over anything else (B2:I).

The lower SES of the wider community, on the other hand, appeared to have hindered teachers' use of ICT. Three teachers, one from School B (B5:I), one from School C (C8:I), and one from School D (D2:I), mentioned that the social background or SES of the students affected the use of ICT in their school. These teachers stated that ICT was only used with classes which had students of higher social background. The students and classes with lower SES were viewed as an issue for these teachers, as they perceived that these students were less able to cope with, or did not have enough knowledge to use ICT. These teachers' views

⁸⁴ The teacher is an individual who belongs to the school (ecosystem) and is less influenced by external (exosystem & macrosystem) factors. There is a distance between the teacher and these external influences. Tearle (2003) uses a similar term to describe the influence of factors in her model. Not to be confused with the concept of distance (complexity) in section 4.6.5.

⁸⁵ There were three separate questions - individual, school, and others (or repeat questions depending on the participant's answers). This question: What other factors do you think influenced your use of ICT?

reflected recent research by Vekiri (2009), who found that students from low-SES families appeared to have less confidence in their ICT skills.

6.6.2 Policy

There were two policy influences: first, policy prioritisation of certain ICT or subjects, and second, the uneven implementation of policies in ICT.

6.6.2.1 Priority

The MOE policies in ICT, as a factor in the context of these schools, had an effect on the teachers' ICT adoption in teaching and learning. The priorities given to certain ICT programmes can influence teachers and schools; policies can influence teachers' access to ICT labs (see section 6.5.4.5), for example.

An analysis of the MOE documents related to ETEMS (e.g., KP(BS)8591/Jld.XVIII(11)-BIL 11/2002) identified that priority had to be given by school heads to ETEMS teachers and their subjects. Similarly, other policy documents emphasised their programme needs according to the time they were implemented, for example, the CIE policy (e.g., KP(BS) 8601/01/0400/Jld.II(91) - BIL 2/1992) in 1992 and the ICTL (e.g., KP(BS/HEP) 8691/Jld. XVII - BIL 10/2004) in 2004. The prioritisation of certain policies is dependent on the importance of the programme; ETEMS is subjected to national performance reviews and reports, and thus remained the most important ICT programme during the research. ICTL is not as important as ETEMS in these schools, as it affects only a few teachers teaching the subject.

Overall, policy is an overarching factor that can either encourage or discourage teachers' ICT adoption in teaching and learning; in this research it tended to discourage adoption.

6.6.2.2 Implementation

Though Mae (2004) implied that Smart School policies (2000) were the overarching ICT policy for Malaysia, this was not enacted by the MOE as Smart Schools were later re-conceptualised as the Smartising of Schools (TSS) in 2006. The Smartising of Schools (implemented during 2005-2006) provided *access centres* to the schools in my research, so that students could use ICT during and after school hours (as part of policy).

I refer to journal notes and photos of the four schools, as well as interview data to discuss how TSS policy⁸⁶ (implementation) can affect teachers' and students' access to ICT. School B's access centre and the computers in it were not used often (see D:294298-300 in Appendix Q). Three teachers (not teaching ICT related subjects) from School B (B1:I, B6:I & B9:I) mentioned that they used the access centre but overall other teachers did not. Since there was no ICT coordinator (see section 6.5.4.2) assigned to the access centre in School B, the room was not available for students' use (as intended by policy) after school hours. Only teacher B1(I) frequented the access centre to teach his subject, Religious Education.

In School D, teachers used the access centre to teach ICT when the computer labs were unavailable. Similar to School B, the access centre in School D was used by teachers of other subjects, not teaching ICTL or ETEMS subjects (D4:I & D6:I). In contrast, the access centre in School A was open for pupils and teachers and used constantly (JN:A).

The inconsistent policy implementation of TSS, as evident in the research schools, illustrates that policy can influence teachers' ICT adoption; its priorities and implementation at school level can either encourage or discourage teachers. Though uneven policy implementation is highlighted, this does not imply that better implementation of policy would result in higher ICT adoption.

⁸⁶ This policy is implemented via the access centre policy documents - *Panduan Pusat Akses (Bahagian Teknologi Pendidikan)*.

The next section summarises the factors that emerged from the data, as discussed earlier.

6.7 Summary of linear factors in teachers' ICT adoption in teaching and learning

From the data, I aggregate the factors and link them to the levels to which they belong. In the theoretical framework chapter, I illustrate a simple or linear model of teachers' ICT adoption. I populate the model with factors that emerged from the data. Figure 6.3 illustrates the links between the factors at different levels that influence teachers' ICT adoption.

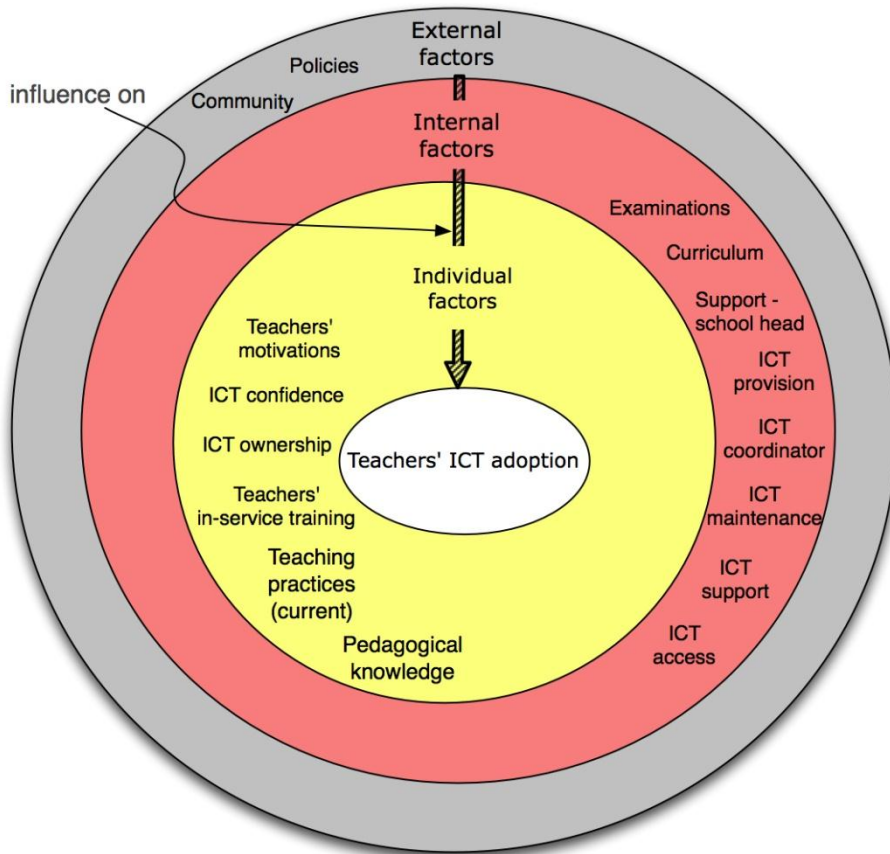


Figure 6.3. External, internal, and individual factors that influence teachers' ICT adoption.

Teachers' ICT adoption is *influenced* (as the arrow in the middle of Figure 6.3 indicates) by a complex interrelation of factors at the external (outside school), internal (school), and individual (teacher) levels.

Figure 6.3 is based on data in this chapter, which indicated that in this research many factors influenced teachers' ICT adoption in teaching and learning. Briefly, the individual factors discussed in this chapter were the teachers' personal and professional motivations, their professional development (in-service), and their ICT confidence. Further, other related factors influenced teachers' individual adoption of ICT. Pedagogical knowledge and teaching practices, which were linked to teacher training and professional development, had an impact on teachers' ICT adoption in teaching and learning. The internal factors were connected with the school as an organisation and covered the influence of the curriculum, the role of the school leadership, the state of the school's ICT infrastructure, and support for teachers. The external factors covered influences outside the school (policies from the MOE), the context of the wider community (support), and social-economic status of the school's immediate community (related to student population).

6.7.1 Individual teacher factors

The teachers' current practices and their lack of pedagogical knowledge have been identified as influencing factors in this research, at the individual level. Mueller, Wood, Willoughby, Ross, & Specht (2008) suggestion that teaching practices are based on vicarious learnt experiences were accurately portrayed by the teachers in this research. Teachers were similarly found to base teaching practices on their own experiences and those around them in the school. The teachers' practices found in this research reflect those in a Korean study by Baek et al. (2008). These researchers identified teachers' practices in ICT as 'shallow', in which the teachers focused primarily on their teaching or instruction rather than student learning.

The lack of pedagogical knowledge is suggested to be a factor that hindered teachers' ICT adoption in teaching and learning. Schibeci et al. (2008) argue that appropriate pedagogical knowledge, i.e., teaching practices in integrating ICT, is difficult and challenging. This factor was traced back to the teachers' professional training at teacher's college or university. The data implies that teachers' initial knowledge in teaching did not include a range of pedagogical approaches, instead focusing on the mechanics of teaching, i.e., the structure of the lesson and its objectives according to the curriculum.

ICT confidence and ICT frequency were influencing factors in the adoption of ICT in teaching and learning in this study. This research has also found that more experienced teachers are equally able, as compared to younger teachers, to adopt ICT in teaching and learning. That has been similarly found by research carried out by Mueller et al. (2008). At the individual level, it is found that teachers' personal use of ICT influenced their ICT adoption in teaching and learning. Further, this research found that as teachers' experience using ICT in teaching and learning increases, the more it influences teachers to use ICT in class, as similarly found Christensen & Knezek (2008). This research echoed Windschitl & Sahl (2002), and BECTA (2005) research, which pointed out that ICT ownership (by teachers) is an influential factor in getting teachers to adopt ICT in teaching and learning.

At the individual level, teachers' motivation (personal and professional), teachers' training (in-service), ICT confidence, and ICT ownership supported teachers' ICT adoption. Factors such as teachers' practices and their lack of pedagogical knowledge hindered their adoption in teaching and learning. Other factors that may have supported or hindered teachers' ICT adoption occurred at the school level.

6.7.2 School factors

Two factors hindered teachers' ICT adoption at school level. The examinations and the curriculum limited teachers' ICT adoption in teaching and

learning due to a need for teachers to ensure students perform in examinations (within the curriculum). The lack of time within school hours and the 'extra' burden perceived in using ICT in teaching and learning was related to these two factors.

Research literature also points out that inadequate ICT provision, i.e., poor infrastructure and related factors, still remain a hindrance in ICT adoption, as found by numerous studies (BECTA, 2005; Granger, Morbey, Lotherington, Owston, & Wideman, 2002; Mumtaz, 2000; Yong Zhao & Frank, 2003). The findings suggest that, in this research, the poor standard of ICT provision was a factor that hindered ICT adoption. There were two related factors associated with ICT provision. Access to computer labs and the maintenance of computer labs consequently hindered teachers' use of ICT for teaching and learning.

Factors related to ICT provision are thus likely to be highly relevant in developing countries where ICT provision is centralised and its development is dependent on an external organisation. Findings on ICT provision suggest that the MOE's role is instrumental in teachers' ICT adoption in centralised education systems, as also found by Eteokleous (2008).

Another key finding in this research is support from the school head, which can enable or hinder teachers' ICT adoption. School head decisions, interpretations of policy, and implementation of ICT influenced how teachers perceived the relative importance of ICT in teaching and learning in their schools. Further, school head selection of ICT coordinators became an important factor, as they provide support for teachers and maintained the computer labs.

In summary, school level factors emerged to be the most important. The findings suggest that several factors at this level can either support or hinder teachers' ICT adoption in teaching and learning.

6.7.3 External factors

At the external level, two factors hindered teachers' ICT adoption in schools. The uneven implementation of ICT related policies from the MOE hindered teachers' ICT adoption, due to the variations in interpretations of policy by school heads. The lack of participation from the community (related to ICT) is suggested to hinder teachers' ICT adoption. Without community support in ICT, schools are limited by the available ICT provision provided by the MOE and are unable to develop ICT further.

Baek et al. (2008) found factors in the Korean context that were similar to the ones found in this case study. According to Baek et al., the most important finding was that teachers adopted ICT in their teaching because of internal and external 'requests' (policy and directives in this case study context). In this study, teachers were influenced according to the policy enacted upon them. The ETEMS policy, though superficial, influenced some teachers to adopt ICT in teaching and learning. Other teachers, not teaching ETEMS, found that this policy limited their access to computer labs and other facilities. This is similar to teachers in the Korean case study who used ICT in teaching because of ICT based policies, which mandated them to teach using ICT⁸⁷.

Factors at the external level do have an influence on teachers' ICT adoption in teaching and learning. This study suggests that policies in ICT, as well as other policies related to examinations and curriculum (discussed at school level), have a pervasive influence on teachers and schools.

As discussed in chapter 1, previous research related to teachers' adoption of ICT in Malaysia has commonly presented a 'laundry list' of factors that do not link the factors affecting adoption at different levels (Afshari, Bakar, Luan, Samah, & Fooi, 2009; Melor, 2007). The justification for using the ecological

⁸⁷ The Korean Ministry of Education mandates Korean ICT policies, which are based on advisories from KERIS (Korean Educational Research Institute).

framework was not only to gather factors but to also show that there are conditions that influence these factors.

The next chapter discusses the influence of the ICTPD programme, i.e., KPEC influence on teachers' ICT confidence and pedagogical change. Further, it looks at the factors that influence the adoption of the ICTPD programme.

7.0 ADOPTION OF AN ICT PROFESSIONAL DEVELOPMENT INNOVATION

In this chapter, I identify the influence of the K-Perak E-learning Cluster (KPEC) ICT professional development (ICTPD) programme as an innovation on teachers' ICT confidence and pedagogical change in the context of this research. To reiterate, the *adoption* of the ICTPD innovation is the focus in this chapter, instead of the transfer of an innovation, based on reasons outlined earlier in section 3.4.4. Furthermore, as discussed in section 1.2 (dual lenses in adoption), KPEC is viewed as a separate innovation, independent from the adoption of ICT in teaching and learning, as aspects of the ICTPD were new to the Malaysian context, e.g., the clustering of schools. Moreover, I also look at the factors that influence the adoption of the ICTPD in terms of the ICTPD's implementation and content. There are three sub-questions (SQs) that relate to research question 2:

2. How has KPEC as an ICTPD innovation influenced teachers' ICT confidence and pedagogical change?
 - a. What has been the impact of the ICTPD innovation, i.e., KPEC, on teachers' ICT confidence and pedagogical change?
 - b. How has teachers' pedagogy changed as a result of their participation in the ICTPD programme, i.e., KPEC?
 - c. What factors influenced the adoption of KPEC as an ICTPD innovation in terms of the adoption of the cluster model and the in-school facilitation process?

Research question 2 (RQ2) seeks to understand how the ICTPD innovation influenced teachers' ICT confidence and their subsequent pedagogical change. Teachers' ICT progression, a term used in *Apple Classrooms of Tomorrow* (1995) or ACOT (see section 4.5 - *ACOT five-stage model of teacher progression*) is used to gauge teachers' ICT confidence and pedagogical change.

RQ2 also looks at factors that influenced teachers' decisions in the *adoption of the ICTPD programme*. More importantly, RQ2 seeks to understand change, if any, in the teaching practices of teachers who participated in the ICTPD innovation. In short, RQ2 deals with adoption and change.

In this chapter, references to *KPEC* cover both *KPEC I* and *KPEC II* unless *differentiated*.

7.1 Structure of the data analysis

To understand how the ICTPD programme influenced teachers' ICT progression in terms of their ICT confidence and pedagogical change, I have structured this section into three main parts: (a) the contextual features of the KPEC innovation (related to SQ 2a); (b) the teachers' ICT confidence and pedagogical change in relation to teachers' participation in KPEC (related to SQ 2b); and (c) the factors that influenced the adoption of KPEC (related to SQ 2c).

I first discuss the contextual features of the ICTPD programme, the development of the ICTPD programme from the initial KPEC I programme to the current KPEC II programme, and show the similarities and differences of the two programmes. Further, I contextualise the time in which the research was carried out to provide an understanding of what has developed.

Then, I discuss the impact the ICTPD programme had on ICT confidence and teaching practices, and gauge the progression of ICT adoption by the teachers through their use of ICT in teaching and learning, using the ACOT's (1995) five-stage model of teacher progression. As mentioned earlier, this is a snapshot of the progression of the teachers' ICT confidence and teaching practices, and not a comparative measure of where teachers were in KPEC I in 2007 and where they have progressed to in KPEC II. This research was carried out 18 months after the initial KPEC ICTPD programme.

In the third part of this chapter, I trace the linear factors that influence the adoption of the ICTPD programme in the research schools in a multilevel way. Similar to the previous chapter, these factors and influences are placed within the ecological framework and do not yet illustrate the complexities in the adoption of this ICTPD programme.

At the end of this chapter, I reflect briefly on the linear factors from teachers' ICT adoption from chapter 6 and the adoption of the ICTPD programme in this chapter. I discuss how these two types of adoption may be elaborated upon in the ecological-complexity framework, which sheds light on the complexities, dynamics, and degrees of adoption.

7.2 ICT confidence and pedagogical change

As mentioned in section 6.4.4, teachers' ICT confidence relates to a teacher's perception that he or she is able to use ICT effectively in teaching and learning. A teacher with ICT confidence will demonstrate assuredness in using ICT, with better ICT skills, positive experiences, and teaching practices. Even though a teacher's current practice in ICT may be teacher centred, it nevertheless contributes to their ICT confidence.

As Kennewell, Parkinson, & Tanner (2000) suggest, teacher practices are often based on the subject they are teaching, which may not be suitable for ICT. The most appropriate teaching practice in ICT, as argued by Orlando (2009) and Somekh (2008), should be constructivist, i.e., learner centred instruction. In my research, pedagogical change is focused on the change from teacher centred instruction with or without ICT, to learner centred instruction in using ICT when looking at changes in, for example, teachers' organisation of learning in their classrooms with ICT use. Further, I recognise that changes in teachers' practices may also be dependent on social and cultural contexts, processes, and relationships, as Orlando suggests.

In this research, teachers' progression in ICT is related to increased ICT confidence and change in teaching practice, and is framed on the ACOT (1995) models discussed in chapter 4, where the teachers' integration of ICT is described in stages and incorporates changes in teachers' pedagogy in using technology. The ACOT models indicate that teachers' progress follows a predetermined path of change in terms of ICT confidence and teaching practices.

I justified the use of the ACOT models in my theoretical framework in chapter 4 and also addressed the limitations of the models in terms of gauging teachers' progression in a sequence of stages in a continuum. In this chapter, I use the five-stage ACOT model of teacher progression because it provides a useful means of measuring teachers' progression in relation to their ICT skills and pedagogical change. In contrast, the first ACOT model, i.e., the three-stage development model, is too general in its description of teachers' development. In the K-Perak E-learning Cluster (KPEC), Innovation New Zealand Education (iNZed) used the ICT Challenge Assessment Rubric (ICAR), a four-stage model of teacher development in ICT. I did not use ICAR for my data analysis, though comparable to ACOT's five-stage model, as the rubrics or descriptors in this model were too dependent on ICT challenges as a way to gauge teachers' ICT progression. ICT challenges in KPEC required teachers to fill a planning template with the help of a facilitator in order to design and plan a challenge for integration of a particular ICT skill or task within the existing curriculum. The ICAR model is discussed later in this chapter in relation to KPEC's report, as a basis to understand the impact of the innovation on teachers' pedagogical change.

The next part of this chapter traces the development of KPEC and situates the data collected in the research.

7.3 The differences between KPEC I & II

7.3.1 Research timelines

As explained earlier in chapter 5, the data for this research was collected in October 2008. In chapter 2, I discussed how KPEC started in May 2007 and ended in 2010 (see section 2.6).

KPEC I was initiated by iNZed, which continued on as KPEC II and was managed by K-Perak Incorporated (KPI) and the Perak State Education Office (SEDO). The later dubbed KPEC II (term from documents-D:294325) started on 14th February 2008, according to official documents from the SEDO (D:64643-64666) after a proposal was made to continue with the project, as a locally initiated ICTPD modeled after KPEC I.

The teachers involved in the research included teachers from KPEC I and KPEC II in 2008. K-Perak Incorporated, which originally funded iNZed to train the teachers in the cluster, continued to support the teachers and schools in the 'spin-off' KPEC II.

In the perspective of the teachers involved in KPEC, there is no clear distinctions between KPEC I and II. Teachers considered KPEC as a single innovation, KPEC I being the starting point for the ICTPD programme and KPEC II as the follow-on programme. Teachers, such as Teacher C4 and D7, viewed and understood KPEC as single continuous professional development programme. The basic components of the KPEC I ICTPD programme, i.e., the facilitation process (e.g., coaching and mentoring), the in-school PD and 'loose' affiliation of the cluster (schools) continued in KPEC II.

To clarify, the teachers who participated in the research had participated in one or both KPEC programmes. Of the 44 teachers, 15 were involved in KPEC I and 29 were involved in KPEC II. Fourteen of the 15 teachers involved in KPEC I were also involved in KPEC II, because these teachers were either state facilitators, school facilitators, or teacher mentors who continued to play these

roles in KPEC II. One teacher who was originally involved in KPEC I dropped out of the project mid-way and did not participate further.

7.3.2 KPEC - overall differences

The purpose of discussing the differences between KPEC I and II is to provide an understanding on how the innovation evolved from KPEC I to KPEC II. KPEC I was a cluster based ICTPD programme that was carried out in a 10-week period, as detailed earlier in chapter 2. Innovation New Zealand Education, the providers of the ICTPD programme, based the implementation of KPEC on New Zealand's ICTPD model. The main argument for the training programme is that it was: (a) cluster based; and (b) implemented in-school by facilitators and mentors who share learning experiences among the KPEC schools. These two characteristics differentiated KPEC I from all other ICTPDs carried out in Malaysia.

There were a number of features that distinguished KPEC I from KPEC II. I explain briefly the differences in terms of the features (of the project), teacher roles and selection, and the objectives, activities and training in KPEC II. The KPEC II programme did not have documentation that detailed the changes from KPEC I. Thus, the differences are constructed from documentary evidence and teacher interviews.

The proposal for the continuance of KPEC was based on a number of features in KPEC I, such as mentoring and coaching. However, in spite of basing KPEC II on features of KPEC I, what emerged from the data was significantly different, as shown in Table 10.

Table 10. KPEC ICTPD programme implementation differences.

Features	KPEC I	KPEC II
Main facilitators	iNZed personnel	State & school facilitators
Online support (Web-based)*	Yes	None
Professional development organisation	Clustered schools	In-school
Leadership of project	iNZed	State Education
Time	Short (10 weeks)	Long (on-going)
Official evaluation (end / on-going)	Yes (ended)	No (on-going)

* The online support was intended to be the contact point for support for schools, teachers, facilitators, and iNZed staff.

There were significant differences in the implementation of KPEC II according to the data. The change from cluster-based PD to in-school PD had a substantial impact on the state and school facilitators involved (see section 7.8 onwards). The lack of an official evaluation (see section 7.3.5) suggests that KPEC II did not have clear planning and objectives to develop the programme further but has been rather ad hoc in planning and implementation.

7.3.3 KPEC - structure and facilitation

In KPEC I, the *state facilitators* facilitated the *in-school facilitators* across the cluster, and the in-school facilitators facilitated other teachers who participated in the programme in their respective schools. However, in KPEC II there was significant change in the facilitation process; the state facilitators, the in-school facilitators, and teacher mentors (previously teachers who participated in KPEC I) together facilitated other teachers (called teacher mentees) within their respective schools, as shown in Figure 7.1. This suggests that the schools preferred the existing 'traditional' pyramid or hierarchical structure to the cluster structure advocated by KPEC I, as shown in Figure 7.1.

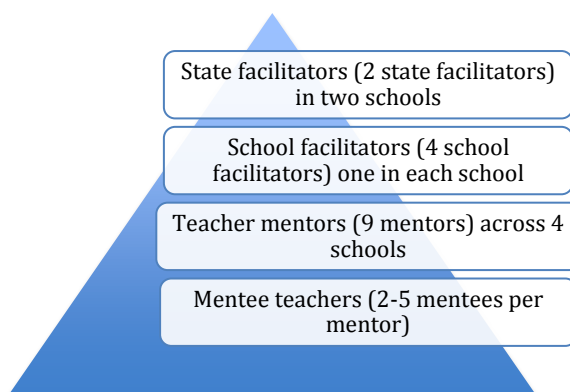


Figure 7.1. The 'pyramid' structure of training in KPEC II.

The figure was based on accounts of school head's C and D and teacher's C8 and A6, and shows that the KPEC II programme followed the common training structure in Malaysia, i.e., the cascade approach.

A key difference between KPEC I and KPEC II was the role played by the state facilitators. In KPEC I the two state facilitators were given mandates to facilitate outside their respective schools, i.e., to 'roam' between the four schools, as evident from the interviews with them (A6:I & C8:I). However, in KPEC II, this did not continue. The two state facilitators could not continue supporting other teachers in other schools in the cluster because it was deemed too time consuming by their school heads, and KPEC II was not sanctioned by the MOE (A6:I & C8:I).

The focus of the facilitation also changed from KPEC I to KPEC II. In KPEC I, my research findings show that the state facilitators, the in-school facilitators, and teachers who participated in the innovation focused on new ICT skills, ICT confidence, and pedagogy through KPEC's ICT challenges. However, in KPEC II, the state facilitators, the in-school facilitators, and teacher mentors (previously teachers who participated in KPEC I) concentrated purely on ICT skills. Eleven teachers linked KPEC II to learning new technologies, as these two quotes illustrates:

In KPEC [II] the one I'm involved in, is all about learning new technologies, like the iBoard. (B4:I).

This KPEC [II] is all about ICT, more towards all types of ICT activities teachers do. (C1:I)

The shift in focus to learning new skills in ICT showed that the state and school facilitators either could not continue with changing teachers' practices, as in KPEC I, or did not sufficiently understand how to change teacher practices. It implies that KPEC I did not concentrate on pedagogical change as an objective.

KPEC II objectives, activities and training were markedly different to those in KPEC I. In KPEC I, iNZed planned and implemented activities. In contrast, the KPEC II programme was carried out on an ad hoc basis, as this quote by a teacher mentor demonstrates:

The difference between KPEC II and KPEC I, there was a schedule and we had to do the activities accordingly. This year, there's none so we [the teachers] did it when we had the opportunity or when we wanted to do it. (C3:I)

This change suggests that there was a lack in focus in KPEC II, i.e., no school or school head wanted to lead the KPEC II programme. It also implies neither K-Perak Incorporated nor the SEDO were able to provide leadership for the KPEC II programme.

The selection process in KPEC I and KPEC II remained the same. School heads selected and assigned teachers to both programmes rather than teachers volunteering to participate in the programmes.

In summary, there were significant differences between KPEC I and II. The impact of these differences is discussed in the next section.

7.3.4 An overview of KPEC I and II

In this section I discuss the relevant data to understand the 'impact' of KPEC I, following the KPEC report and KPEC II. To clarify, generally, these two different programmes are considered as a single innovation in this research.

The first part of this section discusses KPEC I's influence on teachers and schools. I discuss the PD process, teachers' progression in ICT, and pedagogical change with reference to the KPEC I evaluation report.

The second part of this section discusses KPEC II and its influence. A summary of both programmes is offered in terms of teachers' ICT confidence and change in pedagogy.

7.3.4.1 KPEC I influence

The KPEC I report provided a reference point to frame the innovation's impact at the end of the programme in May 2007. It gives one account of the processes, implementation, objectives, and outcomes of KPEC I. In the KPEC I evaluation, I identify two parts relevant to RQ2: first, the 'case studies' carried out with teachers, and second, iNZed's assessment of the teachers' ICT progression and pedagogical change. These two parts are crucial to understanding the decisions that schools and teachers made in KPEC II.

According to their baseline and exit surveys, the KPEC Report (Norton, 2007, pp. 24-26) showed that teachers adopted new ICT skills and changed their pedagogy (no definition of pedagogy was offered in the report), as indicated by teachers' ICT confidence, ICT capability, and curriculum delivery. According to Norton (pp. 26-31), there were increases in the teachers' confidence in using ICT in class, use of new Web 2.0 applications, and frequency of ICT use by these teachers in teaching and learning.

Documents showed that school plans (D:064630-064940) and reports of KPEC I corroborated these claims, demonstrated by the number of ICT

challenges (see example in Appendix S) - twenty-five ICT activities were carried out by 25 teachers in KPEC I across the cluster schools. Norton explained that ICT challenges were used to gauge how teachers changed their teaching practices (this will be explained in detail later). To illustrate change in ICT and pedagogy, the KPEC report discussed individual teachers, i.e., case studies of teachers.

According to the report, individual case studies of teachers (Norton, 2007, pp. 36-84) in KPEC demonstrated how teachers learnt new ICT skills and changed their teaching. The KPEC report also claimed that the KPEC ICTPD programme impacted on the teachers' pedagogy (p. 34) by exemplifying teachers different approaches to learning, scaffolding learning and responses to curriculum needs. These teachers went through a process called Reflection-On-Action (ROA). Figure 7.2 explains the ROA framework used in KPEC I.

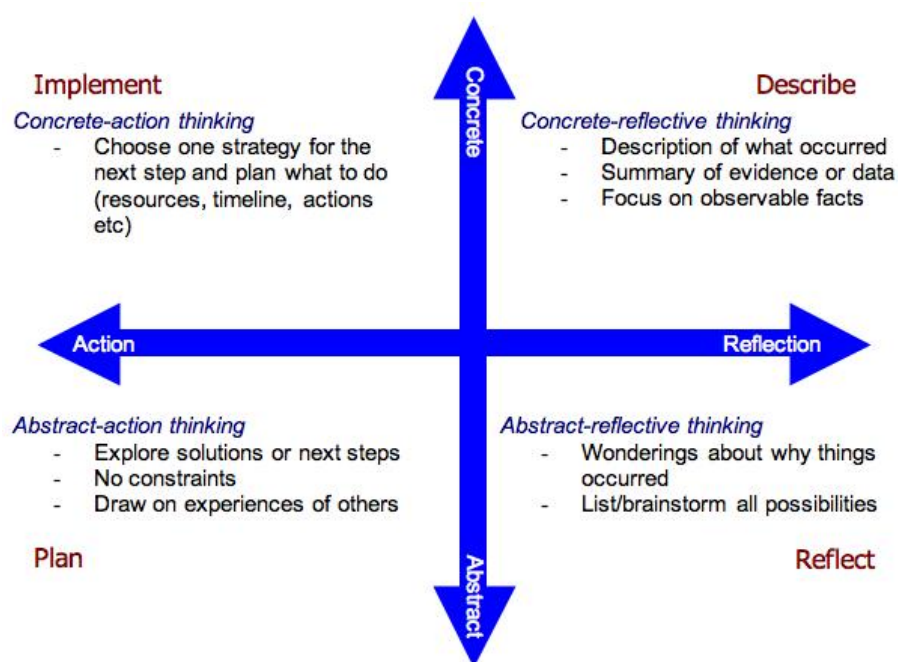


Figure 7.2. The Reflection-On-Action action model used in KPEC.

(Norton, 2007, p. 20)

This figure shows the four-step process teachers were introduced to in KPEC I.

The ROA model was an important part of iNZed's professional development approach, as the objective of the first programme initiated by iNZed was to empower teachers to think about their use of ICT and change in relation to their pedagogical approaches (Norton, 2007, p. 20). As a result of ROA, Norton (p. 34) claimed that KPEC managed to help these teachers identify new ideas and approaches, and to reflect on their teaching and learning. In the individual case studies in the KPEC report, teacher statements referred to changes in pedagogy but no specific evidence was presented to justify these claims. For example, one teacher was quoted to have used a range of ICT and changed her teaching practices, "she planned and implemented a comprehensive ICT challenge involving a wide range of technologies along with a range of pedagogical approaches" (p. 58).

The use of ICT challenges was an important method for iNZed facilitators to evaluate the ICT activities the teachers carried out in their classrooms. In assessing these ICT challenges, according to Norton (2007, p. 33), teachers were asked to self-assess the shift in terms of their ICT confidence and capability. These self-assessments by teachers demonstrated that 15 teachers planned ICT lessons with different pedagogical practices that supported different students' learning needs (p. 34). Furthermore, 10 teachers could respond to curriculum needs and had carried out inquiry and problem solving activities. Norton claimed that 13 teachers used ROA to identify new strategies and ideas, and saw themselves as practitioners who shared these new ideas and strategies (p. 34). These claims made by the KPEC report on ROA and change in teaching practices will be discussed later in section 7.4.

7.3.4.2 KPEC I - teachers' ICT confidence

In this section, I refer to the micro-model used by iNZed in KPEC to measure teachers' confidence, before and after KPEC I. The findings in KPEC I provided an indication of where teachers were at the end of May 2007. I also discuss key factors that iNZed perceived as barriers and enablers in KPEC I, to determine whether these factors were still evident in KPEC II.

Even though the iNZed report did not include any third party evaluation, the KPEC I report provided evidence that pointed to the impact of KPEC I on teachers' acquisition of new ICT skills and thus increased ICT confidence. The report based teacher progression on a model called the ICT Challenge Assessment Rubric (ICAR - see Appendix R), which was based on the Concerns Based Adoption Model (CBAM). According to Newhouse (2001, pp. 2-3), CBAM ranks teachers and managers of schools (as organisations) according to their perceptions of an innovation (ICT), in a six-tier stage. The KPEC I model, i.e., ICAR, was a four stage model, from Level 0 - Novice to Level 3 - Refinement and Renewal. The report summarised (Norton, 2007, p. 33) that 26 teachers moved from Level 0 or Level 1 to Level 2 (Transfer/Routine) or Level 3 (Refinement and Renewal), according to their assessment criteria which stated that teachers experienced, "significant shifts in terms of teacher confidence with ICT" (p. 33).

There are similarities in the stages in ACOT's (1995) five-stage model of teacher progression and ICAR, which placed teachers at adoption-adaptation in ACOT stages and transfer-refinement in ICAR stages. Though the two models are not directly similar, they do provide a comparable measure of the progress that the teachers experienced in participating in KPEC. However, ICAR is too intertwined with the ICT challenges to measure progress and is based on teachers' self-assessment, i.e., teachers assess their progress in carrying out ICT challenges. This self-assessment may be flawed as the teachers may be incapable of understanding these rubrics, which include concepts such as reflection. Further, teachers in the Malaysian school context do not do self-assessment; it is always others (e.g., school heads) who assess them. Thus, it may imply that ICAR may be unsuitable as a measure of teachers' ICT progression.

7.3.4.3 KPEC I - Factors related to the innovation

For the purposes of understanding the factors influencing the adoption of ICTPD programme which emerged in my research, I refer to the KPEC report that

described barriers and the subsequent mitigation (partial solution) of these barriers (Norton, 2007, pp. 110-113), which I summarise in Table 11:

Table 11. KPEC I - barriers.

The table illustrates the main barriers that influenced the adoption of KPEC I as an innovation.

Attribute	Barriers	Mitigation
Curriculum	Highly prescriptive	Worked to 'fit' ICT in curriculum
Pedagogy	Whole-class teaching & lack of student involvement	Focus on micro-level change & teacher reflection processes
Content	Dependent on textbook & ETEMS courseware	Supplementary materials provided by subject matter experts from NZ
Assessment	Focus on assessment of learning	Continued with traditional methods & introduced alternatives & promoted assessment in relation to ICAR
Cluster organisation	Geographically distant with no network relationships	Frequent meetings of principals & teachers, increased iNZed facilitator visits & encouraged online environment
Leadership	School heads not involved in decision to participate and unclear of objectives	iNZed increased contacts & meeting with school heads
Facilitator	Two State KPEC facilitators were partly released (limited days)	iNZed and State KPEC facilitators planned one day per week visits to each school
Facilitation	'Supply-driven' - teachers relying on external facilitators & teachers' schedules limited participation	School facilitators prepared material & activities for visits & used after school time for meetings and workshops
Online participation	Teachers' hesitant reactions & initial reluctance to share online	Facilitators modeled online use & online responses timely to build confidence
PD approach	Expectation of withdrawal from participating in KPEC	Strong guidance & direction required at early stages
Technology	Few computer labs working reliably, Internet access unreliable (no wireless in some schools) & student access limited	10 additional laptops provided to schools

(summarised from Norton, 2007, pp. 110-113)

The discussion of barriers and their mitigation in the report highlighted the factors that influenced the adoption of the ICTPD programme in the cluster schools. Table 11 shows two overlapping influences in the adoption of KPEC: (a) the contextual factors that existed in the research schools, and (b) factors inherent in the implementation of KPEC as an innovation.

As illustrated in Table 11, factors: (a) at the external level, such as the curriculum and assessment⁸⁸; (b) at the internal level in the school, such as leadership and ICT infrastructure; and (c) at the individual level, such as the pedagogy and content, have an influence on how the innovation is adopted. These factors were similarly found in the previous chapter in different sections, such as the influence of the curriculum and examinations.

Moreover, in the KPEC report, factors related to the ICTPD programme and its implementation impacted on the adoption of the innovation; such as the cluster organisation, the PD approach, the facilitation processes, and the online environment. These factors and its influence were also similarly identified in my research and will be discussed further in this chapter.

However, not presented in the KPEC report was the constraint of time, in terms of KPEC 'compressed' implementation, of three months. Norton (2007, pp. 110-113), did not mention the short duration of the pilot as a barrier in KPEC I. According to Ham (2005, p. 9), the amount of time that teachers are involved in the ICTPD programme affects their use of ICT in the classroom. In a study of teachers involved in a PD programme, those who were involved for 1-6 months used ICT significantly less than teachers who were involved for a longer time.

As such, the short time span of three months in KPEC I, may not show significant impact of teachers' use in the classroom. Though no specific data was collected on whether the length of time affected the adoption of the ICTPD

⁸⁸ Assessment in the KPEC report referred to examinations (in the context of the schools). There was no distinction made between assessment for learning or of learning.

programme, the low frequency of use of ICT in school (previously discussed in section 6.5.1.2) demonstrated that time may have affected the adoption of the ICTPD programme, in terms of ICT confidence (section 7.4.1). This limitation though not highlighted in the KPEC report, may stem from the need to show the funding organisation, K-Perak Incorporated (KPI) that it can be successful in a short time.

The KPEC I report stated that a 'rigorous' weekly programme was initiated in which school visits by iNZed facilitators and in-school facilitators increased to eight per school (Norton, 2007, p. 10). This may have been a strategy iNZed used to ensure that the short time they had, was utilised fully.

The factors discussed in the KPEC report were important as they indicated issues that the KPEC I implementers had to deal with during the ICTPD programme. The localisation and implementation of KPEC I, in the context of the research schools, influenced how KPEC I was viewed and received by the teachers and school heads and the change they experienced. Further, the continuance of KPEC I, seen in KPEC II, was also an indication of how the initial innovation was understood and embedded by teachers in these schools.

The next section provides an overview of the developments in KPEC II.

7.3.5 KPEC II influence

KPEC II's implementation and influence differ from KPEC I. Unfortunately, there was no official evaluation (sanctioned by MOE or SEDO) carried out during the KPEC II implementation (2008 onwards).

Across the four schools in the research, the state facilitators and mentor teachers involved in KPEC II only provided numbers of activities carried out during a school year and the data did not cover all schools, according to school documents found in School D (D:64667-64684). The state facilitator in School D

collated reports and activities given to her from other schools and she entered them in the KPEC project file.

In November 2008, at the end of my data collection, one of the state facilitators (School D) carried out a survey in her school to justify continuing KPEC II in 2009 onwards (D:125064-125066). The survey data was collected and documented in the school's project file and a PowerPoint⁸⁹ presentation was created from the survey. I summarise the key points of the evaluation from her PowerPoint slides:

1. Numbers surveyed: 14 teachers and 718 students.
2. 64% of teachers thought that they have carried out a high number of activities.
3. 55% felt that there was an increase in ICT activities since KPEC.
4. 64% of teachers have improved ICT skills (not specified).
5. 55% of students gained ICT skills (according to teachers).
6. 64% of teachers received support from the school head, at the medium level.
7. 100% of teachers received support from facilitators, at the medium level.
8. 73% of teachers communicated with each other in the project and 100% of teachers gauged it at the high level.

The survey indicated that these were the barriers in KPEC II:

1. Lack of ICT skills.
2. Chasing the curriculum.
3. Lack of time.
4. ICT infrastructure:
 - a. Wireless access unreliable.
 - b. Server always offline.

⁸⁹ PowerPoint was printed out as a document in the school file. Translated into English. A survey of teachers involved in KPEC. No definitions were offered for measures such as 'medium' or 'high'.

- c. Many computers in disrepair.
- d. Scheduling conflicts.

The conclusion of this survey recommended that KPEC II should continue and argued that 100% of teachers supported the continuance of KPEC II because it:

1. Helps improve ICT use in teaching and learning.
2. Helps improve ICT skills.
3. Gives challenges in using ICT.
4. Motivates teachers to try.
5. Helps teachers plan teaching and learning.
6. Allows teachers and students to find information quickly.

As documentary evidence, this evaluation provides an indication of the status of KPEC II (in one school at least). More importantly, it gives a snapshot of the teachers' and schools' perceptions of KPEC II and its continuance at 18 months of implementation. It also suggests that there were many issues still unresolved from KPEC I.

7.3.6 Summary of KPEC

The KPEC I report (Norton, 2007) illustrated that there were a number of factors involved in teachers' progression of ICT in their respective schools and the adoption of the ICTPD programme as an innovation. The report showed the impact of the ICTPD programme on teachers' ICT progression in terms of ICT confidence and change in teaching practices. Norton's claim on improving teachers' ICT confidence can be traced in the case studies she described, but her claims of change in teaching practices were not substantiated in the report. Thus, the lack of evidence may imply that teachers either did not learn to change their practices in ICT, or that teachers superficially changed their teaching practices when carrying out ICT challenges during KPEC I.

The KPEC II PowerPoint 'report' suggests that teachers involved focused solely on ICT instead of changing their teaching practices. This focus indicates that the level of adoption is superficial; teachers and schools adopted what they perceived as the key element or objective.

Further, the iNZed group who aimed to implement KPEC I as an innovation may have underestimated the level of resistance of teachers and schools in adopting the new approaches that the ICTPD programme took. As pointed out earlier, the self-assessment and the reflective processes are *not* common practices in Malaysian schools. The concept of self-assessment may be too 'distant' (as described by Tearle (2003) and Zhao & Bryant (2006) - cultural and knowledge distance in section 4.6.5) for these teachers and schools to embed as part of their school culture.

The KPEC II PowerPoint 'report' showed that the factors which impacted KPEC I persisted in KPEC II. The barriers towards KPEC II implementation remained the same, such as the lack of ICT facilities in the schools. Further, the localisation of KPEC II showed a preoccupation with numbers or quantity of ICT challenges or activities and increasing the number of teachers involved. In terms of objectives, KPEC II only focused on learning new ICT skills.

In sum, I established the combined influence of KPEC I and II on teachers and schools. The differences in implementation and processes show that there is a range of factors that has influenced the adoption of the ICTPD programme.

The next section discusses teachers' progression in ICT in relation to the ACOT model. This is my analysis of the impact of the ICTPD innovation on teachers' ICT confidence and pedagogical change.

7.4 KPEC's influence on ICT confidence and pedagogical change

To answer SQ2 (b) and (c), I examine the impact of KPEC on teachers' ICT confidence and pedagogical change in the research schools. According to Norton,

KPEC I was specifically designed to change teachers' teaching practices (p. 24). The KPEC report, as mentioned earlier, had stated that teachers involved in KPEC I increased their ICT capability (see section 6.4.4) by using more ICT and acquiring new skills (Norton, 2007, pp. 26-31). More importantly, the report also claimed that the teachers' pedagogy (p. 34) changed as indicated by different approaches to learning, scaffolding learning, and responses to curriculum needs.

7.4.1 Teachers' perception of ICT confidence

Teachers' progression of ICT in the research was influenced by the teachers' participation in KPEC I and II. In section 7.2, I mentioned that teachers' ICT confidence relates to a teacher's perception that he or she is able to use ICT effectively in teaching and learning. Related to ICT confidence were ICT skills, positive experiences, and teaching practices.

According to the KPEC I report, there were specific increases in ICT skills in the use of Web 2.0 (e.g., Wikis - see section 6.4.1) applications and the increases in the use of ICT, i.e., frequency of KPEC activities according to the number of ICT challenges. In my research data, 21 teachers perceived that they progressed due to KPEC in relation to their ICT confidence and skills. This quote exemplifies the responses of the 21 teachers:

For me I feel more confident. From the perspective of ICT use, I'm more confident now because I have gone through and learnt many things [in KPEC I]. (C8:I)

There were increases in ICT skills, for example, teacher A6 (I) recounted how she learnt about online conferences, podcasting, blogs, and Wikis during KPEC I. Other teachers defined their progression in terms of using digital cameras and videos during their ICT challenges. From the data, it appears that teachers' ICT progression (as per ICT skills) had increased for most teachers involved in KPEC I. Their participation increased their ICT capability in terms of adding new skills to these teachers' repertoire in ICT and positively influenced their ICT confidence.

Despite increased ICT confidence and skills, the frequency of use of ICT remained minimal since KPEC I (also shown in the previous chapter). Teachers' frequency of use ranged from: "this year, none at all" (C3:I); "I can recall doing one" (C2:I); "Two for this year, one has finished" (B9:I); to a maximum of "three challenges" (C8:I). One teacher who participated in KPEC I and II confessed that: "During KPEC I, I did many ICT activities but now, I've slowed down a lot in KPEC II" (A4:I). Another teacher echoed teacher A4's opinion: "It's less successful now [number of activities], I can say KPEC [II] is struggling" (D5:I).

There seemed to be a separation between KPEC's ICT challenges and the subjects teachers were teaching. One teacher pointed out that KPEC II ICT challenges did not have any relation to what she was teaching: "It's some sort of separate entity." (D3:I). Twenty-seven teachers (including teacher D3) in KPEC I and II viewed the ICT challenges as separate ICT activities for them, not subsumed into their subject teaching, as this quote from a Religious and Special Education teacher demonstrates:

For KPEC [I & II], I had to create a separate project, a separate ICT challenge for the students. From the start to the end, they [students] learnt how to use the laptops, take photos with the digital camera, download it to the laptops and then label the diagram using Word. (B9:I)

Though ICT challenges were touted as part of the subject and related to the curriculum in the KPEC report, almost all teachers in my research perceived them as separate activities, not linked with the subjects or the curriculum. This implies, as the quote above shows, that teachers were still focused on teaching ICT skills to their students.

7.4.2 Pedagogical change

The change in pedagogy, in the context of this research, relates to *changes in teachers' practices*, specifically change in teaching approaches from

instructivist to constructivist. Further, I illustrate teachers' perceptions on what *had changed* in their teaching since participating in KPEC.

Twenty seven teachers in this research described the changes in their teaching practices in terms of how they accommodated ICT into their teaching *processes*, as opposed to change in *teaching practices*, as this quote illustrates:

There's a PC in my room, so I take all my students there. I ask them to stand behind me and I teach [and instruct] them using the PC, with one monitor. I let them watch and see, like for example, how to do a pie chart. I type in the numbers and click the button and show them how to choose. When I finish showing them, they go back to the computer lab and do [...] Change in teaching approach [since KPEC]? Mainly the same as I have been doing, I use my earlier practices because I only know how to teach this way. (D3:I)

The quote above illustrates two important points in relation to change: (a) that pedagogical change was understood as the management of the lesson or class when ICT is used; and (b) teachers still referenced existing practices and approaches despite participating in KPEC I and II. This suggests that teachers have not moved on into changing their practices but are substituting ICT as a tool in their teaching. Their teaching practices remain unchanged.

7.4.3 Superficial change in student learning

Teachers' understanding of pedagogical change, in relation to student centred approaches and student learning, emerged to have been superficial during KPEC I and continued to be superficial in KPEC II. Changes in student learning is an indicator in changes in teaching practices; teachers are supposed to facilitate and scaffold student learning.

Documentary evidence from student work on solar systems during KPEC I (DB:114976-115006) showed that these students used 'copy-and-paste' and did not edit any of the information they found when producing their group project (see Appendix T), as all the information was copied *verbatim* from the

Nineplanets⁹⁰ (www.nineplanets.org) website. This solar system project work was touted to be an example and evidence of how student learning occurred, and that teaching practices had changed during the KPEC celebration held on 21st May 2007, according to teacher A7(I). However, this student project illustrates that students have not moved from their 'rote-learning' roots, as they merely reproduced information from the Internet which they had found and compiled as a report.

There were 27 teachers who discussed changes in their teaching and learning in ICT. These teachers' discussions on change focused primarily on ICT as a tool, instead of changes in student learning, as this quote shows:

Researcher:

In your teaching and learning, when you use ICT in your classroom, what sorts of things do you do? Say, for example, if you are teaching a topic in your subject. Also, could you tell me if you did anything different, for example, in organising student learning?

Teacher:

When I teach using ICT, it is to ensure that my students pay attention to me. They look at my PowerPoint, I discuss the topic and they answer questions which I have put on my PowerPoint. I give them a sheet in which they have to write the answers to the questions. (D1:I)

This quote and the documents on student work indicate that teaching practices have not changed. What has changed is how this teacher presented to his students, i.e., using a PowerPoint presentation. Similarly, the four teacher observations showed that teachers *believed* they had changed but, in reality, experienced superficial change as they merged ICT use with old practices, as illustrated by teacher A2(O) (see section 7.4.2).

⁹⁰ As of September 2009, this website's name has changed to 'The eight planets'.

These findings suggest that teachers still played a central role in managing learning, and that student learning still mimicked old learning styles when teachers used ICT. Furthermore, these findings imply that KPEC did not influence teachers' pedagogical change. KPEC, through their ICT challenges, focused on the use of ICT in the classroom; teachers' current practices which were traditional (non-transformative), did not change despite claims.

In the next section I explain and situate teachers' progression in ICT, after 18 months of KPEC I and KPEC II, and I refer to the ACOT (1995) model to gauge how far the teachers have progressed in the research.

7.5 Snapshot of teachers' progress in ICT - ACOT model

The main purpose of using ACOT (1995) five-stage model is to understand the impact of the innovation on teachers' ICT skills and teaching practices (pedagogy). To clarify, the ACOT model is used in this context as a snapshot of the point to which teachers progressed and is *not* a comparative measure of teachers (before and after) within a time span.

The most important aspect in ACOT's five-stage model is the change in teaching practices, primarily, the shift towards student-centred learning, i.e., constructivist approaches. The ACOT five-stage model used in this research, as well as the *three stage development model* as described by Sandholtz et al. (1992b), is based on a long-term research project in American schools from 1985 to 1995, which showed that teachers journey through a number of hierarchical stages when integrating ICT in their teaching and learning. The ACOT model applied here, as elaborated in section 4.5, describes a five-stage pattern: *entry, adoption, adaptation, appropriation, and invention* in relation to change in teachers' instruction or pedagogy.

However, it is important to recognize that the progression of teachers does not follow a fixed sequence of stages (Dall'Alba & Sandberg, 2006), particularly in developing skills within professional development. This may be a

significant point, as my ecological framework considers that teachers may progress or regress depending on a number of influencing factors. Apart from gauging ICT progression, Wilson et al. (2001) suggest that micro-models, such as this ACOT model, can describe the patterns that shape the adoption process as well as factors that influence the adoption.

In chapter 6, I discussed the influence of teachers' backgrounds and experiences as factors in teachers' ICT adoption in teaching and learning, which was based on ACOT's (1992b) three stage development model. Following on, in research question 2, I now identify the stages to which teachers have progressed in ICT skills and change in teaching practices.

7.5.1 Teachers and ACOT stages

In terms of the ACOT five-stage model, taking into account the data collected from the interviews, teachers were placed at the stages shown in Table 12; these stages were derived from three factors - ICT skills, the frequency of use of ICT in teaching, and the 'typical' teaching practices in ICT (interviews).

Table 12. Teachers according to ACOT stages.

Stage	Type	Teachers (numbers)
1	Entry	0
2	Adoption	22
3	Adaptation	21
4	Appropriation	1
5	Invention	0

Table 12 shows that the majority of teachers in the research were either at stage two, *adoption*, or three, *adaptation* of ACOT. The four observations (subsumed into the descriptions of progression of teachers in ACOT) corroborated with this 'conclusion', with two teachers representing stage two, one teacher at stage three, and one teacher at the beginning stages of stage four.

7.5.2 ACOT stage 2 teachers

As mentioned previously in section 6.4.4, the teachers in this research adopted ICT before KPEC I. Consequently, none of the teachers were at the entry stage of ACOT. Based on the aggregated data (primarily from semi-structured interviews), 22 teachers were at the *adoption* stage, where their teaching practices using ICT mirrored the approaches to teaching they used previously. Teachers at this stage used teacher centred approaches and used ICT applications such as Microsoft PowerPoint to teach, as this teacher explained:

During induction [the lesson], I explain the topic, then they do the exercises...meaning the student will do the activities from my PowerPoint, following my instructions. Then, they can do the exercises from my PowerPoint slides after finishing the activities and find out the answers straight away. (C1:I)

For these teachers, the use of ICT applications supported their current teacher-centred teaching practices, which were based on traditional instruction. For 11 teachers at the adoption stage, ICT was viewed as a tool that supported teaching, as demonstrated by this quote: "I use ICT as a tool, to gather materials from the Internet and the courseware" (C6:I). Characteristically in this research, teachers at this stage used the ETEMS teaching courseware or materials gathered from other electronic sources or media to teach their subjects using traditional approaches, as illustrated by this quote:

Researcher:

You mentioned that you use ICT when you taught your subject [Science] in ETEMS. Why do you think you use ICT?

Teacher:

It's because I use it [ICT] as a teaching aid, but not the usual teaching aid. It's much more interesting than the normal large poster paper, it [ICT] is more interesting for the pupil and it helps them remember, teaching aid like the teacher courseware... If before we used chalk and talk, we now show the courseware in front, then give explanation, easier for the teacher, easier for the students to understand. (C7:I)

Overall teachers at stage two did not extend their use of ICT into learning and only focused on teacher activities when using ICT in their classes.

7.5.3 ACOT stage 3 teachers

I distinguish the differences between stage two and three of ACOT based on how the teachers discussed their teaching practices in relation to student learning and the integration of ICT in teaching. In the context of my research, the teachers at stage three used various ICT applications (e.g., Microsoft Office applications) along with Web-based applications on the Internet and at times in combination with the ETEMS teaching courseware.

The data showed that 21 teachers used the Internet, courseware, and Office applications. Of the 21 teachers, four teachers (all of whom were male - see section 6.4.4.1) used media applications such as MovieMaker. At stage three, teachers planned or structured their lessons to include ICT but also focused on student learning when they used ICT, getting students to seek information and produce work, as demonstrated by this quote:

Researcher:

Could you give me an example of what you did with your class or students when you taught using ICT?

Teacher:

The pupils used the web to search for pictures and they also used the camera. If they used the camera, students then transferred the photos to the computers. Some pupils like to create presentations using PowerPoint and some use Moviemaker to produce it. (B5:I)

Despite using a range of ICT applications and the Internet, these teachers still used traditional practices to teach their subjects, as exemplified by this quote:

I teach using a blend of both [teacher centred & student centred] when I use ICT. Initially, the lesson is more

teacher-directed. Then my students go into groups or pairs. So that *is* student-directed. With my 5 Science 2⁹¹ class this year, I taught the novel, *The Pearl* by John Steinbeck. Students had learnt the novel. So after we completed the reading, I directed the students to work in groups and go on the web and come up with a response to the different questions I had on my PowerPoint. In each group, I explained to them what I wanted. They work in groups and come up with a group presentation in PowerPoint. (C6:I)

The two quotes above show that there is a shift in teachers' use of ICT to include aspects related to student-centred learning. The teaching practices have not progressed towards constructivist practices but show that the teacher has managed to include student directed activities when ICT is used. However, teachers' progression in ICT seems to have reached its limit at this stage among the teachers in the research schools.

7.5.4 ACOT stage 4 teachers

Only one teacher was placed at stage four, appropriation, due to the teacher's *integration* of web-based applications, such as blogs and Wikis, with her pupils (A6:I). As compared to teachers in stage three, she integrated ICT into her subject (English) far more than other teachers. Her teaching observation (A6:O1) showed that she facilitated her pupils to write sentences in their blogs. This innovative activity showed a high degree of integration of ICT, with more focus on student learning - which was done in groups - but she did not, however, use constructivist approaches per se as she still directed much of the activity.

During the post-observation interview, Teacher A6 did not reflect on how she might facilitate student learning in groups to construct new learning but concentrated on the uses of the blog (A6:O11), which showed that she needed to shift from integrating ICT to facilitating learning. Her stage of progression was attributed to her involvement as the state facilitator for KPEC I (Norton, 2007, pp. 37-38). She continued to innovate after KPEC I ended and mentioned, "Like

⁹¹ *The Pearl* by John Steinbeck is taught in all English classes in Malaysian secondary schools at Form 5 (students at 16 years of age).

now, we have this project with another NZ school using *blogmeister*⁹² to have shared blogs of students within a class" (A6:I).

7.5.5 Summary

Overall, even though teachers showed some progress especially in acquiring new ICT skills by adopting web-based applications and other Web 2.0 applications, the change in teaching practices and the move towards student centred learning has not occurred. This is not the 'significant shift' reported by Norton (2007, p. 33) in the KPEC report. This is because the definition of change in the context of this research focuses on the shift in pedagogical change (teaching practices in ICT) and not only on the use of ICT in teaching.

The next section discusses the factors that influence the adoption of ICTPD programme in relation to teachers' ICT confidence and pedagogical change. I structure these factors into three parts: (a) individual; (b) school; and (c) the ICTPD programme (as a factor in adoption).

7.6 Adoption of innovation - factors at the individual level

The individual factors that influenced teachers' adoption were primarily based on how teachers perceived the KPEC I programme. This is due to the research focus, which examines the unique features in the KPEC ICTPD programme, implemented by iNZed. KPEC II is analysed when there is a need for comparison.

Three individual factors emerged to influence the adoption of the ICTPD programme: the perceived lack of time for the innovation, the teachers' anxieties about the ICTPD programme, and teachers' perceived burden in implementing the ICTPD programme.

⁹² Classblogmeister (<http://www.classblogmeister.com/>). It is a classroom blogging site.

7.6.1 Lack of time for the innovation

For 23 teachers in the research, *lack of time* during school hours was viewed as a factor that hindered their adoption of KPEC I and II. Thirteen teachers expressed the lack of time in terms of teaching for the examination and trying to finish the syllabus. Ten teachers related the lack of time to other school activities or programmes that needed to be carried out. Two quotes demonstrate the effect of this factor on teachers:

Researcher:

What do you think the constraints were in KPEC?

Teacher 1:

The constraints were as I mentioned before, the syllabus and all that, if we want to follow a programme like KPEC, I worry that we don't have time to do other school work which is important too. (A10:I)

Teacher 2:

I see that the problem is time. Sometimes KPEC is not suitable in terms of time, not suitable at all with the school especially with the schedule. At times, we are in the middle of something like for students of standard six, whom are busy with examinations. Every month there are tests, so I feel that there's limited time. (B8:I)

The evidence showed that teachers were more concerned with the limited time they have in school. Carrying out the innovation consumes part of their time, which they perceived would be better used in finishing school work. Further, teachers held the view that the normal obligations in teaching the syllabus and examinations, carrying out tests, and other schoolwork should not be disrupted by KPEC I.

There were also other competing ICT programmes. In terms of school routines and other programmes that vied for time, 16 teachers linked lack of time to programmes related to ICT, which were not related to KPEC. Out of the 16 teachers, 13 teachers mentioned ETEMS, one teacher mentioned ICTL, one

mentioned a school management programme called *Sistem Maklumat Murid*⁹³ (SMM), and one mentioned *E-Ringkasan*⁹⁴.

Apart from teachers, three school heads also emphasised the lack of time for carrying out the innovation in their schools in relation to implementing various other programmes that needed to be carried out, as exemplified by these two quotes:

The problem is that this school is busy. We don't have enough time to carry out KPEC because we have to cram in all sorts of other programmes as well. (HB:I).

Time is a constraint. Because, at school, we have a multitude of programmes that we need to chase up on and each one has a deadline. (HD:I).

In summary, unlike factors mentioned in the KPEC report (Table 11 earlier in this chapter), the curriculum and assessment factors are subsumed under the lack of time as a factor. Teachers viewed KPEC I as *consuming time reserved for teaching and learning and schoolwork they were required to do*. School leaders saw it as another programme that needed to be implemented along with all the others from the MOE or the SEDO in their schools. Fullan (2001) suggests that schools are laden with a multitude of programmes and projects from external organisations and experience the 'Christmas Tree Effect', i.e., an innovation overload. Thus, schools and teachers are unable to cope with implementing these programmes and projects due to a lack of time.

The next section discusses a factor not found in the KPEC I report - anxiety related to the innovation. Anxiety as a factor emerged as teachers related how they felt when they first encountered KPEC I, in relation to the iNZed

⁹³ Student Information System - used in all schools to track student numbers, records, and discipline.

⁹⁴ Online Teacher Record System - only in School A.

personnel, and the approach taken to implement the innovation. Anxiety was also related to language, primarily the use of English.

7.6.2 Anxiety and the innovation

This section illustrates the effect of anxiety on the adoption process.

7.6.2.1 Foreigners

The teachers started to run!! The white-man is coming!
(B5:I)

The KPEC I programme was initiated and implemented by iNZed facilitators, who were from New Zealand (NZ). Anxiety as a factor related to how teachers reacted to being involved for the first time with foreigners as facilitators of a programme, the use of language, and the additional burden of participation. To clarify, the phrase 'white man' was used to describe the British during colonial times (historical use - before 1957 in British Malaya). The current usage of this phrase is generic for 'white-skinned people', not related to racism but rather to power relations.

Nine teachers discussed not only their anxiety of foreigners, but also other teachers' anxiety in participating in KPEC I, as illustrated by the first quote and the following ones:

At first, I saw the white-man, I was shocked. All the teachers were. We were all scared, especially the older teachers, but for me it was all right. At first I was afraid to be interviewed and then to do [with] computers nonetheless. The whole school was abuzz when we knew that we were involved with KPEC. The situation was really bad at the start and looked scary, but afterwards, when the head and deputy were involved and explained, we settled down. (B4:I)

The quote shows the degree of apprehensiveness the teachers felt in encountering the iNZed personnel. Their anxieties were also related to other factors, such as the lack of ICT confidence, as this teacher explained:

When some teachers saw the first KPEC group coming into our school, so many of them went into hiding, here and there. When this man comes, go and hide, said the teachers. I think it's because they were scared. This man and these people are going to ask us to do so many things using computers. The first perception was like that. (D3:I)

From the quotes above, it appears that foreign facilitators were not familiar to these teachers, both in the rural and urban contexts. This created an unexpected barrier towards the adoption of KPEC I. It further implies that foreign facilitators are perceived to have a higher status accorded to them. The use of the phrase 'white-man', as understood by this researcher, has two meanings. The first interpretation is *literal*, in that the phrase relates to teachers' perception of foreigners as 'possessing' a higher status due to their knowledge (of education). However, Temple & Young (2004, p. 164) argue that translators must include a social reality in a translation and as such represent and recognise power relations. Thus, a second interpretation is offered. I understand the phrase to relate to *power and knowledge*, according to Foucault's conceptions of discourse (in power and resistance), as cited in Caldwell (2007, pp. 774-776). Simply, the phrase 'white-man' carries connotations of power and, to a certain degree, subjugation brought over from the colonisation of Malaya.

The data suggests that anxiety of foreigners affected the whole school and was not limited to the teachers who participated in KPEC I.

7.6.2.2 Language

Another factor associated with anxiety was the use of language, particularly English. Though English was not a necessary requirement to participate in KPEC I, teachers assumed that all interactions with the facilitators

used English. Eight teachers talked about their and other teachers' anxiety towards using English, as shown by these three quotes:

One thing was the problem, language. We had to communicate in English. (A8:I)

They [teachers] all thought, how am I going to communicate with the white-man using English? They didn't know how to and that's why they ran. (D8:I)

When the facilitator came, teachers had problems with the language because they couldn't understand the New Zealander's English. (D3:I)

Apart from these teachers, the State Education Officer (SEO) recognised that English was problematic for teachers and mentioned that: "The problem was language, because in our school the level of English isn't very good" (S0:I). The quotes above demonstrate that English can become a barrier in the Malaysian context, where English is a second or foreign language. Despite being teachers of English, two teachers were also worried and scared about interacting with the NZ facilitators, as this quote shows:

Apart from me, there was one teacher, an English teacher. She was scared too! Some other teachers cried! (B5:I)

According to the KPEC I report, the two state facilitators, who provided translation into Malay, mitigated these anxieties about English. However, it would suggest that this solution did not allay the anxieties teachers felt about using English. In sum, the data suggests that English as a language carries socio-cultural and linguistic barriers beyond that of the innovation.

7.6.3 Teachers' burdens and avoidance of the innovation

This section discusses two interrelated factors that influenced teachers' adoption of the innovation: teachers' perception of the innovation as a burden and teachers' reluctance to participate in the innovation. I discuss teachers'

reluctance in terms of KPEC I and not KPEC II because the data implies that teacher reluctance may be related to the 'foreigner', i.e., iNZed facilitator.

7.6.3.1 Teachers' burden in KPEC I and II

In addition to language, another factor that influenced teachers' adoption of the innovation was their perception that KPEC I and II would add to their workload, consequently adding burden to the teacher. Workload in this context refers to teaching (e.g., preparation), administrative work (e.g., school, class, and personal), extra-curricular activities, extra or tuition classes, meetings etc. Fifteen teachers discussed how they and other teachers viewed KPEC I and II as adding more work to their already heavy workload, as illustrated by these following quotes:

It [KPEC] is a burden [...] with the workload already heavy and more coming [...] I have more work to do because I am the class teacher and am involved in many other things [...] (A8:I)

I'm not happy with the programme because of more work. I have my own work so when I got involved, I had to do more. So I wasn't really happy. Other teachers were not interested because of that. (D8:I)

Even though these teachers expressed that they viewed KPEC I and II as a burden, four teachers commented that the KPEC 'workload' eventually became part of their regular school workload. These teachers were exceptions because one was the state facilitator, one was a mentor teacher, and the other two were school facilitators in KPEC I:

At the start, when it was new, I felt it as a burden to me but eventually, I felt ok with it. (C7:I)

Fifteen teachers felt anxious because they viewed KPEC - as others in their schools did - as additional work. This influenced some teachers to avoid participating in KPEC I and II.

7.6.3.2 Teachers' avoidance in KPEC I

Ten teachers discussed their own reluctance and the reluctance of other teachers to participate in KPEC I, particularly in the initial stages of the program, as illustrated by these two quotes:

Actually at first, I was reluctant to get involved. The reason is that as teachers we already have many things to do. It's not only me; other teachers were reluctant to get involved too. (A8:I)

Teachers in my school were tense. They were apprehensive and did want to participate. When they saw me, they tried to avoid me [as a mentor teacher in KPEC]. They said, 'no, no, no.' (C6:I)

According to teacher D3(I), he and other teachers in his school were, at the beginning, apprehensive about participating in the KPEC I programme and refused to do any activities for the programme for the first two to three weeks. I understood, from his accounts, that this was not confined to his school but all schools in the cluster. Three teachers who were originally selected to be school facilitators by iNZed facilitators echoed these views. One teacher in particular strongly rejected the ICTPD programme because he perceived that KPEC activities were adding to his routine workload, as this quote demonstrates:

First, we were selected, it was five or six of us but after a while maybe, after the first or second meeting then those people from New Zealand, those white-men from New Zealand, they came in. [...]I'm not against it or anything but there are limitations. You cannot sacrifice adding one more thing [KPEC activities] for another more important thing. [...] After that they didn't even call me anymore but my name was still there. [...]They gave a report to my principal that I wasn't cooperating with them. (D11:I)

According to interview data, the three teachers, namely, teacher D3, teacher D5, and teacher B5, replaced the three teachers who opted out of KPEC I. The accounts of teachers D5 and B5 corroborated with accounts given by teacher

D3, in expressing the teachers' avoidance of KPEC in their schools. From the quotes above, the non-participation or rejection by teachers points to problems in the implementation of KPEC I in the cluster schools.

The next factor relates to school or internal factors that influenced the adoption of the ICTPD programme.

7.7 Adoption of innovation - factors at the school level

This section focuses primarily on the perception of school heads and teachers involved in the innovation.

7.7.1 Support from school leadership

School leaders as a factor emerged from two categories in the data, first, teachers' views of the school heads' support of KPEC, and second, schools heads' views of KPEC. Support from school leaders is essential as it determines the success or failure of a programme (Fullan, 2003b).

7.7.1.1 KPEC I implementation - school heads'

views

Innovation New Zealand Education's involvement and experience in the NZ ICTPD programme influenced iNZed personnel to approach the teachers *first* in the schools. This was suitable in the NZ context, but did not fit the research schools because Malaysian schools are defined by hierarchical power structures. School heads in Malaysian schools hold all the power and cannot be sidelined, as explained by this teacher:

As the school head, you want to make sure everything is going well. That's the reason I'm scared [as a teacher]. I'm terrified of the school head. (B2:1).

The iNZed facilitators did not seek the support of school leaders initially, as one school head pointed out: "Nothing. They didn't explain anything to me when they came to my school." (HD:I). The SEO pointed out:

One thing was clear. The school leaders didn't understand it. And worse, they felt as if they weren't really involved at all with the project. So when we asked for some action, they were slow to respond. (SO:I)

Consequently, the SEO stressed to iNZed that, in Malaysia, it needed to approach the school heads for the project to run effectively (SO:I) and, thus, initial exclusion of school heads hindered the adoption of the ICTPD programme.

7.7.1.2 KPEC I implementation - teachers' views

Twenty-seven teachers discussed the support they received from their school heads. Of these, 23 teachers commented that their school heads supported them and did not hinder them in participating in KPEC I and II, and often provided teachers with "words of encouragement, that's all" (C6:I). These teachers viewed their school heads as *non-committal* in their support of KPEC, as illustrated by this quote:

Honestly, I felt that the school head had problems with it [KPEC I]. I remembered that during a meeting, the school head seemed disinterested (C5:I)

Four teachers expressed the view that their school heads did not support KPEC I as they expected, as voiced by these teachers:

I really want to tell you the truth. I'm not happy with the school head. [...] She doesn't want to do anything and never asked about anything [KPEC I & II]. Never! (B5:I)

The school head couldn't really be bothered but didn't try to stop it either. [...] What I mean is that she went for meetings, had meetings with us and that's all. (B6:I)

In truth, the reality is, I don't want to say bad things about her. Because actually, the situation is that she didn't let me carry out the responsibilities that I needed to do in KPEC [I & II] like facilitating other schools. (C8:I)

In summary, these quotes stress the importance of school leaders in supporting the adoption of an ICTPD innovation in the research schools. Of the four school heads, only one school head gave his 'full' support to his teachers, facilitators, and mentors, according to teacher A6(I). School A's head, for example, released his teachers to facilitate other teachers in the cluster (A6:I).

The next section discusses teachers' views on the adoption of the ICTPD programme, i.e., the innovation. Apart from individual and school factors, features of the innovation have also influenced how teachers received the innovation and consequently adopted the content of the innovation, i.e., ICT skills and pedagogy. Two factors emerged that influenced the teachers: first, the clarity of the implementation and the processes involved in professional development related to facilitation; and second, the lack of knowledge transfer in pedagogy.

7.8 Factors related to the ICTPD innovation

The data suggests that the innovation structure, components and implementation may have influenced teachers' adoption of the ICTPD programme. I applied Fullan's (2001) concept of clarity in analysing the data.

7.8.1 Clarity of implementation in KPEC I and KPEC II

Teachers' views on the implementation of KPEC I and, to a certain extent, KPEC II, offered insights into how the ICTPD programme was received and continued forward. These views are important as they give an understanding of how an innovation like KPEC, brought in from New Zealand, worked in a different context and culture.

Clarity is a factor in influencing the adoption of an innovation, according to Fullan (2001) and Rogers (2003) (see section 3.4). The lack of clarity of the innovation and its implementation, from the teachers' perspective, became a factor that hindered the adoption of the ICTPD programme. Teachers in the research could not express a clear process of implementation and understanding about KPEC I and II. Clarity in this context relates to how teachers viewed KPEC's implementation, and teachers' basic understanding of KPEC and its objectives. Twenty-five teachers talked about the implementation of KPEC I⁹⁵, and 14 teachers related the lack of clarity in the programme. The following quotes are samples of the myriad of answers about what KPEC I meant for the teachers concerned:

Actually, it's a twinning program [KPEC I], I can say twinning program with New Zealand. (A5:I)

Actually, I am not clear about the objectives of KPEC [I], I really don't know what it is, what to do, where to go. [...] For teachers and students, what are the objectives? It is just using the computers to help you teach? (B7:I)

I don't really know what KPEC [I] is actually. I just do the teaching and learning in class using ICT and I fill in the forms, and then file the form in a file. (D9:I)

KPEC [I] is about techniques, techniques to be applied to students. (B1:I)

Only one teacher, who was one of the two state facilitators, managed to explain what KPEC I was convincingly:

⁹⁵ The number of teachers was higher due to: (a) teachers who were involved in KPEC I continued their involvement in KPEC II, and, (b) teachers had a better understanding of KPEC I from their involvement in KPEC II. In comparison, teachers in KPEC II may not have been involved in KPEC I.

KPEC [I] was a three-month project whereby we introduced ICT to the teachers to use in the classroom with their students. But, we helped the teachers first. What happened was, teachers were given lots of software, and they were given laptops and trolleys and were asked to use ICT in your class for at least one period in a week. [...] So in KPEC [I & II] we tried to change that perception so we helped the teachers with all their ICT challenges. We showed them, these are the ways you can integrate ICT into your class, be it a small thing. (A6:I)

Other stakeholders in KPEC I, primarily, three school heads (out of four) and the SEO, also believed that KPEC I's objectives and processes were not clear to them at the outset, and this impacted on the clarity of the ICTPD programme:

It is clear to me that the schools were not clear about what exactly KPEC [I] was. [...] Actually the programme started badly because the school heads did not understand the project. (S0:I)

With all the evidence presented, it appears that teachers' experiences of KPEC I were confusing and frustrating, with feelings of anxiety. According to Fullan (2001, p. 37), innovations need to be clear in their processes and objectives. The lack of clarity contributed to a less successful adoption of KPEC I.

The continual development of KPEC in KPEC II showed that the lack of clarity continued. Twenty-two teachers talked about their understanding of KPEC II implementation in their school, and 17 teachers related similar 'lack of clarity' of experiences in KPEC II, as demonstrated by these quotes:

Now the focus of the project is more towards activities. I mean more towards teachers using ICT. The important thing is that ICT is used in learning. That's how much I know about it. Meaning that I also fill the ICT template and all that. (C5:I)

KPEC [II] is about learning to use new ICT equipment, like the iBoard we just got. (B4:I)

KPEC II evolved to be an ICT skills based training programme. This point illustrates that the lack of clarity from KPEC I transitioned into KPEC II. Teachers and schools adopted ICT skills, which they perceived as an objective, and did not adopt new teaching practices. In short, the lack of clarity influenced the degree of adoption of KPEC.

The next section discusses KPEC's professional development (PD) process and its impact on the teachers.

7.8.2 Professional development process

Training programmes for teachers (national or state) in Malaysia are typically carried out in training centres, outside of school. In chapter 1, I differentiated between training and professional development. Training referred to national or state initiated programmes where teachers were selected to attend (top-down), and PD referred generally to school-based programmes where teachers usually volunteer to attend the PD (bottom-up).

KPEC I was innovative and unique because it was the first PD programme that was in-school, facilitated, and cluster-based. Thus, the in-school professional development process emerged as a factor. The facilitation process, in the context of this research, refers to teachers' acquisition of knowledge on coaching and mentoring, which included new teaching practices, or exemplars of practice. Further, these teachers had to implement the PD and, consequently, their perceptions and adoption of the facilitation process, including its roles and responsibilities, became important.

Thirty-six teachers commented on the facilitation process and the roles of facilitators, mentors, and mentees. Nearly all of the 36 teachers had different definitions and understandings of the facilitation process and the roles that facilitators, mentors, and mentees played in KPEC I and II. The data pointed to confusion by teachers and the lack of understanding of the PD process, as shown in Table 13.

Table 13: Different responses on facilitation and the roles of facilitators, mentors, and mentees in KPEC.

Theme	Teacher numbers	Quote (examples)
Technical support	6/36	I deal with technical with ICT support or problems. (D2:I)
Committee member	2/36	Mentors are part of the KPEC committee. (D6:I)
Receiving facilitation	4/36	Facilitators give information on how to do things [to me]. (C7:I)
Facilitating teachers	8/36	I facilitated teachers alongside the New Zealanders... (A6:I)
Teaching students	7/36	I'm a facilitator so I have to get students in groups and teach them ICT. (D10:I)
Do not know	9/36	I'm a mentor but I don't know what to do actually. (A5:I)

Of the 36 teachers, only two managed to explain clearly what their role was and what they did in the KPEC ICTPD programme. These two teachers were the two state facilitators. Other teachers' accounts showed that teachers were not clear in terms of what responsibilities they held and what they needed to do.

The data in the following sections mainly refers to KPEC I.

7.8.2.1 The adoption of the PD process

Twelve teachers discussed KPEC's professional development process and its implementation at school level. This school facilitator's detailed account captured some of the reasons behind the lack of understanding of KPEC I PD process:

Researcher:

Could you describe to me how the iNZed facilitators trained you as a school facilitator in KPEC?

Teacher:

So, they [iNZed facilitators] gave a presentation on how the programme was going to run. They didn't tell us how we were going to implement the programme. [...]How did it go? They said like this and then like that. If there are problems,

like this. It's not like they were involved together in the class situation. I wished that they gave advice on teaching and learning to make it interesting.

Researcher:

What do you mean by giving advice on teaching and learning?

Teacher:

Meaning that they gave ideas of what we can do. They didn't look at what we did. I think it would have been better if they showed us their way of doing things, how they did it in their classes in NZ, because they said everything is online over there. Try showing us how to do it first. An example would be good. And then we could try following what they did. It's not that we want to copy. [...] They didn't teach us anything at all. How do you expect us to do it? How can we do something when we don't know how to do it? [...] I think they should have given us a proper briefing. To all those involved. Tell us how to do it properly! If we don't have the required knowledge, teach us and train us before starting the programme. It was a shock when they suddenly came in and asked us how to do it! (A10:I)

This extensive quote indicates two key points in terms of teachers' adoption of the PD process in this research. First, teachers need to understand and be clear on the PD's implementation, and need a structure and planning to implement the PD. Teacher A10 stressed that she did not know what to do in the PD and needed advice and ideas. Teacher A10 required clarity in terms of the PD process, content and its implementation in school but iNZed did not provide it. Furthermore, the teachers in this study are used to following a clear structure based on firm planning as per their experiences of previous training programmes, as Teacher A10 suggests. Teacher A10 implied that iNZed did not fully understand the teachers who participated in KPEC I and assumed that teachers in this study could plan and structure a PD.

Second, the teachers who participated in KPEC I required additional or new knowledge in terms of supporting teaching practices in ICT, i.e., examples of best practices. Teacher A10 expected to gain new and appropriate ICT practices and be given exemplars. Teacher A10 was disappointed when she did not learn much from the iNZed facilitators. It may be that iNZed facilitators overestimated the level of professional knowledge the teachers in the research possessed. As

discussed in section 6.4.3.2.2, teachers' professional development routes (in diplomas or certificates or degrees), identified in this study, lacked certain types of professional knowledge such as pedagogical knowledge. Thus, the teachers who participated in KPEC needed sufficient pedagogical knowledge before they could implement the PD.

The evidence suggests that the lack of a clear structure, proper planning, and appropriate professional knowledge made it difficult for teachers to understand and adopt the new PD process. Teachers in this research, as the findings suggest, are used to being told what to do, how to do it, and when. The open-ended PD approach that iNZed took may be appropriate in the NZ context, but the evidence suggests that it did not work in this context.

7.8.2.2 Coaching, mentoring, and the reflective

process

Coaching and mentoring are two innovative and new features that were introduced in KPEC I as part of the PD process. Briefly, coaching and mentoring are interchangeable terms but are different, according to O'Connor & Ertmer (2006), because coaching is 'someone to learn from' and mentoring is 'someone to learn with' (p. 98). O'Connor & Ertmer point out that coaching and mentoring are often associated with PD programmes in schools.

The two state facilitators (Teachers A6 and C8) had to coach and mentor other teachers involved in KPEC (see section 5.3.3). These two state facilitators did not manage to explain what coaching and mentoring were and, instead, focused on what they did, as Teacher C8:I explains:

Researcher:

You mentioned previously about the training you received from the New Zealanders. Could you explain a bit more on that?

Teacher:

The training was more about coaching and mentoring.

Researcher:

Can you elaborate on that?

Teacher:

They [iNZed facilitators] taught us how to facilitate, according to the situation. They brought us [the two state facilitators] and we followed them to the other schools. They used us to approach the teachers in the schools and helped them interview the teachers, asked them about their subjects, how to teach and how to integrate ICT in teaching. (C8:I)

The quote implies that Teacher C8, as a state facilitator, did not clearly understand the processes involved in 'coaching and mentoring' and the role of being a coach and mentor. By limiting the 'training' to only the two state facilitators, this further compounded the lack of understanding and clarity in the facilitation process; most in-school facilitators and mentors did not understand coaching and mentoring. This may have influenced some school facilitators and school mentors to superficially adopt the ICTPD programme process.

Another key feature in the facilitation process was Reflection-On-Action (ROA). The ROA four-step model (as discussed in section 7.3.4.1), as part of the PD process, was conceptually difficult for these two state facilitators to understand. One of the two state facilitator's explanations of ROA revealed her level of understanding of ROA:

Researcher:

Could you tell me about Reflection-On-Action? What did you do when you carried out Reflection-On-Action?

Teacher:

Like this [ROA]. The teacher, after the lesson knows that we want to do reflection on what the teacher did that day. So we recall. What did you teach today? So, the teacher will tell me what happened. (C8:I)

The quote illustrates that the pre-requisite knowledge required for reflection either had not been taught to, or was not learnt by, these two state

facilitators. The quote also shows that the state facilitators superficially understood ROA.

Research also suggests that mentoring, coaching, and reflection requires experience to be effective (Lowther et al., 2008; O'Connor & Ertmer, 2006). Consequently, superficial knowledge about facilitation, and the lack of experience and support to scaffold facilitators and teachers, impacted on all the school facilitators, mentors, and mentees in KPEC I.

In summary, the data about the PD process, as evident in these teachers' accounts, illustrates that the iNZed facilitators did not ensure the teachers had an adequate level of knowledge required to implement KPEC I, and did not scaffold teachers' knowledge nor provide exemplars of ICT practices required for change. Further, the findings imply that this PD approach may not have fit this educational context without deliberate promotion of practices, new to these teachers, such as reflection, coaching, and mentoring.

The next section summarises the factors according to the ecological framework. This summary provides a link between the factors at three levels, i.e., individual (species), school (ecosystem), and cluster (system), and the innovation 'levels', i.e., the PD content, PD process, and PD structure. Further, this summary highlights certain linear factors that may have led to the superficial adoption of the innovation.

7.9 Summary on factors influencing adoption of KPEC

I summarise the factors that emerged to influence the adoption of the innovation in Figure 7.3, according to the ecological framework.

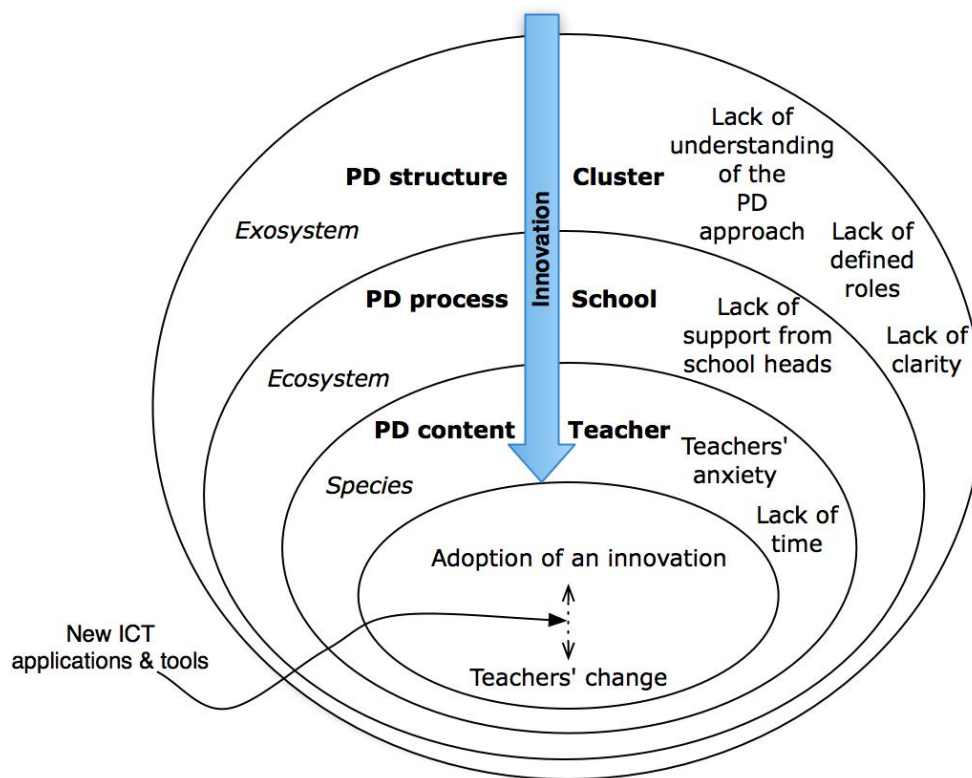


Figure 7.3. The adoption of KPEC framed in the ecological framework.

Teachers in this research appeared to have adopted new ICT applications and tools (as the dotted arrow indicates) as a component in the innovation (as the large middle arrow indicates).

In the ecological perspective, KPEC is viewed as a new 'invading' species that is introduced into the ecosystem. Thus, KPEC adoption occurred at three levels: (a) *at the exosystem* level, the schools adopted the cluster structure (implementation); (b) *at the ecosystem* (i.e., the school level), the school heads and teachers adopted the PD process (facilitation etc.); and (c) *at the species* level, the teachers adopted ICT skills and new teaching practices.

At the exosystem level, the lack of responses on the cluster⁹⁶ model by participants indicates that school heads and teachers did not adopt or understand the cluster concept. Thus, the cluster concept as an innovative

⁹⁶ Specific questions were asked about the cluster and its implementation.

feature of the ICTPD programme emerged as a factor that hindered the adoption of the ICTPD programme. The reliance on the *online* community⁹⁷ of practice as a strategy to bring together the schools within a cluster also appeared to have hindered the adoption of the ICTPD programme.

At the ecosystem level, three factors relating to the innovation⁹⁸ emerged: (a) the lack of clarity in KPEC's implementation; (b) the lack of defined roles and responsibilities in the KPEC; and (c) the lack of understanding in the professional development process (facilitation, mentoring, and coaching) appeared to have hindered the adoption of KPEC by teachers in all four schools.

In the ecosystem, one key factor emerged relating to the keystone species, i.e., the school heads. The support of the school heads, as similarly discussed in the previous chapter on teachers' ICT adoption, influenced the adoption of KPEC. The data indicated that the approach iNZed took had a detrimental effect on KPEC's adoption. However, the support of school heads as a factor cannot be separated from the issue that schools in this research were inundated with a multitude of innovations from the SEDO and the MOE. It may be that these schools were experiencing innovation overload and school heads have to prioritise and choose which innovations to support.

The adoption of the innovation by the dominant species, i.e., teachers, was negatively influenced by: the *lack of time*, which was traced to the curriculum and examinations, and *anxiety*, which was related to workload burden and language. The lack of time was a key factor in influencing teachers' decisions in adoption as a whole, in this research. Anxiety also impacted adoption: teachers viewed foreigners as bearers of 'extra' work, adding burden to their already

⁹⁷ The online environment (see Table 11), which was a strategy iNZed implemented to facilitate the cluster (organisation) and encourage online participation (between schools and teachers).

⁹⁸ I have placed the innovation at the ecosystem level due to its implementation i.e., the KPEC ICTPD was a cluster school PD programme.

heavy workloads. Teachers' perceptions of the 'white-man' power and education also became a barrier.

The introduction of newer ICT applications and tools benefited teachers in KPEC. However, the impact on student learning appeared to be limited to exposure to learning new ICT applications. Students were not given the opportunity to engage in new learning styles nor use new strategies, instead continuing with rote learning and using ICT as a tool.

In summary, the adoption of KPEC emerged to be superficial and limited. This research shows that the ecological framework can be used to gather and understand factors related to the adoption of an ICTPD innovation.

In this last section, I briefly reflect on the linear level of factors following the ecological framework on the two types of adoption, i.e., teachers' ICT adoption and the adoption of the innovation.

7.10 A short reflection on teachers' ICT adoption and the adoption of an ICT professional development innovation

In this chapter, as well as in chapter 6, the factors that influenced the adoption of the innovation were discussed in a linear approach to clearly elaborate on the influence of multiple factors at multiple levels. Figure 7.4 incorporates the two types of adoption (at different levels), in an integrated model.

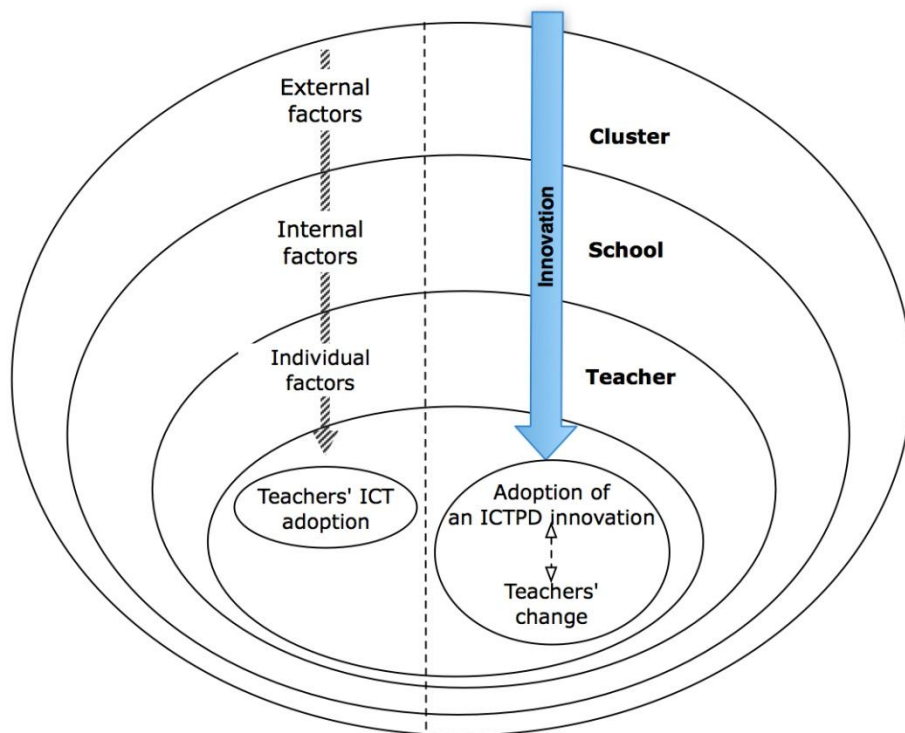


Figure 7.4. An integrated model incorporating teachers' ICT adoption and the adoption of an ICTPD innovation.

This integrated model illustrates the linear factors that emerged in teachers' ICT adoption in teaching and learning (left hand side of circle) and the adoption of an ICTPD innovation (right hand side of circle), as discussed in the previous chapter and in this chapter respectively. Even though teachers' ICT adoption in teaching and learning can be perceived as a linear process, the ecological perspective calls for a discussion on the complexities that occur in these teachers' adoption of ICT in schools. In the next chapter, I discuss the interrelationships between the species, i.e., the relationships between teachers and other stakeholders in the school, by integrating the ecological perspective and complexity thinking (see section 4.6.2).

In terms of the adoption of the KPEC ICTPD programme, complexity within the ecology and the interaction between species is discussed (in the next chapter) in relation to the processes that the schools and teachers go through in deciding whether to fully adopt, superficially adopt, or reject the innovation in

terms of the extent of adoption. The ecological model taken to describe the adoption of the ICTPD programme is different due to: (a) the need to focus on the factors and processes; and (b) the 'distance' between the innovation (the adapted ICTPD programme) and the local context (recipients of the adapted innovation). Further, the concept of 'distance' captures the two ideas in the ecological perspective: (a) that the innovation is an 'introduced' species that needs to adapt; and (b) the adaptation has to find a place in the ecosystem, leading to the extent of adoption or non-adoption.

In the next chapter, I will use the ecological-complexity perspective to discuss the adoption of ICT and will also use the ecological approach to elaborate on the processes teachers and schools went through in relation to the adoption of the ICTPD innovation.

8.0 DISCUSSION

The discussion in this chapter follows the dual lens approach (see section 1.2) used to differentiate between the two innovations or adoption processes, teachers' ICT adoption in teaching and learning and the adoption of the ICTPD programme.

In the first section of this chapter, I discuss the use of the ecological perspective and complexity thinking in articulating the processes and conditions that influence teachers' ICT adoption in teaching and learning. I elaborate on the influence of a variety of factors through three conditions in complexity thinking: (a) possibility of adoption and non-adoption; (b) stability and instability; and (c) feedback loops, both negative and positive (see elaboration in section 4.6.3). I have linked the three conditions to the different levels of adoption, from the individual or species level to the school or ecosystem level and the external or system level.

In the second section of this chapter, I apply the ecological perspective on the adoption of the cluster based ICT professional development (ICTPD) programme called K-Perak E-learning Cluster or KPEC. Tatnall & Davey's (2003) four conditions, referred to as themes in this chapter, are used to understand the dynamic processes that occur in the adoption of the ICTPD programme. The four conditions outlined by Tatnall & Davey (2003) are different to the ones used in complexity thinking and describe the processes teachers and schools go through when adopting an innovation (a professional development programme in this research). I use 'themes' instead of 'conditions' in this discussion to avoid confusion. In a latter section, I apply *distance* as a perceptual concept to explain the *space* between the school and the innovation. As noted earlier in section 3.4.4, the *adoption* of the ICTPD innovation is the focus in this chapter, rather than the transfer of the ICTPD innovation. The issue of transfer, for future research, is discussed later in section 9.4.

8.1 Teachers' ICT adoption in teaching and learning

In this first part of the chapter, I discuss teachers' ICT adoption in teaching and learning in relation to my theoretical framework. This initial discussion provides a basis for understanding ecological concepts, conditions in complexity thinking, and the multilevel complexity of interactions between species and systems used in this research. I later merge these three parts into my ecological-complexity perspective to discuss the emergence of teachers' ICT adoption in teaching and learning.

8.1.1 Ecological concepts

Traditional approaches to understanding ICT adoption, such as Tearle's whole school model and the ACOT model, encourage an examination of the factors in a linear way. The use of these two linear models, for example, would isolate specific factors or variables such as the teacher's age, and link that factor or variable to the teacher's ICT adoption process. The problem with this approach is that it is weak in describing the complex interrelationships between factors and the influence of the context or ecosystem on these factors.

To discuss the findings in the context of the ecological perspective I refer back to the key ideas, as discussed in chapter 4. To recap, Zhao & Frank's (2003) ecological perspective, is a multilevel model that takes into account different factors which influence the ICT adoption within an ecology (2003, p. 809). As explained in section 4.6.1, I have adapted four ecological concepts from Zhao & Frank and a fifth ecological concept from Hargreaves (1994), for the purposes of my research:

1. Schools as *ecosystems* which have hierarchies and are in a state of homeostasis.
2. Schools as *ecosystems* are made up of organic (e.g., teachers) and inorganic (e.g., computers) communities.
3. Teachers are the *dominant species* and school heads are the *keystone species*.

4. Each *species* has a *niche* with specific roles and responsibilities.
5. Innovations such as ICT are *introduced* and *as invading species* are also *disruptive*.

These five concepts provide descriptions for: (a) the ecosystem where teachers' ICT adoption occurs; (b) the characteristics of the dominant species in the ICT adoption process; and (c) the disruption caused by ICT, in teachers' ICT adoption in teaching and learning.

8.1.2 Complexity thinking and interactions in complex systems

In the theoretical framework chapter, I discussed the use of complexity thinking as a way to further understand ICT adoption within the ecological framework. Ecological concepts and complexity thinking are complementary; complexity thinking gives an approach to describing the variety of factors that interact within the individual, school, and society.

Complexity thinking extends my ecological framework in two ways: first, by adding an interactional element within both individual levels and different levels (i.e., complex systems which are nested) that interact with each other, and, second, by adding the conditions in which teachers' ICT adoption emerges.

Inherent in my ecological framework is the concept of a multilevel combination of systems, or 'multileveledness', as suggested by Boyatzis (2006). There are four levels in my ecological framework: the microsystem (teacher); the mesosystem (school); the exosystem (district); and the macrosystem (national), according to Bronfenbrenner (1979). However, in this chapter, these four levels are collapsed into three, following the structure of the findings in the previous chapters, starting from the microsystem (teacher), the ecosystem (school), and the system (external to the school, i.e., district etc.). *Multilevel complex systems*, as compared to large linear systems, according to Boyatzis, are characteristically: (a) non-linear; (b) evolving and adaptive; and (c) have structure and function.

Further, complex systems are also scalable, hierarchical, and interactive. Multilevel complex systems are: (a) *interdependent*, focusing on the interactions between the levels and components; and (b) *independent*, where simple systems are part of a larger complex system, as explained by Boyatzis. In other words, in *independence*, a species (such as the teacher) is considered an organism that is a part of a more complex system, i.e., a number of teachers within an ecosystem make up a dominant species. Further, there is *interdependence* in the ecosystem between species (such as between the dominant and keystone species), which influences teachers' ICT adoption in teaching and learning. Thus, in this chapter, the discussion assumes that:

1. The interactions between species and systems (e.g., ecosystem) influence the emergence of teachers' ICT adoption in teaching and learning.
2. The emergence of teachers' ICT adoption in teaching and learning is varied at different levels, depending on the influences stated above.

Similarly, in complexity thinking, large complex systems are made up of nested systems, which in turn are made up of smaller *interactive units* in a *complex unity*. According to Davis & Sumara's (2006, p. 146) concept of complex unity, the individual belongs to a social unit, or social units, that interact with other individuals, or units in a system, which has established norms (e.g., routines) and a collective identity (e.g., English teacher, in an urban school). In this case, schools are considered to be a complex unity, and teachers are individuals within it. In this chapter, I use Davis & Sumara's complex unity as a way to discuss teachers' ICT adoption in teaching and learning at different levels.

Generally, the main difference between linear and complexity thinking is that complexity looks at the network of behaviours or actions, with interconnected interactions, as compared to the linear perspective, which looks at what contributes to teachers' ICT adoption as an 'end-product'. In this research, adoption is not a 'product' at the end of a linear process. Instead, adoption is dynamic and constantly changes; it advances and regresses

depending on factors and interactions between species in the ecosystem, and the innovation. Even though the reasons behind teachers' ICT adoption are important, complexity thinking gives the researcher an understanding of not only the *what* and the *why*, but *how*⁹⁹ ICT adoption occurs in the context of the school. In other words, it provides patterns in which I can model an explanation within my qualitative research. Thus, complexity thinking provides a perspective on the interaction between the teacher's individual factors, the differences or variations in their adoption of ICT, and their difficulties in using ICT in teaching and learning in school.

According to Davis & Sumara (2006), complexity researchers have identified a number of conditions that give the researcher a way to understand the complex emergence of factors and adoption (as explained in section 4.6.3). Further, Davis & Sumara advocate researchers to select conditions that apply to them (p. 151). Hence, I have reflected on the range of conditions and have selected and adapted three conditions that apply to the context of the research. Davis & Sumara articulated that conditions should have a dual characteristic, and, as such, I have constructed my three conditions accordingly. They are:

1. Possibility of *adoption* and *non-adoption*.
2. *Stability* and *instability*.
3. *Feedback* loops, both *negative* and *positive*.

I recognise that there are other concepts and elements which relate to complexity thinking but, in this context, I consider these three conditions appropriate for describing teachers' ICT adoption in teaching and learning.

The possibility of adoption and non-adoption considers the interdependent relationship between the dominant species (teacher) and the keystone species (school head), in determining whether ICT adoption occurs in

⁹⁹ The *what, why and how* of a phenomena, as used by Lichtenstein & Plowman (2009) in explaining the emergence of leadership.

an ecosystem. The possibility of non-adoption, which is based on Davis & Sumara's (2006) concept of the possibility of dying (p. 151), also assumes that authority and power play a role. Stability relates to the ecosystem, specifically the activity and interactivity within a system that makes it stable, i.e., the school characteristics or culture or norms that exist and which influence ICT adoption. Further, complexity thinking assumes that instability, i.e., space for change to occur (adaptability), is possibly due to 'supportive' or 'complementary' characteristics that enable ICT adoption, as suggested by Davis & Sumara (2006, p. 151). Feedback loops are mechanisms that keep the system in check (negative) and the means to encourage characteristics or qualities that may be of use (positive). Feedback loops, in the context of this research, apply to policies or influences that perpetuate non-adoption or enable adoption. I stress that I have adapted these three conditions according to the purposes of discussing the complex factors that emerged using the ecological perspective.

8.1.3 The ecological-complexity perspective

The integration of the ecological concepts - the 'multileveledness' of the ecological framework and complexity thinking into an ecological-complexity perspective - provides an approach for discussing teachers' ICT adoption in teaching and learning. Figure 8.1 shows the merging of the ecological and complexity into my ecological-complexity perspective.

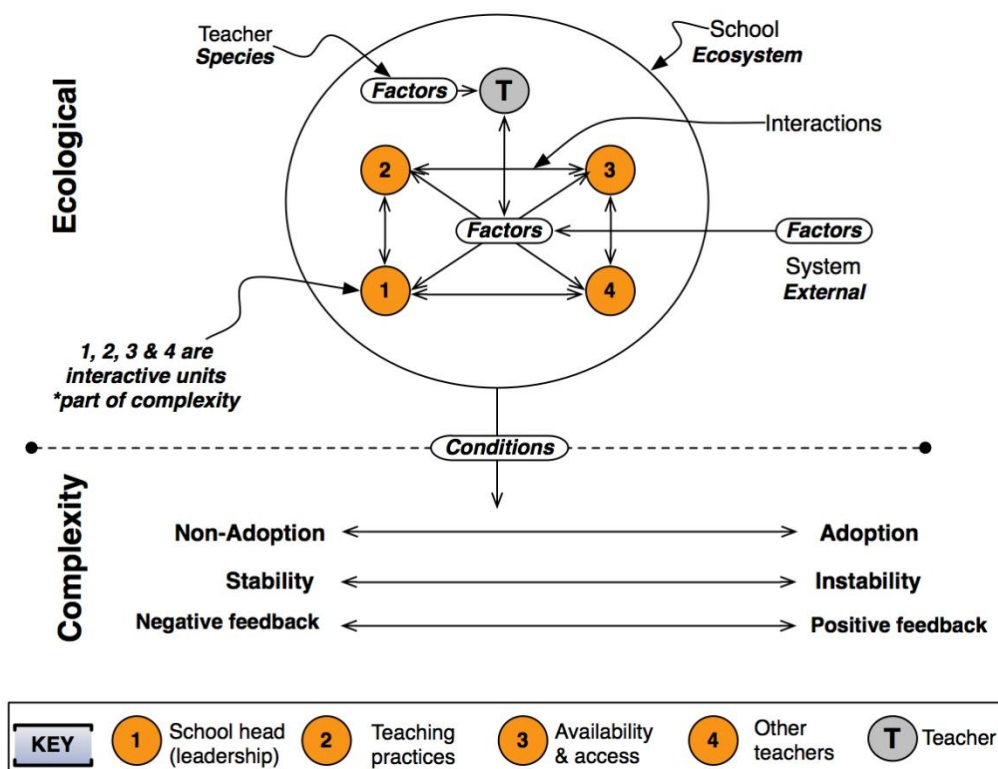


Figure 8.1. The ecological-complexity perspective.

Figure 8.1 illustrates the structure of the discussion on teachers' ICT adoption in this section. For example, in the following section I will integrate and discuss the adoption and non-adoption by teachers at the individual level in relation to factors (individual-school-external) found in my research in chapter 7.

To further focus on the interactional units within the ecosystem, I offer Figure 8.2 as an extension to Figure 8.1 and a basis for explaining how teachers' ICT adoption in teaching and learning in the school is affected by: (a) the degree of influence of factors, and (b) the interactions between the species. Figure 8.2 illustrates that teachers' ICT adoption in teaching and learning is complex, non-linear and dependent on a number of factors and interactions.

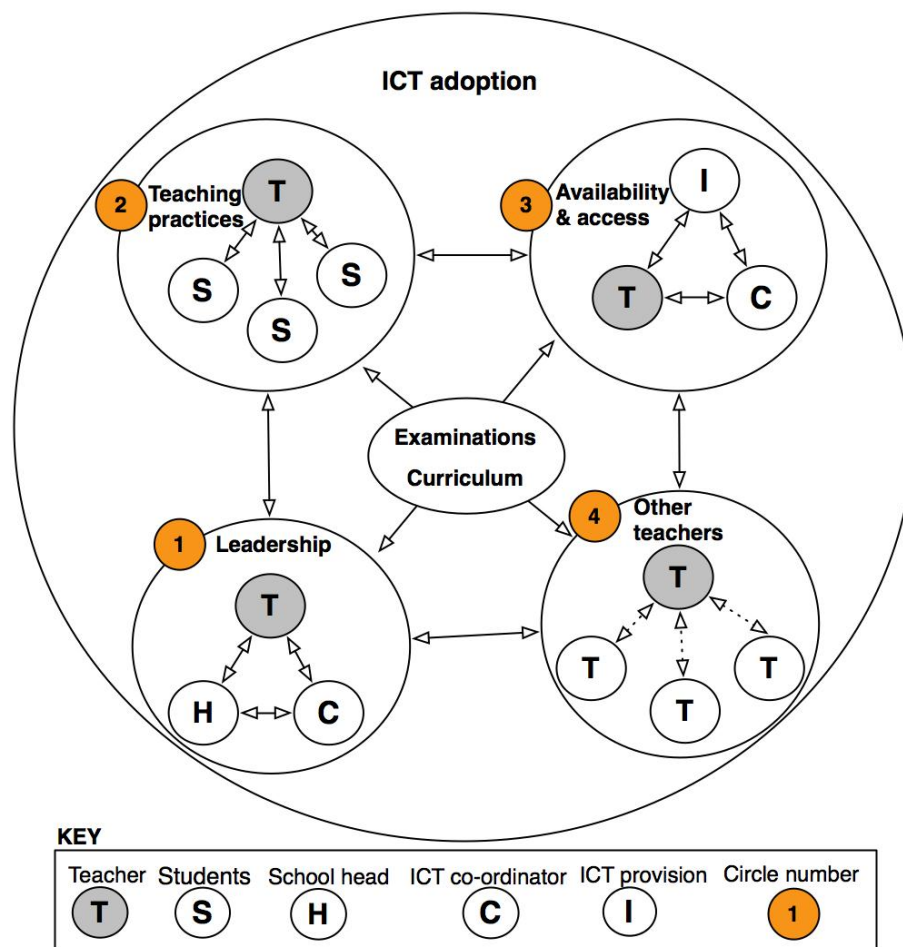


Figure 8.2. Interactive units in the ecosystem.

The numbered circles 1, 2, 3 and 4 represent the units of interaction, each of which has within it individuals in different contexts or interactional spaces that influence teachers' ICT adoption in teaching and learning.

Figure 8.2 shows the types of interactions between species that can occur. If the school head (as shown in circle 1) is primarily concerned with examination performance (as shown by the arrows from the large middle circle), the school head is likely to hinder teachers from using ICT because it disrupts the examination oriented process, i.e., the 'natural' state of the ecosystem. Further, individual teacher and teachers' collective interaction can either support or hinder ICT adoption in teaching and learning. In circle 4, teachers do not generally collaborate with each other, indicated by the dotted arrows. The dotted arrows show that teacher interactions do occur (e.g., in the teachers' common room) but does not necessarily support the development of professional

knowledge or ICT adoption. The data in chapter 5 indicates that two teachers (KPEC state facilitators) 'shared' or 'collaborated' with other teachers. However, in general teachers do not collaborate professionally. Figure 8.2 is used later in this section to frame and explain teacher and school's shifts according to my ecological-complexity perspective.

The next section explains in detail the complexity of teachers' ICT adoption in teaching and learning. I apply the three conditions in my ecological-complexity perspective at different levels, from the individual to the system.

8.1.3.1 The possibility of adoption and non-adoption

As mentioned earlier in this chapter, the possibility of adoption and non-adoption is based on the interdependent relationship or interactions between the dominant species (teacher) and the keystone species (school head) in determining whether ICT adoption occurs in an ecosystem.

Inherent in the possibility of adoption and non-adoption is the concept of 'shifts' between the possibility of adoption and non-adoption. I define shifts as a qualitative movement between these two 'states', similar to Tearle's continuum (see section 4.4.2). Rather than being influenced by factors per se, shifts are affected by the interdependent relationships between dominant species, inorganic factors, the keystone species, the ecosystem, and the external system. Teachers' ICT adoption or non-adoption shifts according to these influences and so does the level of ICT adoption in the school.

8.1.3.1.1 Dominant Species - teachers as individuals

The findings in section 6.4.4, at the individual level, show that ICT confidence played a role in influencing teachers' adoption of ICT. Kessler & Plakans (2008, p. 270) found that ICT confidence contributes to adoption of ICT

in the classroom. As shown in Figure 8.3, there are a number of factors that led to ICT confidence in individual teachers: professional motivation, teachers' professional development (specifically, ICT in-service training), teachers' experience in using ICT (as defined by teachers' pre-existing skills and use in ICT), and ICT ownership.

I illustrate the factors relating to teachers as individuals that emerged according to my ecological-complexity perspective. Figure 8.3 shows the teacher as a species and the relationship between the factors that emerged. Figure 8.3 is related to Figure 8.2 illustrated earlier. Each factor contributed to the development of the teachers' ICT confidence and consequently helped shift the teacher towards ICT adoption in teaching and learning. The emergence of these factors suggests that the ICT adoption of individual teachers is complex and largely dependent on the individual.

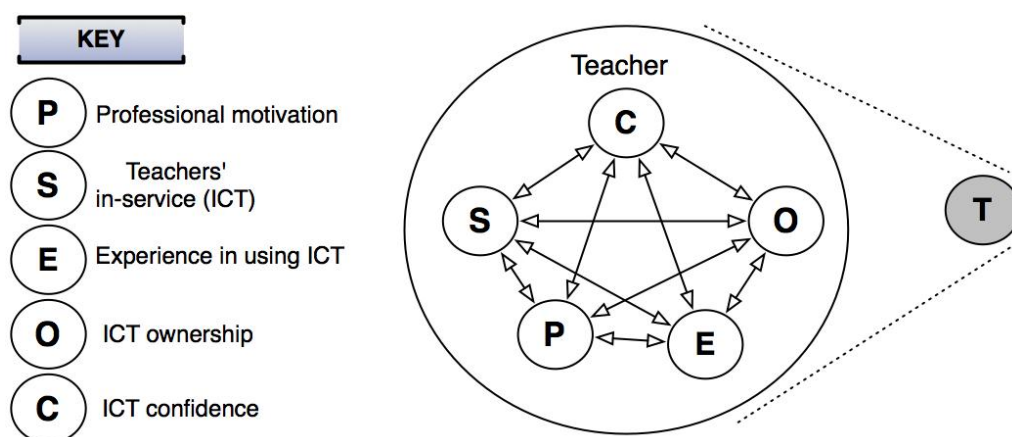


Figure 8.3. The complex relationships between factors in ICT confidence.

In Figure 8.3, the arrows indicate the complexity of relationships that occur in the process of developing ICT confidence. The findings in this research suggest that there are some reciprocal relationships, i.e., individual factors are interrelated, for example between teachers' in-service training and experience in using ICT for some teachers. Basically, Figure 8.3 focuses on the teacher as a dominant species.

8.1.3.1.2 Relationships between individual factors:

Teacher A5 & Teacher D12

The relationship between individual factors influences teachers' ICT adoption in teaching and learning. Teacher A5 adopted ICT for teaching and learning due to her need to teach Mathematics using ICT under the English for the Teaching of Mathematics and Science (ETEMS) programme. My findings in section 6.4.3.2.4 show that teachers who do not attend courses that build their ICT skills, are unlikely to have the confidence to use ICT in their classrooms. Haddad (2002) and Burniske (2002) stress the importance of in-service training (INSET) as an essential element in the integration of ICT in teaching and learning. Teacher A5 had learnt ICT during college and attended training to adopt ICT in teaching and learning under ETEMS. The requirement for teacher A5 to teach mathematics using ICT, though driven by policy implemented at school level, gave her the professional motivation to use ICT. In the ecological perspective, ICT has to fill a niche in order that teachers perceive it as a useful tool for administrative tasks or for teaching and learning. Teachers' professional motivation drives them to adopt ICT. ICT has to help teachers achieve goals, which they perceive as priorities in school.

Along with ICT skills, teachers need to practice or gain experience¹⁰⁰ (from courses or other teachers) in order to adopt ICT in teaching and learning. My findings suggest that teachers are more likely to use ICT progressively in their teaching when they have confidence and frequently use ICT in their classrooms (see section 6.4.4). Experience becomes a positive feedback loop for most teachers in the research. Teacher A5's experiences in using ICT in teaching Mathematics were positive for her and this reinforced her view that ICT was useful in her teaching and learning.

¹⁰⁰ Experience in this chapter refers to the frequency (practice) of teachers' use of ICT for teaching and learning (building towards a positive experience) and not related to teaching experience (general) or teaching practices (approaches).

Linked with ICT skills, ICT ownership is seen to help teachers to be confident users of ICT. Most teachers who are confident in ICT own laptops or computers. Ownership gives them an opportunity to try out and learn new software and find resources for teaching and learning. Twining et al. (2006, p. 46) emphasise the need for teachers to own laptops or computers, as it makes a difference to the adoption of ICT among teachers. In the research, teacher A5 owned a laptop, which she received as part of the ETEMS programme, and this gave her confidence to try new software and applications. She learnt to use web-based communicative applications and provided extra help and support for her students outside of school time.

Teacher A5 gives us a clearer understanding of how complex factors contribute to the development of ICT confidence and ICT adoption. Complexity thinking underscores that each teacher's ICT confidence does not necessarily lead to ICT adoption in teaching and learning. Teacher D12, who had training under ETEMS, had ICT skills and owned a laptop, did not perceive that ICT played a role in supporting his teaching. He was not professionally motivated to use ICT and perceived ICT as a hindrance because it did not help him achieve his goals as a teacher. ICT adoption for teacher D12 was affected at the individual level, as he shifted into non-adoption which may have been due to personal choice or lack of motivation or both. Further, the choices he made were partly influenced by the ecosystem or school.

Before discussing the influence of the ecosystem on the dominant species, my findings suggest that some factors were associated with the Malaysian context. Two characteristics of Malaysian teachers influence their adoption of ICT in teaching and learning. I will discuss these contextual characteristics according to the different levels presented in this section of this chapter.

8.1.3.1.3 Two characteristics of teachers in the

Malaysian context

From the findings, two characteristics emerged which are important considerations in the Malaysian context in understanding the behaviours or interactions that occur in both teachers' individual interactions and teachers' interactions in the ecosystem. The two characteristics are teaching practices (see section 6.5.2) and the lack of collaboration between teachers (termed as private practice teachers - explained in 8.1.3.1.3.2, as indicated by the teacher characteristics box in Figure 8.7).

8.1.3.1.3.1 Current teaching practices

The current teaching practices of teachers in the research schools are integral to our understanding of the interactions between teachers and students in the classroom. Practices taught in university and practices learnt vicariously from other teachers in the same subject area in the school influenced teachers' ICT practices, as similarly found by Mueller et al. (2008, p. 1533) and Judson (2006, p. 585). New practices did not emerge because teachers lacked the pedagogical knowledge necessary for integrating ICT in teaching. The contradictions between beliefs about what constitutes appropriate teaching practices in using ICT, and their own philosophical beliefs which underpinned those practices, mirror the observations found by Judson (p. 585). In this research, teacher A2:0 showed the contradictions between beliefs and practice. He believed that his teaching practices had changed and were appropriate and different when he used ICT in teaching and learning. However, observations showed that integration was superficial and instructional, and focused on the teacher.

8.1.3.1.3.2 Private practice teachers

Riel & Becker (2008) discuss that teachers can view their roles, i.e., their responsibilities and duties as teachers, as private (confined to the classroom). They term these types of teachers as private practice teachers:

Teachers with a private practice orientation have little time for meetings, conferences, or other forms of professional engagement. They use the textbooks, other supplied teaching resources or created materials and orchestrate their own instructional practices without significant input from others. (p. 398)

Most importantly, *private practice teachers* (PPT) focus solely on students' academic performance in their classes and choose to believe that their approach to teaching is the most effective way. Norton (2007) reported that the current practices of the teachers in KPEC I were based on textbooks. In this research, PPTs teaching practices were found to focus on examinations and covering the curriculum, which they perceive as being more efficient (see sections 6.5.1 and 7.6.1). Teacher D11 exemplifies PPTs in the research. This teacher voiced his objections to using ICT in teaching Mathematics in his examination class. He deemed ICT use as irrelevant as his teaching practices have always delivered good examination results. Any change, according to him, is unnecessary, as his current practices have been proven effective. Many other teachers in the research also expressed this point of view, but to a lesser extent. In Figure 8.7 (later in section 8.1.4), circle number 4, illustrates PPTs not collaborating (indicated by the dotted arrows) with each other to support their adoption of ICT in teaching and learning.

The following discussion focuses on the ecosystem.

8.1.3.1.4 The ecosystem

In my research, the four schools were different in their level of ICT adoption, as discussed in chapter 7. Figure 8.4 illustrates the school according to the possibilities of adoption or non-adoption. Schools A, B, C, and D are placed according to the findings in chapter 7. Figure 8.4 also shows that each school is able to shift towards adoption or non-adoption according to the influences within their ecosystem.

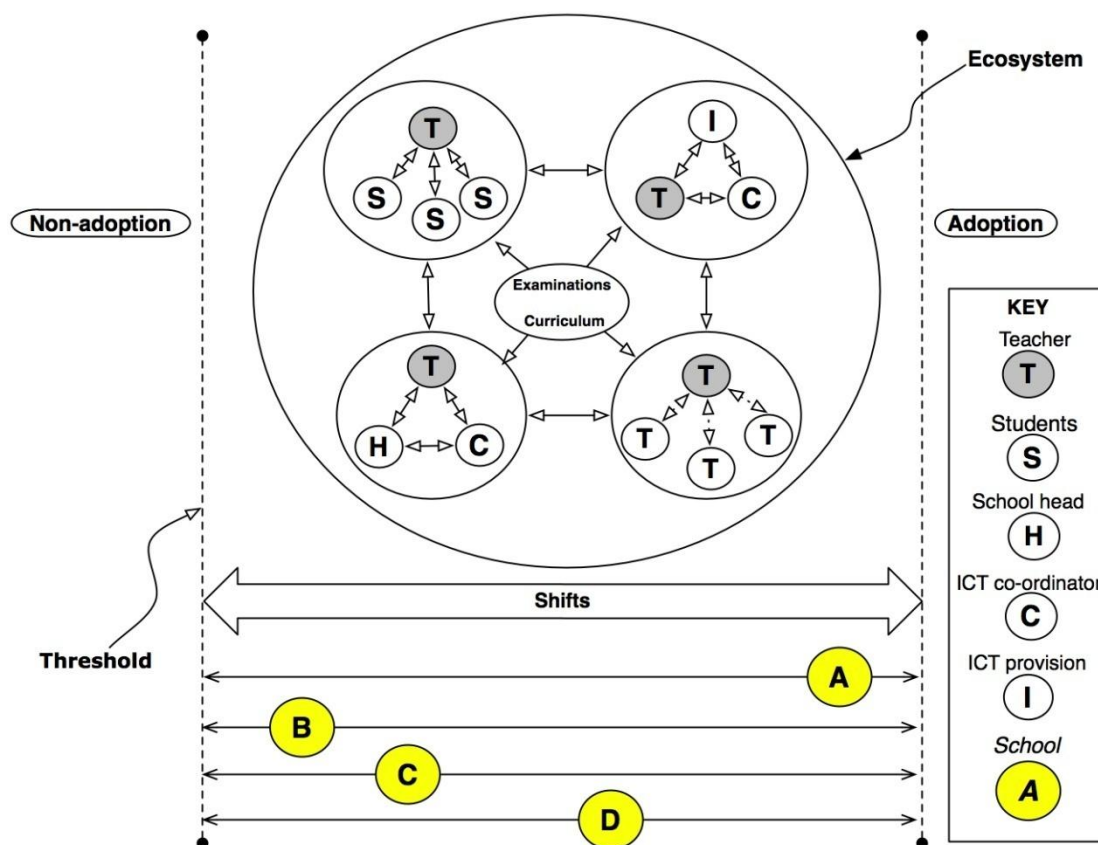


Figure 8.4. Shifts between adoption or non-adoption of ICT at the ecosystem level.

The possible shifts (as shown by the large arrow) towards adoption or non-adoption of ICT at the ecosystem level are shown in Figure 8.4. This figure also shows the degree of adoption or non-adoption in relation to the schools (i.e., A, B, C, and D) in the research. At opposite ends of the shifts, there are thresholds (as the broken lines indicate) for non-adoption and adoption. School A, for example, is on the threshold for ICT adoption according to findings in chapters 6 and 7.

8.1.3.1.5 The keystone species

The ecological perspective denotes the school head as the keystone species as she has the most influence in that ecosystem. Researchers in complexity thinking, such as Lichtenstein & Plowman (2009) consider the leader

of an organisation (e.g., the school head) as the central decider (p. 617). Thus, the school head, i.e., the keystone species, can determine the interactions that influence ICT adoption in teaching and learning.

The shifts in individual teachers' ICT adoption are influenced by the interactions teachers have with the school head, the availability and access to ICT, the pressure (or non-pressure) to teach to the examinations, and the needs of the curriculum, as earlier illustrated in Figure 8.2. The findings in this research indicate two major concerns which influence the keystone species and the dominant species - the examinations and the curriculum. These concerns exert pressure on the ecosystem and species to act accordingly. Findings also show that external factors, such as ICT policies and community involvement, further influence the shift towards ICT adoption or non-adoption.

The patterns of interactions within the school are largely influenced by the school head, i.e., school leadership. The literature has shown the influence of leadership on teachers' ICT adoption. Fullan (2000, 2001) and Tondeur et al. (2008) argue that innovations such as ICT require leadership and a supportive environment. Dexter (2008) and Tearle (2003, p. 573) further argue that effective leadership is a strong indicator in ICT adoption in schools. Thus, school leadership plays an important role in two ways, first, in ICT provision, and second, in providing the opportunity for ICT to be integrated into the school's 'core business' of delivering the curriculum and ensuring good examination results.

The school heads as keystone species have hierarchical or positional power, as suggested by Handy (1993), which influences teachers' shift towards adoption or non-adoption. School heads, attributable by their support and actions, affect not just individual teachers but all teachers in the school. Leadership influences either the possibility of ICT adoption or non-adoption, i.e., the possibility of teachers using ICT in teaching and learning or otherwise.

8.1.3.1.6 Interactions between species and inorganic factors in school

In School A, with the highest ICT adoption level, there were a number of factors that influenced the possibility of adoption. The school head used ICT personally, had knowledge about ICT, and created an ICT school system to benefit the teachers in the school. Further, she encouraged and supported teachers in all ICT initiatives. The school head provided two ICT coordinators and further support for her teachers while they taught in the computer labs. The teachers in the school also felt that there was an opportunity to adopt ICT in teaching and learning when computer labs were available. In general, teachers in this school were more likely to adopt ICT.

In contrast, School C shifted into the possibility of non-adoption due to the pressures of the examinations and curriculum coverage. Teachers in that school felt pressured to ensure that their students performed well in the public examinations. The school head gave superficial support to the teachers in the school with regards to ICT. Findings in that school showed that there were teachers who adopted ICT. However, further ICT adoption in teaching and learning by these teachers and other teachers, were hindered by the lack of support from the ICT coordinator and the lack of ICT facilities available in School C, even though they were motivated to use ICT in teaching and learning.

Pressures or concerns within the ecosystem influence how species interact and thus, affect inorganic components (such as the ICT provision, and its availability and access) and reinforce certain priorities. The next section discusses the effect of stability and instability in teachers' ICT adoption.

8.1.3.2 Stability and instability: ecosystem and species

Stability relates to the ecosystem, specifically the activity and interactivity within a system that makes it stable, i.e., school characteristics or culture or

norms that exist which influence ICT adoption. Complexity thinking assumes that *instability*,¹⁰¹ i.e., space for change to occur (adaptability), is possible due to 'supportive' or 'complementary' characteristics that enable ICT adoption. Schneider & Barsoux (1997, p. 79) quoted Hofstede's study that indicated that Malaysia has 'large power-distance' (LPD) and 'weak uncertainty avoidance' (WUA). In LPD, power is unequal and is accepted by the less powerful (e.g., the school head holds power in the school (autocratic) and teachers accept that they have to follow her directives), and people with WUA require structure and order with clear rules and guidelines. These national characteristics indicate that organisations in Malaysia like the MOE tend to be hierarchical (power is concentrated at the top and distributed unevenly), and, more importantly find discomfort in uncertainty and prefer predictability and stability (hence conflict avoidance). Schools in Malaysia exhibit these traits.

8.1.3.2.1 Two characteristics of Malaysian schools

There are two characteristics of Malaysian schools that further influence ICT adoption in schools. They are: (a) the lack of interaction or collaboration between schools, and (b) the dependency of schools on the MOE. In explaining stability, I first take into account these two characteristics, which are present in the research schools.

8.1.3.2.1.1 *Lack of interaction between schools*

One salient characteristic of the schools in the research is that these schools did not interact with each other, even though they belonged to a cluster (KPEC). For example, School A, an innovative ICT school before participating in KPEC, was unable to influence other schools in the cluster to adopt new projects and programmes, or to share its knowledge and expertise across the cluster. Mioduser et al. (2002) describe a similar phenomena in the adoption of a

¹⁰¹ A property of the steady state of a system such that certain disturbances or perturbations introduced into the steady state will increase in magnitude. (<http://amsglossary.allenpress.com/>)

curricular innovation, where schools can become islands of innovation, unable to extend the innovation beyond that of a teacher or a group of teachers in one school. Mioduser et al. use of the term 'islands of innovation' can be considered, at the school level, as 'island schools'. In this research, 'island schools' is used to show the isolation of one school from another, so as to ensure competitiveness, for example, in delivering examination results.

8.1.3.2.1.2 *Dependency*

One characteristic of ICT implementation in Malaysia, as previously discussed in chapter 2, is that all ICT funding, development, and maintenance is managed by the MOE. The dependency on the MOE and the SEO (implementers) at the state or district level has created a dependent relationship in which schools are more likely to 'wait and see' rather than take the initiative. Schools B and D did not maintain or repair their computers in the labs because they were dependent on the MOE to provide direction, finances, and contractors to carry out the work. Schools A and C, however, took the initiative and lessened their level of dependency by engaging the parents or the business community or both. Dependency was still evident but to a lesser extent.

The culture of competitiveness or non-collaboration and the dependency on the MOE show that the research schools were constrained in their ability to adopt ICT. These two characteristics partly influence whether the schools were stable (*stability*) or lacked stability (*instability*) or are between the two in the adoption of ICT and also the adoption of an ICTPD innovation. In complexity thinking, stability is dependent on the dominant species, the keystone species, the inorganic factors, and the interdependent relationships or networks that exist in an ecosystem. However, instability in the ecosystem is preferred as it allows for, in this case, ICT adoption to occur.

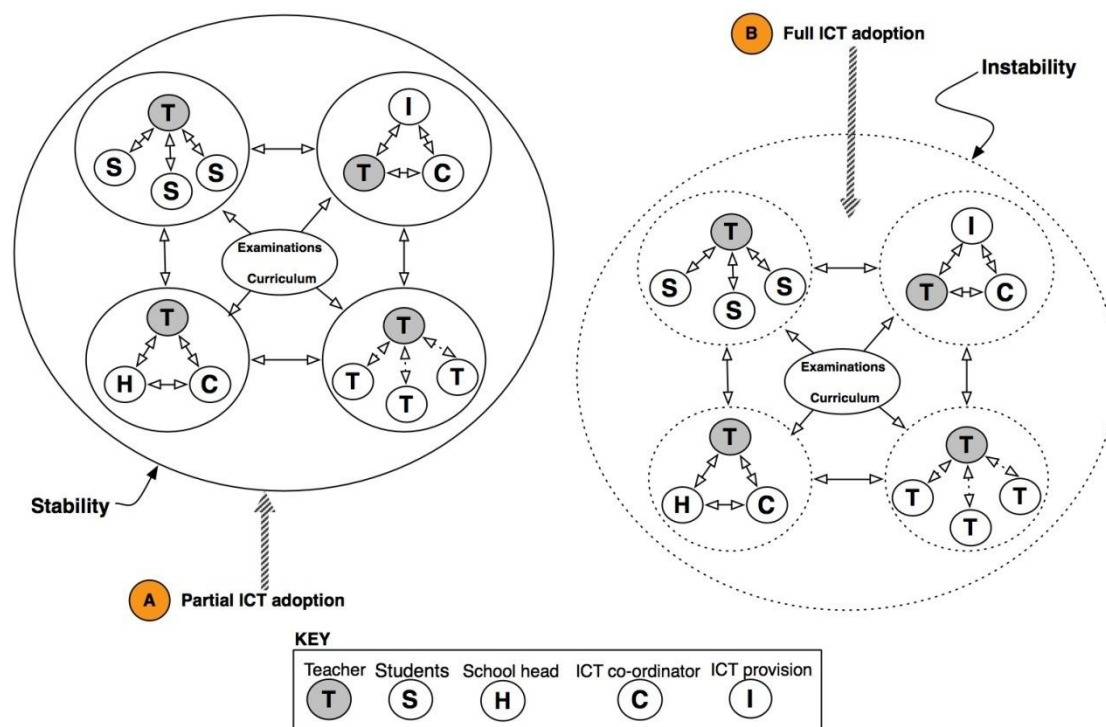


Figure 8.5. The differences in ecosystem states - stability and instability.

Figure 8.5 shows that in *stable* systems, ICT adoption remains at the periphery of the ecosystem and is superficially adopted (partial adoption, as indicated in *circle A*). In contrast, *instability* provides space in the ecosystem and its species is able to adopt ICT (may lead to full ICT adoption, as indicated in *circle B*). The interactions between species and other factors are influenced by the adoption of ICT. In stability, the boundaries are defined (as indicated by the circle or circles in (A)). In contrast, the boundary is permeable (less defined) in instability (as indicated by the dotted circle or circles in (B)).

8.1.3.2.2 Ecosystem shifts - stability

Ecosystems can shift between stability and instability. Stability implies that the ecosystem is unable to change or adopt ICT, due to the school routines and norms that the ecosystem prioritises or is concerned with. In this research, School C exhibited stability. The school was rooted in its concern to maintain the school's performance in the public examinations, and the teachers' practices and routines revolved around examinations. The documentation on examination statistics and other artifacts (photographic evidence) showed that the school

prioritised examinations above the adoption of ICT by teachers (from findings in the previous chapter). Stability, thus, does not provide space for ICT adoption, or any other non-examination innovation, to disrupt the school. In School C, ICT was perceived to be disruptive and remained in the periphery. Due to its stability, ICT adoption remained superficial in terms of the schools' support and commitment in ICT, as articulated by Teacher C8.

Similar to School C, School B also exhibited stability. School B was also concerned with achieving examination results and covering the curriculum. Teacher B1 expressed his anxieties in attempting to use ICT and covering the curriculum for the examinations. He chose to superficially adopt ICT, admitting to pressure put on him by the school head to ensure that his students would pass their examinations, leading him to minimally adopt ICT in his teaching and learning.

8.1.3.2.3 Ecosystem shifts - instability

Instability in an ecosystem, in contrast to stability, is reflected in the way the school adapts or accommodates change - in this case, the adoption of ICT. Instead of routines or norms becoming enculturated or locked within defined boundaries, small changes occur within the interdependent relationships between the dominant and keystone species, their interactions with inorganic factors, i.e., access and availability of ICT, and the balance between pressures to ensure that the school still manages to deliver examination results. Instability occurs when the school gives space to individuals within the ecosystem to adopt ICT. Providing space for teachers to adopt ICT is seen in School A. School A has adapted its routines to incorporate ICT into the daily processes. Teachers in School A are required to create lesson plans and schemes of work through an online system created by the school head. Teachers are encouraged to initiate ICT projects for their classes in school A. The school head, as Lichtenstein & Plowman (2009) suggest, engendered an ecosystem of 'discomfort' (p. 622) among the teachers by encouraging and discussing ICT adoption in the school, which created instability in the ecosystem. Teacher A10 expressed her view that

other teachers, whom had yet to adopt ICT, felt anxious and she had noticed that a number of them started to ask her to help them learn ICT. The interactions between dominant species and the keystone species in the ecosystem help foster the collective need and shared understanding to adopt ICT. Further, the emergence of the collective need for ICT was intensified by these interactions in the ecosystem.

Even though School A provided spaces for ICT adoption, examination results were excellent, comparable to School C's achievement. The difference between School C and School A was that School A's routines and norms were not bound rigidly by examinations and the curriculum. The head of School A played a role in creating an environment that encouraged and supported the adoption of ICT among the teachers. Further, ICT was perceived as supportive to the achievement of the school and had a place in teaching and learning. School A's instability enabled the school to adopt ICT, and thus, affect the species in the ecosystem.

The next section elaborates how feedback loops, either positive or negative, have an effect on the ecosystem and species.

8.1.3.3 Feedback loops: positive and negative

Ecological models or theories use the term 'feedback loop' to indicate causal loops, i.e., biological causes, as explained by Zhao & Frank (2003). Davis & Sumara (2006) use the thermostat as a metaphor to illustrate feedback loops. If the room temperature falls, the thermostat increases the heat and vice versa (p. 102). In other words, feedback loops are mechanisms that keep the existing system in check (negative), and the means to encourage characteristics or qualities that may be of use (positive). Feedback loops, in the context of this research, apply to policies or influences (e.g., directives or factors that control the ecosystem) which constraint or enable adoption.

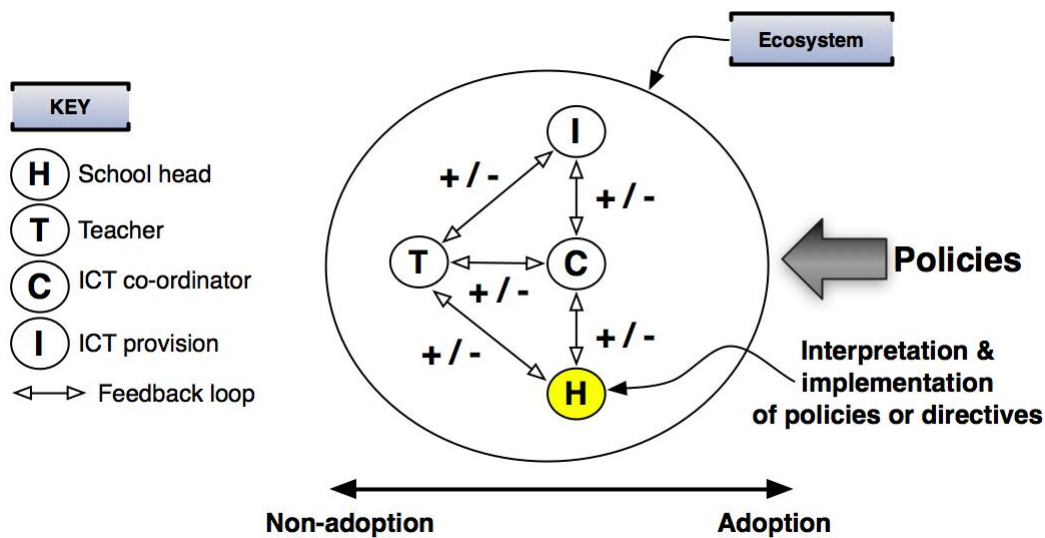


Figure 8.6. Feedback loops that occur at the ecosystem level.

Figure 8.6 illustrates the feedback loops that occur at the ecosystem level and are influenced by policies or directives from the system (e.g., the MOE). The positive and negative feedback loops (as indicated by the plus and minus sign) influence the interactions between the teacher, the school head, the ICT coordinator, and the provision of ICT within the school or ecosystem. The interpretation and implementation of policies (in ICT) is dependent on the school head (as indicated by the arrow and text). The school, thus, shifts to either adoption or non-adoption.

The findings in this research show that there were a number of policies which affected the schools' ability to adopt ICT. Policies that keep the ecosystem and system (external to the ecosystem) in check are negatively viewed in the context of ICT adoption. The findings highlighted that a number of policies were evident to influence the adoption of ICT. They were, by order of introduction, Computers in Education (CIE), ICT Literacy (ICTL), EST (English in Science & Technology), English for the Teaching of Mathematics and Science (ETEMS), and The Smartising of Schools (TSS). The myriad of policies implemented at the ecosystem level led to the fragmentation of ICT, according to subjects and priorities. Further, policy interpretation at each ecosystem differed.

8.1.3.3.1 Feedback loops: negative

The negative feedback loops were primarily centred around the influence of policy on ICT provision and resources available for teachers. The dominant species, who had ICT skills and confidence to use ICT for teaching and learning, could not access the computer labs or other ICT resources due to policy prioritisation. Findings in School A showed that teachers could not gain access to the computer labs due to subject prioritisation, such as ICTL and ETEMS. These two policies constrained teachers' ICT adoption in all schools in the research, because teachers under ICTL and ETEMS have allocated periods and scheduled access to computer labs. All other teachers have to book a time for their classes to enter the computer labs. Furthermore, policies can be used negatively by the keystone species. In school B, the school head used TSS policy to limit the types of activities and the subjects for which the access centres could be used (see section 6.6.2.1). In School C, the school head quoted CIE policy as a constraint. The school head mentioned that the maintenance of computers in the computer labs could not be done due to policy, which stated that computer parts could not be replaced without permission. This influenced the ICT coordinator and, thus, influenced the provision of ICT in the schools. Many teachers in School C complained about the state of disrepair of the computer labs. The feedback loop within the ecosystem of School C was negative among the species and this influenced the degree of adoption in the school.

8.1.3.3.2 Feedback loops: positive

Positive feedback loops can occur in the ecosystem. Policies, as found in the research, are interpreted and implemented differently by the keystone species and the dominant species across ecosystems. School A's head found that older policies, such as CIE, did not support her vision of an ICT capable school (she termed it as a cyber school). Instead of citing CIE constraints, the school head interpreted that the 'obsolete computers' that were out of warranty could be fixed by the community rather than the school. Thus, she maintained the computers with the help of the parent-teacher association (PTA), which ensured that all the computer labs in his school were working. With newer policies, such

as the TSS policy, the school head extended the use of the access centre as an inclusive learning centre, open to students after school hours. Policies implemented in school A created a positive feedback loop for the dominant species. The teachers saw opportunities to use ICT for teaching and learning due to the availability of computer labs. Teachers were encouraged to adopt ICT in teaching and learning as frequently as possible, which led to minor conflicts when certain subjects were prioritised. In school A, positive feedback influenced teachers' adoption of ICT.

Feedback loops can be in tension, shifting from positive to negative according to how policies are interpreted and implemented. The findings on teachers' perception of the ETEMS policy on ICT adoption showed that policies influence teachers' ICT adoption superficially, i.e., create a negative feedback loop. Teacher A1 admitted to using ICT in teaching and learning due to the ETEMS policy. Without the ETEMS policy, the teacher would not adopt ICT to teach his subjects. This means the ETEMS policy can also be positive, in terms that the teachers in the school who usually would not use ICT in their teaching and learning, used ICT because they were told to do so. From there, many teachers saw the benefits of adopting ICT in teaching and learning, and started to incorporate new ICT applications and resources beyond that of the ETEMS courseware.

8.1.4 Teachers' ICT adoption in the ecological-complexity perspective

Referring back to Figure 8.1, which provided the structure for the discussion and using the findings in chapter 6, I illustrate teachers' ICT adoption in teaching and learning (see Figure 8.7, below) according to my ecological-complexity perspective.

The purpose of presenting Figure 8.7 first is threefold:

1. To provide a model of the interactions between species, the ecosystem and within a larger system, i.e., the 'multileveledness' or nested systems.
2. To illustrate the four main *interactive units* that can influence teachers' ICT adoption, i.e., teacher practices, teacher interactions (or the lack of it), school leadership, and the availability and access of ICT.
3. To show the influence of the context of the research, i.e., the Malaysian *characteristics* that emerged to influence teachers' ICT adoption, and possibly adoption as a whole.

This is essentially a meso-level model, illustrating the interactional units (as per Figure 8.1), the species, and the ecosystem.

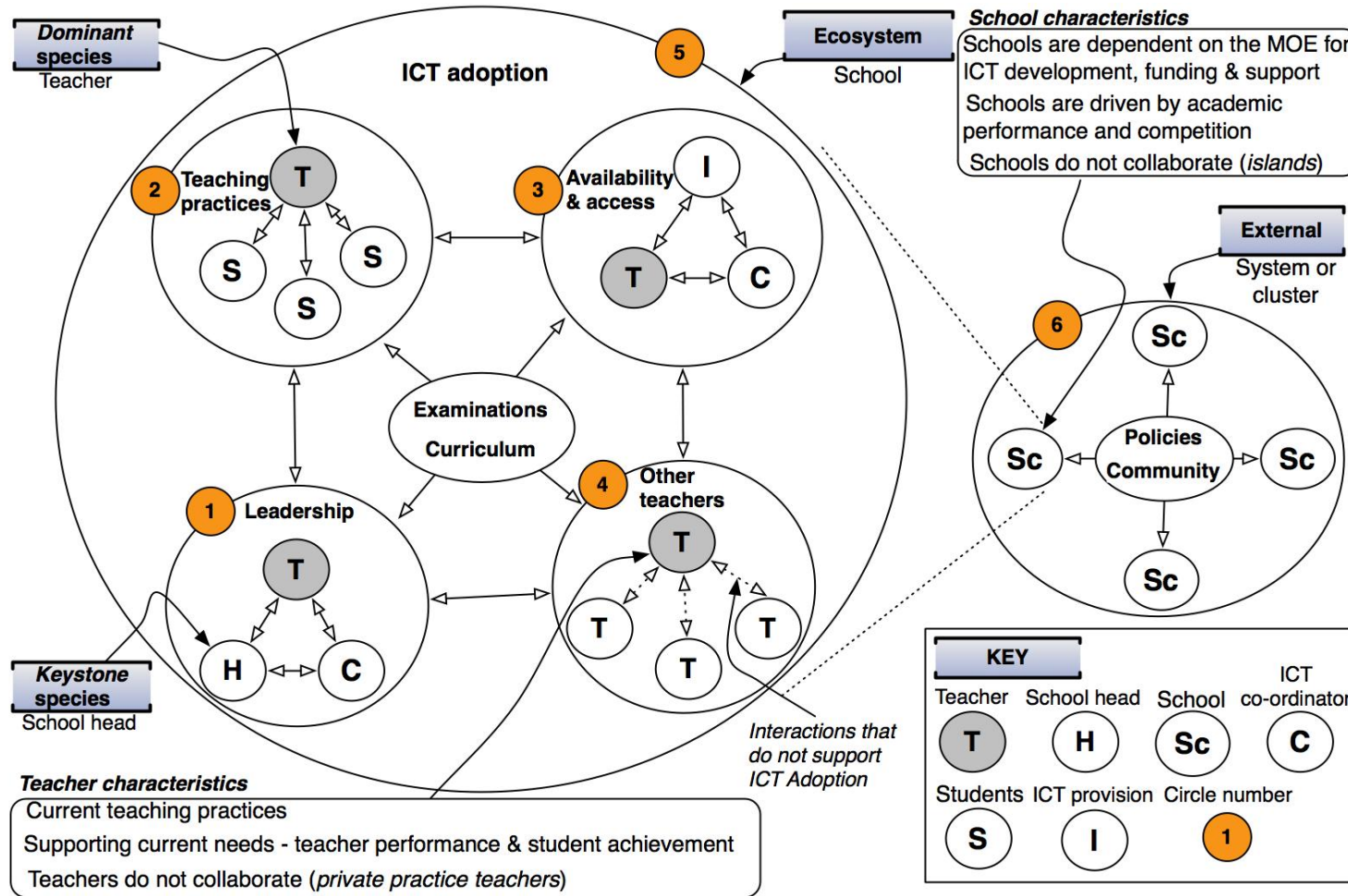


Figure 8.7. A model of interactions and the emergence of teachers' ICT adoption in my ecological-complexity perspective.

Figure 8.7 illustrates the complexity of interactions between individuals and factors at different levels, and characteristics that influenced teachers' ICT adoption in the research. I have *not* illustrated the shifts according to the three conditions outlined in this chapter, as they have been illustrated previously.

The following is a brief explanation of Figure 8.7. I have opted to explain Figure 8.7 in relation to the two main influences in both chapters 6 and 7, i.e., the influence of examinations and the curriculum. I draw upon these two influences following my ecological-complexity perspective. The rationale for applying these two main influences is that they are the main concerns for teachers and schools.

8.1.4.1 The interaction between the external system and the ecosystem

Figure 8.7 shows that the two main circles, numbered 5 and 6 respectively, represent the *ecosystem* (school) and *external* (system). In each of these two circles, two factors or concerns influence the smaller units in each circle. In circle 5, the examinations and curriculum influence the ecosystem. In circle 6, the policies and communities pressure the system and the ecosystem. Findings show (see section 6.5) that in the ecosystem, the examinations and curriculum primarily influence the interactions of teachers with other individuals (teachers) or other species (school heads) in the ecosystem (school). Policies and communities are secondary influences (indirect) for individuals but primary (direct) influences for the school.

8.1.4.2 The interaction between individuals and collective concerns in the ecosystem

The findings in chapter 6 (see section 6.4) demonstrated that the influence of factors was slightly different for each individual or teacher. Further, at the school level, these influences were also different from school to school (see section 6.5). What has emerged from the research concerns not only the individual but also concerns the school, as a collective in the ecosystem. In other

words, the collective concern at school level, i.e., the need to perform in examinations and cover the curriculum (as factors or properties), influences the individual teacher to act or perform accordingly. The combination of both individual and collective needs influenced teachers' ICT adoption in the ecosystem.

8.1.4.2.1 Interactional units in the ecosystem

The numbered circles 1, 2, 3 and 4 represent the units of interaction, each of which has within it individuals in different contexts or interactional spaces that influence teachers' ICT adoption in teaching and learning. Depending on (a) the degree of influence of factors, and (b) the interactions between the species, ICT adoption in teaching and learning in the school is affected. For example, if the ICT coordinator helps to support the teacher and there are available computers and access to computer labs, teachers would be more likely to use ICT in teaching and learning in the school (as shown in circle 3). However, if the school is more concerned with examinations, the conditions which led to the teachers using ICT are influenced or modified to accommodate that concern, i.e., the teachers will use ICT to help students perform better in exams and thus choose instructive approaches to teach (as shown in circle 2). Figure 8.7 also shows teacher characteristics (as shown by the box at the bottom left) that primarily hinder their adoption of ICT, such as the need for them to teach for the examinations, which in turn influences their practices, e.g., focus on rote learning.

8.1.4.2.2 Keystone species

Chapter 6 indicated that school leadership is a factor which influences teacher adoption of ICT in schools. Figure 8.7 shows that if the school head (as shown in circle 1) is primarily concerned with examination performance (as shown by the arrows from the large middle circle), she is likely to reinforce and influence the teacher to either use ICT in teaching for learning for examinations, or hinder teachers from using ICT because it disrupts the examination oriented

process, i.e., the 'natural' state of the ecosystem. Further, the school head interactions with teacher and ICT coordinator (in ICT) can be supportive or otherwise. Thus, the ICT coordinator's support of the teacher is dependent on the support he or she receives from the school head (as the arrow indicates). In sum, the leadership does not only influence the individual teacher, his or her teaching practices, and the support the teacher receives, but also the other teachers in the school.

8.1.4.2.3 Species and ecosystem characteristics

The other teachers (as individuals) belong to a school culture (characteristics that define the school - as shown in box in upper right of Figure 8.7) that either supports or hinders ICT adoption (as shown in circle 4). Further, the teachers exhibit certain characteristics that either support or hinder their adoption of ICT in the classroom. In circle 4, teachers do not generally collaborate with each other, indicated by the dotted arrows. The dotted arrows show that teacher interactions do occur (e.g., in the teachers' common room) but they generally do not support the development of professional knowledge or ICT adoption. In terms of the external system, the cluster schools in the research were influenced by the local factors, i.e., the community they belong to and the MOE policies. Again, schools reflect the teachers' non-collaborative feature, due to the competitive nature of the examination-oriented nature of the system.

Figure 8.7 is a meso-level model that illustrates the individual teacher in different interactional units of concern or influence within an ecosystem. The ecosystem, in turn, belongs to an external system, which consists of other schools in the local, district, and national context. Figure 8.7 illustrates that teachers' individual factors, and the interactions and concerns of the school and the system as a whole, influence teachers' ICT adoption in teaching and learning. Thus, the emergence of teachers' ICT adoption in teaching and learning is complex, non-linear, and dependent on a number of factors and characteristics.

8.1.5 Emergence and teachers' ICT adoption

Emergence is a way to understand how adoption may be *facilitated* and *nurtured* at different units, interactions, and levels. Further, emergence focuses on the sum effect of different factors and interactions between units and levels which contributes to the materialisation of innovations, species and niches. The use of emergence, along with the ecological-complexity perspective, provides further insights into teachers' ICT adoption in teaching and learning and the ICTPD adoption.

8.1.5.1 Species and niches

My research has illustrated that there is a need to think about the dynamics of the emergence of ICT adoption, focusing on non-linear effects and a network of factors which work together to shape patterns of interactions between the keystone species (school heads) and the dominant species (teachers) and their negotiation of constraints and conflicts (factors that hinder adoption). These interactions and negotiations in the ecosystem may trigger the emergence of adoption but can also lead to non-adoption.

As the ecosystem is nested in a complex system, the emergence of ICT adoption within a cluster can occur across schools if other schools similarly adopt ICT. Figure 8.8 illustrates the factors, conditions, and emergence of ICT adoption in my research.

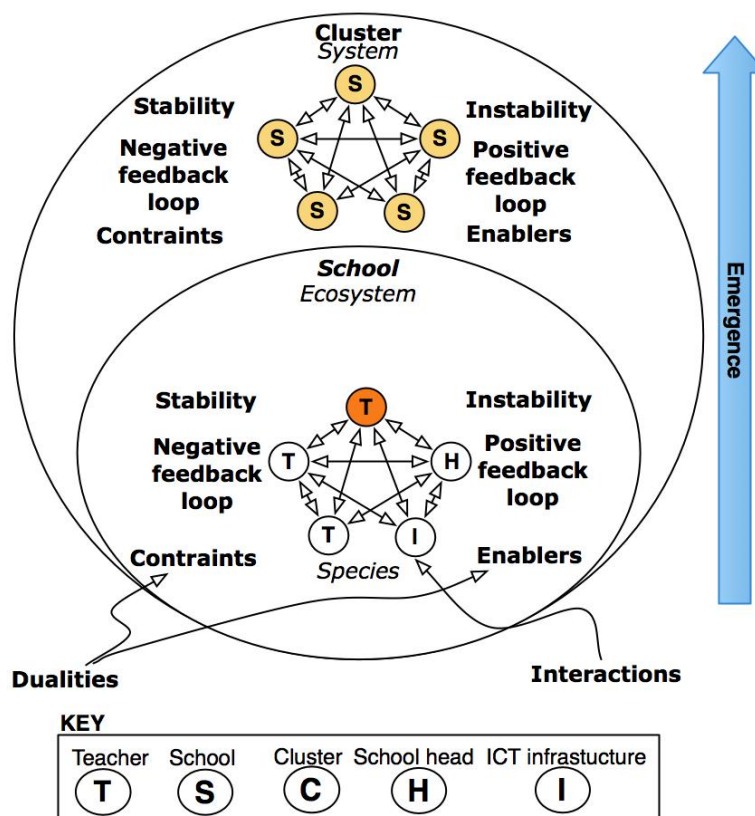


Figure 8.8. The emergence of ICT adoption at different levels.

On the right and left of Figure 8.8 are dualities that influence the emergence of ICT adoption. On the left of Figure 8.8, the conditions and constraints influence non-adoption, while the right influence adoption. These dualities are nested within a complex system; the possibility of emergence is illustrated reflecting concepts in my ecological framework.

The keystone species are a catalyst for teachers' ICT adoption in the ecosystem. The behaviour of the keystone species serves to either foster networks of interactions, which offer opportunities for the dominant species to deal with constraints and enable adoption, or to present constraints, which limit adoption. My research further highlighted that negotiation of constraints occurs at the meso-level (school), which also reflects the broader dynamic influences from the macro-level (system). The system influences the ways the keystone species deal with constraints or enablers at the ecosystem level, the management of networks (interactions between species and inanimate factors as shown in

Figure 8.8 - ICT infrastructure), and the 'empowerment' of the dominant species to adopt ICT in teaching and learning.

Keystone species can be viewed as *managers of emergence* in the ecosystem, as enablers of ICT adoption. In other words, the keystone species is an essential part of the interactive dynamics at the ecosystem and system, i.e., an important part of a broader dynamic, as suggested by Marion & Uhl-Bien (2002). Thus, ICT adoption is not only *bottom-up*, from the individual level factors as discussed in chapter 7, but also *top-down* from the system level factors, also discussed in chapter 7, with recursive interactions at all levels from the individual to the system and vice versa, as outlined by Davis & Sumara (2006).

Although not an intended outcome of my research, the ecological-complexity perspective has reframed my understanding of school leadership in complex organisations. I recognise the influence on my thinking and trace it back to the use of complexity theory and evolutionary theory espoused by Fullan (2000, 2001).

Essentially, school leadership in my ecological-complexity perspective is similar to the *leadership of emergence*, as suggested by Lichtenstein & Plowman (2009). According to these authors, the leadership of emergence is a complex systems leadership theory, which discusses how leaders nurture the emergence of an innovation (or change) at different organisational levels. For example, at the school level, the school leader has to manage, facilitate, and nurture the emergence of ICT adoption in teaching and learning, as shown by School A's head, influencing the network of interactions between teachers in school instead of leveraging on hierarchical control, as school heads of School B and D did in my research.

The leadership of emergence is, thus, a new approach to understanding the role of the keystone species in an ecosystem. In practical terms, I perceive it as a way to further explain the need to support and nurture school leaders for

the emergence of ICT adoption, from the view of policies at the system level, which are enacted at the ecosystem level of the school.

My research has pointed out that the ICT coordinator played an important role as a species, in supporting teachers and ensuring the ICT infrastructure was maintained. ICT coordinators evolve to become an emergent species within the dominant species as they fill a niche or adapt to a different role, apart from being a teacher. The roles and responsibilities of this new emergent species or, as I define it, a *niche species* in ICT, is reconceptualised as managers, facilitators, and nurturers of change in the school between species, towards the adoption of ICT.

Thus, school leaders need to empower ICT coordinators to support teachers and facilitate communications between school leaders and teachers, and vice versa. In ICT literature, this extension of the role of the ICT coordinator is called ICT leadership, according to Kennewell, Parkinson, & Tanner (2000), or teacher leaders in ICT, according to Riel & Becker (2008). However, the empowerment of ICT coordinators in such rigid and stable ecosystems (as discussed in the previous chapter) requires a shift in thinking by the school leadership. Further, school leadership has to assume a new role as managers of ICT emergence in their schools.

Apart from niche species, other niches can occur in an ecosystem. According to Conole, de Laat, Dillon, & Darby (2008, p. 522) niches can adapt as individuals adapt ICT tools for particular needs rather than using ICT for the sake of using ICT, i.e., teachers adapt technologies to their particular circumstances. In my findings, I discussed how two teachers adopted communicative technologies to help them connect with their students to offer support and help. In other words, adaptation occurred and a niche (or specialization) emerged. According to Nardi & O'Day (1999, p. 49) tools can change or coevolve over time.

Adaptation occurs in complexity along with self-organisation. Species diversity may occur as ICT adoption occurs in the school. New niches may emerge in terms of different technologies (e.g., new Web technologies), which

may be adapted to suit different species in an ecology. Teachers' ICT adoption, as outlined in section 6.5.2.2, was hindered by the lack of suitable ICT 'oriented' teaching practices (constructive or transformative) and pedagogical knowledge. I traced this factor back to their professional training, which focused on traditional or instructive practices (see section 6.4.3.2.3).

To enable teachers' ICT adoption in teaching and learning, training for pre-service and in-service teachers should include learning-centred constructivist pedagogy. Apart from this, teachers should also learn to reflect on their teaching and learning, and share and collaborate with other teachers in professional discussions in school.

Overall, for teachers to adopt ICT in teaching and learning, they would require: (a) ICT skills (basic), (b) pedagogical elements (teaching), and (c) change enablers (strategies in reflection and collaboration). With respect to change enablers, teachers require strategies to help them cope with constraints, such as the lack of time and examinations, in order to find 'space' for them as individuals to adapt and change. This is similar to a proposal by Clarke & Hollingsworth (2002, p. 965) for an interconnected model for teacher professional growth as it looks for non-linear structures and change sequences that contribute to teachers' growth. Clarke & Hollingsworth (2002) point out that these perspectives are reflective of the types of interventions carried out to change teachers. In other words, ICT training in the ecological-complexity perspective is about teacher change and less about ICT.

8.1.6 Summary

Previous research related to teachers' adoption of ICT (especially in Malaysia), as shown by Afshari, Bakar, Luan, Samah, & Fooi (2009) and Melor (2007), has commonly presented a 'laundry list' of factors but has not linked the factors affecting adoption at different levels. The ecological perspective and complexity thinking, i.e., my ecological-complexity perspective, provides a unique understanding of ICT adoption beyond that of the traditional linear

perspectives. In the linear approach, factors are ordered in a hierarchy or according to importance. The factors gathered using theories and models, such as ACOT (see section 4.5), were sufficient in giving me a linear understanding of teachers' ICT adoption. Though linear factors are useful as starting points for further exploration, by using the ecological perspective as a frame and complexity thinking as a scaffold, I have understood that teachers' ICT adoption is able to shift from one qualitative state to another (non-adoption to adoption) based on a confluence of factors situated in the context in which the ICT adoption is occurring. Furthermore, the system or external influences may constrain or enable ecosystem shifts, either to enable or hinder ICT adoption. The ecological perspective, which includes complexity thinking, supports Fullan's (2000) assertion that the connection between cause and effect is difficult to identify and that complexity can offer another approach to understanding change.

As a part of my ecological-complexity perspective, complexity thinking provided a deeper understanding of the emergence of factors and the emergence of ICT adoption. Furthermore, in expressing the three conditions in relation to emergence, I was able to understand the interdependencies of the emergence of ICT adoption in a school and the emergence of ICT adoption across schools (at the system level). Originally, the framework included the individual (micro), the school (meso), and the external (macro). In reflection, my research has evolved to essentially be a 'meso-theory' (see Figure 8.7), as suggested by Lichtenstein & Plowman (2009). It has primarily two levels of analysis, one concerning the individual adoption (teachers or others in the school) and the other, the organisational adoption (in the school). The interdependent relationships between the species and the organisation are important linkages between these two levels in the model.

Leadership, specifically in relation to the role of school heads, arose as a key concept in the ecological-complexity model of teachers' ICT adoption. In addition, a niche species, which was related to ICT leadership in school, was identified as playing an important role in teachers' ICT adoption. The implication of *leadership of emergence* in this context recasts school head roles in

schools; instead of managing ICT, school heads should nurture and facilitate ICT. Extending *leadership of emergence*, the ICT coordinators are considered as the niche species in schools that not only manage ICT but become agents for change and teacher leaders for ICT adoption in teaching and learning. As a result, I suggest that school policies should reflect the emergence of leadership and offer training and support for school heads and ICT coordinators.

To nurture teachers' ICT adoption in teaching and learning at the individual level, I simply suggest that ICT training programmes in Malaysia (pre-service and in-service) should include pedagogical elements as well as components to enable teachers to change. In this way, teachers may be able to reflect and change when ICT is adopted in their classrooms.

The second section of this chapter discusses the ecological perspective in relation to the innovation. The innovation is the cluster based PD programme, called KPEC ICTPD, which was carried out by Innovations New Zealand Education (iNZed) and K-Perak Incorporate (KPI).

8.2 Adoption of an ICT professional development innovation

8.2.1 Ecological perspectives: species, ecosystem and disruption

The teachers' adoption of KPEC as an innovation and the factors related to the individual teachers, the school, and the ICTPD programme were discussed in the previous chapter. In my discussions of the findings, I implied that KPEC had an impact on the teachers' ICT confidence but did not change their teaching practices, as illustrated by the ACOT stages (see section 7.5).

In the theoretical framework chapter, I discussed how an innovation is perceived to disrupt the ecology of the school when an innovation is introduced to the dominant species in the ecosystem. To recap, the dominant species is the teacher, the ecosystem is the school, and the KPEC ICTPD programme is the

innovation. In this part of the chapter, I discuss the adoption of the innovation by the dominant species, following Tatnall & Davey (2003), and the disruption of the ecology by the innovation, according to Zhao & Frank (2003; 2002), in relation to the key species within the ecosystem. Then, I apply the concept of *distance* (see section 4.6.5) to discuss the degree of adoption by schools in relation to the innovation.

8.2.2 K-Perak E-Learning Cluster (KPEC) as an innovation

Fullan (2001) states that there are four features in initiating and sustaining change in educational contexts (as discussed in section 3.4.3) in terms of an innovation: (a) the suitability of the innovation at the district and school levels, i.e., whether the innovation fits the *needs* of the district or the school; (b) the clarity of the goals of the innovation; (c) the extent and difficulty of implementing the innovation, i.e., the *complexity* of carrying out the innovation; and (d) the quality and practicality of the innovation, i.e., the accomplishment of the goals of the innovation and how good it is.

This conceptualisation is similar to the ideas in the theoretical framework in chapter 4, where I merged Zhao & Frank's (2003) ecological theory with further innovation related refinements from Tatnall & Davey (2003). The four characteristics related to the adoption of an ICTPD innovation were:

1. *Co-operation*, which relates to factors that influence how a school receives an innovation (within the school context).
2. *Energy and satisfaction*, which relates to the effort required for adoption of an innovation (in this instance, the ICTPD innovation) and its subsequent satisfaction as a result.
3. *Competition*, which relates to other innovations or projects that compete with the innovation.
4. *Filling a niche*, which relates to whether the innovation fills a need in the school and the teachers.

Fullan's (2001) and Zhao & Frank's (2003) assertions on change and innovation illustrate the need to incorporate complexity and compatibility in understanding the factors that affect the adoption of an ICTPD innovation and its subsequent impact on teachers.

Figure 8.9 illustrates the main concepts and ideas in relation to the adoption of the KPEC ICTPD programme as an innovation.

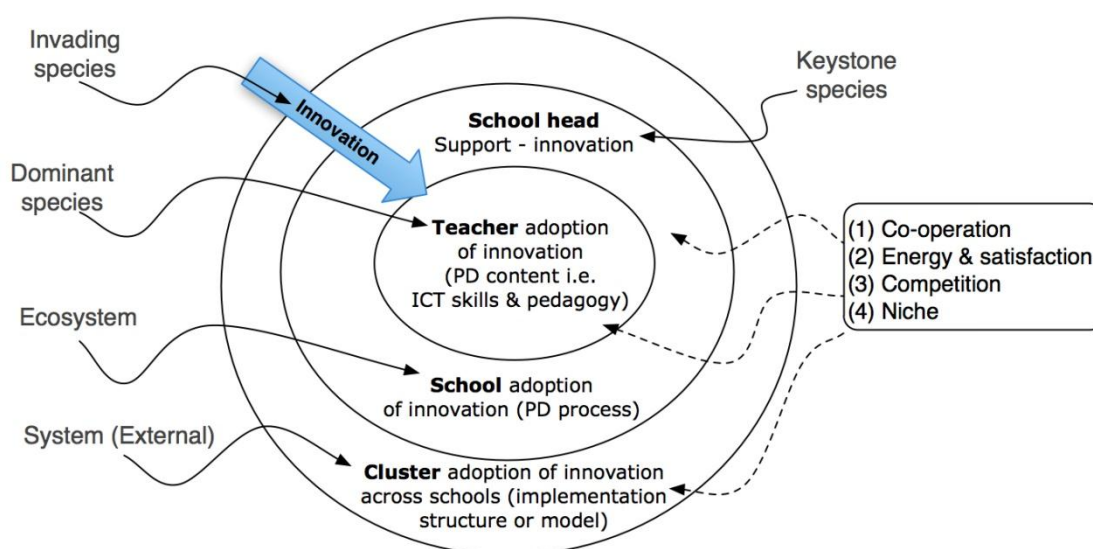


Figure 8.9. The levels of adoption in relation to the components of the innovation.

The innovation is a species introduced into the ecosystem, which invades and affects the school and the teachers (as shown by the large blue arrow). The school's adoption of the PD processes (in-school facilitation) occurs at the ecosystem level. The keystone species can either support or hinder the adoption of the innovation. The teachers' adoption process (the PD content) is subsumed within the school adoption process. The cluster model is also part of the PD process at the exosystem level. The four characteristics (as shown in the box above): (a) co-operation; (b) energy & satisfaction; (c) competition; and (d) niche, are applicable at all levels (as indicated by the broken lined arrows).

In the following four sections, I use the term *themes* instead of characteristics, because themes indicate an area for discussion rather than characteristics, which may indicate a typical trait. Further, I use ecological terms (e.g., invading species), as well as terms used in the findings (e.g., innovation), interchangeably.

8.2.3 Theme 1: co-operation

In Tatnall & Davey's (2003) ecological model of ICT innovation, *co-operation* looks at how the species and the ecosystem, including the factors that influenced them, supported the adoption of the innovation. To clarify, this means that co-operation is understood by existing factors which are able to support the innovation in relation to the species and ecosystem.

To discuss co-operation, I first examine how the innovation did not co-operate with the species in the ecosystem, i.e., the perceptions of school heads as keystone species and the perceptions of teachers as dominant species. I discuss these perceptions in the context of (a) the bottom-up approach taken by iNZed to initiate the innovation, which influenced the school head, and (b) the in-school facilitation process, i.e., the coaching and mentoring for teachers, which influenced the superficial adoption of the innovation. Then I will discuss how the innovation did not co-operate with the ecosystem, i.e., focusing on the cluster concept and its adoption, associated with sharing and collaboration across schools.

The keystone species, i.e., the school head, as noted earlier, is the most powerful species in the Malaysian school ecosystem. In my findings, school heads played an important and pivotal role in the adoption and support of the innovation. Further, the school head in each Malaysian school holds hierarchical power, as described by Handy (1993; 1995), by virtue of the position and is *the* person with the most power and influence. As such, the school head defines all decisions about any innovation in terms of uptake and implementation. This

reflects the bureaucratically controlled and centralised educational system upon which Malaysia is based.

According to my findings, the strategy taken by iNZed personnel in approaching schools in the case study conflicted with the power relations in those schools. The facilitators from iNZed approached teachers rather than the school head in their initial survey, without first approaching (and discussing with) the school head about the selection of teachers for KPEC. School D's head explained that she was not consulted during this process. The other school heads had similar comments. Consequently, school heads perceived that they were sidelined, which led to misunderstandings between iNZed and the school heads when it came to implementation and support (across schools and within their school). The school heads were non-committal, giving superficial support to KPEC. This approach appeared to seal the fate of KPEC's implementation and its potential. All four schools were late in implementing the innovation and teachers took two to three weeks to start their ICT challenges. Though school heads did not hinder the implementation process, teachers perceived that their school heads were not supportive of KPEC and, thus, teachers did not commit fully to KPEC.

The innovation implementers did not co-operate with teachers in providing them with adequate knowledge to implement the PD process. Findings show that iNZed *assumed* that these teachers had prior knowledge and certain practices (pedagogy) which would support their PD processes, for example, the use of reflection-on-action (ROA) and the use of coaching and mentoring. Teacher C8 exemplified the lack of prior knowledge, which led to superficial understanding of ROA. Findings showed that teachers had no prior knowledge of pedagogy¹⁰² related to ICT, nor of the reflective teaching culture. These types of

¹⁰² Pedagogy in this research relates to teaching approaches or practices. The data collected in this research specifically looks at ICT pedagogy. However, it is uncertain why (from the data) teachers in the research generally did not understand the term pedagogy, even when rephrased as teaching practices. Tentatively, it implies that teachers were trained without knowledge of or an understanding of pedagogy. My

knowledge were evidently lacking in teachers in the case study. In short, it seems that iNZed did not understand the needs and requirements of the teachers in terms of their strengths or weaknesses.

The innovation, as a whole, did not co-operate with teachers and schools in terms of outlining clear objectives and processes. Fullan's (2001) clarity of an innovation, in terms of goals and means, is applicable here, as it illustrates that if an innovation does not have clear goals and processes, the innovation is unlikely to be well received and understood. Schools and teachers were unclear about the professional development process in KPEC (as discussed in section 7.8.2). Teachers were unclear of the processes that underpin the PD process in KPEC, and, moreover, the roles and responsibilities assigned to them. Most teachers, like Teacher C1 and B4, thought that KPEC was about learning new ICTs (related to teaching) and carrying out micro-projects, i.e., ICT challenges for students. Further, teachers did not clearly understand KPEC's objectives and its linkages to their adoption of ICT in teaching and learning. Teacher B7 conveyed that she did not understand KPEC's objectives and questioned whether KPEC was for teachers or students.

At the ecosystem and the system (external) levels, the innovation did not co-operate in two ways: the objectives of the cluster (i.e., collaboration and sharing between schools was incongruous with the priorities of the schools), and adequate ICT provision to support the innovation. The cluster concept, as related in the previous chapter, did not co-operate with the schools due to the existing characteristics of these schools, which are in competition with each other, as mentioned in ICT adoption. Associated with this is examination and curriculum, two priorities, which will be elaborated upon later in this chapter. Thus, collaboration and sharing, as a component in KPEC, did not cooperate with the schools.

experience has been that teachers are trained to deliver content (concentrate on teaching), instead of understanding and linking practice with learning.

Other ecosystem factors such as the lack of adequate ICT infrastructure did not co-operate with the innovation. The unavailability of ICT labs, lack of functioning computers, and poor connectivity hindered the innovation. Though iNZed tried to mitigate these factors, for example, by providing additional laptops, nevertheless teachers perceived ICT infrastructure as hindering KPEC's implementation.

In sum, the innovation was only partially adopted by the species within the ecosystem due to: (a) the initial strategy of approaching the teachers rather than the school heads; (b) the lack of clarity in terms of the innovation's implementation and objectives; and (c) insufficient ICT infrastructure.

8.2.4 Theme 2: energy and satisfaction

The main thrust of this theme relates to the effort required to adopt the innovation and the achievement of the intended outcome. Energy and satisfaction are intrinsically associated with two factors - examinations and the curriculum. The findings indicated that teachers perceived KPEC I and II required a great deal of effort and the outcomes of the ICT challenges did not justify the effort required.

Effort in this context relates to teachers' effort required to carry out the ICT challenges (specific ICT activities), as required by KPEC I and II. Teachers perceived KPEC I and II as an additional burden or workload, which competed for their teaching time in school. Teacher A8 explained that KPEC activities became a burden because it took time to prepare, set up and implement the ICT challenges. Teachers, like teacher D8, were worried that their 'core business' of delivering results in examinations, and the related need to complete 'the syllabus', were in jeopardy due to the frequency of ICT challenges. Teacher B7 did not find any purpose in carrying out ICT challenges in relation to student learning, and questioned the overall objectives of KPEC in relation to her subject teaching. Teacher D9, found that the ICT challenges were a benign process of

teaching and learning using ICT, in which the final outcome was a form to be filled.

Similarly, in the earlier discussion of Theme 1:Co-operation, the lack of clarity in KPEC objectives meant that ICT challenges were confined to ICT skills acquisition and not the wider student (learning) achievement objectives, as stated by iNZed in the KPEC report. Thus, teachers in KPEC I and II found that the effort required to implement the innovation did not satisfy their needs in achieving better student performance and delivering their curriculum objectives. The superficial adoption of the ICTPD programme, as illustrated by KPEC II's focus on ICT skills, implies that schools were spending less effort and energy on the innovation and were concentrating on a single outcome - examination results.

One of the objectives outlined in the K-Perak Incorporated's (KPI) conditions in implementing KPEC was that the innovation *improved* schools' performance in examinations. According to school documents, the classes involved in KPEC had an impact on the performance of students in their school examinations, shown across the cluster. However, the data or documents did not indicate how KPEC specifically improved test or exam scores, nor were they verified using quantitative analysis. Rather, they were simple comparative data sets. Thus, it is possible that there was no correlation between implementing ICT challenges and better examination results; the claim may simply serve to justify the implementation of KPEC. As noted in chapter 7, school heads did not commit to the ICTPD programme due to the effort needed to carry it out, i.e., the ICT challenges did not justify the contribution that the innovation had on overall student performance in the school. In other words, the innovation did not satisfy the schools' intended main outcome of improving academic excellence. In sum, at the ecosystem level, the energy required to implement the innovation, and the satisfaction derived from it to improve examination results, were incongruous.

Extending from the school, a great deal of energy is required to collaborate and share within a cluster, as Ham (2005) indicated. The school

heads represent their schools at the cluster level. According to my findings school heads did not participate in cluster meetings regularly, nor did they communicate and share in the innovation. The school heads only met when the State Education Office (SEDO) told them to. Even when meetings occurred, not all school heads attended (as minutes of meetings indicated). As such, it can be argued that the idea of implementing the innovation did not provide the school heads with a high degree of satisfaction and, thus, they did not put much energy into it. Further, the innovation did not contribute to their position as school heads, as the ICTPD programme did not originate from the MOE.

In sum, the energy required to implement the ICTPD programme did not match the satisfaction or expectation of teachers and schools in the cluster.

8.2.5 Theme 3: competition

Competition for time and space in the school schedule became an important consideration for teachers in KPEC I and II. Competition, in this instance, relates to activities or projects or programmes that already existed in the school (i.e., were evident in the school ecosystem) before the innovation was introduced. Extending the ecological metaphor, KPEC is viewed as a new 'organism', which had to compete with other established 'organisms'.

The KPEC ICTPD programme, as an external organism, could not compete with the curriculum, as an internal organism, which is perceived to be essential to the school. Findings show that schools perceived KPEC as an external programme of little bearing or minor importance for teachers and school heads, as compared to carrying out the curriculum. This implies that KPEC stayed as an external organism, partially adopted due to the 'stability' of current programmes in the school, as similarly discussed in ICT adoption. According to Teacher C5, her school head was non-committal towards KPEC and the teacher explained that the school's core business, i.e., ensuring the curriculum is covered, was more important. This led, as explained by Teacher D3, to many teachers avoiding implementing ICT challenges and taking a 'wait and see' approach towards KPEC,

as it was perceived to be separate from the curriculum. According to my findings, only after three weeks did ICT challenges start in all of the schools. Overall, the curriculum competed with KPEC and took priority in the schools.

Even though the MOE endorsed KPEC after two weeks of implementation, the perceived lack of involvement by the MOE personnel indicated to teachers and school heads that the programme had little consequence, as stated by Teacher D2. At one level, KPEC could not compete with the MOE initiated innovations, such as ETEMS (see section 2.3.1.5), which had perceived value in the school. The State Education Officer (SEO) explained that the school heads did not want to implement any ICT challenges in their schools until the SEO was involved in the innovation. The school heads perceived the need for the innovation to be 'validated' by the MOE. When the innovation was seen to be non-competitive, i.e., as a supported MOE programme, the innovation as an organism could move into the ecosystem. However, the innovation suffered from being in competition with other MOE programmes.

There were many competing activities or projects or programmes, i.e., existing 'organisms'¹⁰³ in schools, both ICT related and non-ICT related. The most similar ICT programme that competed with KPEC was the English Teaching in Mathematics and Science (ETEMS) programme. There were two reasons for this, (a) the teachers who were involved in ETEMS were also involved in KPEC, and (b) ETEMS is policy, i.e., a programme mandated by the MOE to be carried out in all schools. According to my findings teachers carried out ETEMS because it was mandatory policy and because they perceived ETEMS as a MOE programme.

KPEC, as an invading species, competed in the same 'time and space' as ETEMS, an existing 'organism'. There was some 'perceived' overlap; several teachers linked ETEMS's ICT activities to KPEC's ICT challenges. As a result,

¹⁰³ According to Zhao & Frank (2003), existing school activities can be considered as a 'organisms'.

teachers sometimes found it difficult to quantify and differentiate between these two programmes (as seen in sections 6.5.1.2 and 7.4) and often chose to implement ETEMS rather than ICT challenges, especially in KPEC II. In sum, the competition for teachers' time and space (within the curriculum) affected ICT challenges as they became less important over time, as shown by the diminishing frequency of ICT challenges in KPEC II. This illustrates that the invading species could not compete with the existing 'organism' in the ecosystem.

There was also competition between schools. The cluster innovation depended on schools sharing expertise and knowledge between them. However, as explained previously in chapter 7, the cluster (as part of the invading species), became a factor that hindered the adoption of the innovation. This may be due to the competition between schools for the best examination results, as well as *position* (perceived ranking of the school) in the cluster.

Schools in the Malaysian context are measured according to their examination results, first and foremost. The invading species could not compete with this existing organism in the ecosystem, or across ecosystems. In other words, the innovation was in competition with examinations, which thus influenced schools not to participate in the cluster. This is further associated with the position of the school in terms of ranking (across the district or state). School C's head did not participate in the cluster meeting, as she viewed her school as being the best and not requiring much change, i.e., she had no impetus to participate in the cluster. Her teachers, such as teacher C6, only initiated ICT challenges during KPEC I after School D started their ICT challenges, according to teacher D3. School C then took the lead, in terms of implementing ICT challenges, to raise the school's perceived value in the cluster. According to the school head, School C became the 'model' school.

In sum, KPEC, as an invading species, is shown as being unable to compete with other organisms in the ecosystem and in the system. Consequently, the invading species' inability to compete was a contributor to the superficial adoption of KPEC.

8.2.6 Theme 4: filling a niche

Filling a niche, as a theme, regards the innovation's ability to match a need in the school or the needs of the teachers. I elaborate on this theme according to KPEC's objectives in improving teachers' ICT confidence, the change in teachers' practices, and KPEC's PD processes and its cluster innovation (specifically, the online system).

I discussed earlier in this chapter that KPEC partially fulfilled the needs of the teachers, in terms of ICT confidence, by adding on new ICT skills. Using the KPEC I report and findings using the ACOT model, I suggested that teachers adopted new ICT skills and, with a few teachers, new web based applications for communication and social networking. However, the increase in ICT confidence did not transform teacher practices or student learning in the research schools. Teacher C6 (at ACOT level 3 - Adaptation) perceived that she had transformed her teaching practices to be more student-centred, but described a teacher-directed lesson instead. Teachers taught ICT in conjunction with practices that they were familiar with, i.e., teacher-centred approaches such as 'chalk-and-talk', rather than constructivist teaching approaches. The continued use of teacher-centred approaches implies that the invading species did not fill a niche for the dominant species, i.e., there was no need to change their current practices or the innovation did not provide (knowledge) for change.

Further, the superficial adoption of 'improved' practices impacted student learning. Teacher A7 highlighted her students' work as an example of a good ICT challenge. Instead of producing their own work from their ICT challenge, which was based on planets in the solar system, Teacher A7's students re-produced the Nine Planets website as a report and claimed it as theirs. This shows that the students learnt new ICT skills, but did not change the way they learnt. In part, KPEC fulfilled its objectives in 'upskilling' teachers in ICT but did not fulfill its objectives in changing teachers' practices and student learning; for teachers and students, the invading species did not fill the niche it set out to fulfill.

Overall, at school level, KPEC, as an invading species, made limited impact on change across ecosystems. Findings show that teachers' and school heads' perceptions on how the innovation is perceived to fit the needs of the school played a crucial role in the adoption of the innovation. In other words, if the school was more inclined to focus on ICT as part of the school routine, the innovation had a greater potential to be adopted. In Schools B and C, for example, the innovation was not well received by teachers because these schools did not value ICT, as it did not fit into their day-to-day activities or routines. It may also be that teachers made no attempt to fit the innovation into their day-to-day activities or routines. Thus, the invading species did not fill a niche in these ecosystems.

The invading species, specifically the ICTPD innovation, did not fill a niche in terms of the professional development of the dominant species in schools. The in-school facilitation process via coaching and mentoring was not perceived as an approach to teachers' development, rather, as a process they had to go through as part of the KPEC innovation. Thus, by implementing the PD in-school, teachers saw the innovation as an added burden to their teaching in school and not as a development process. Findings show that teachers, like Teacher C6 and D3, avoided participating in KPEC.

Further, the invading species did not provide adequate knowledge and exemplars for teachers involved in KPEC to implement the PD process sufficiently. In other words, the innovation did not meet the needs of the teachers for carrying out the ICTPD's coaching and mentoring processes. For example, Teacher A10 was accustomed to conceptualising teacher development in terms of training, often outside of school, and, as an in-school facilitator, found the new PD approach confusing and adding to his anxiety. Even the two state facilitators did not manage to explain and convey the processes of coaching and mentoring in the PD process. Findings further suggest that most teachers in the research did not have the pre-requisite knowledge or the ability to understand what was required of them to coach and mentor other teachers.

The lack of clarity in the PD objectives, also mentioned earlier in other themes, further compounded the perception that the PD was not relevant to the teachers, i.e., did not fulfill a need in the school. Teachers, such as Teacher B7 and D9, questioned the purpose and the outcomes of KPEC. This implies that the dominant species perceived there was no purpose for the invading species, i.e., the innovation had no niche to fill in the school.

At the cluster level, the innovation implemented an online system as an approach to ensure that the schools in the cluster shared and collaborated. As a component in the cluster innovation, the online system was a strategy in which online communities of practice could be built. In the KPEC report, Norton (2007) implied that the online system managed to create a community of practice (COP), but my findings suggest otherwise. The teachers' pro-active use of this resource indicated that the online system did not 'produce' a COP, but instead became a support system for the innovation. Teachers used it re-actively, i.e., when they needed to get support or resources to carry out their ICT challenges. Thus, the online system only partially filled a niche in terms of providing teachers and schools support in their use of ICT in teaching and learning.

Overall, the invading species did not fill a niche in the schools and did not fulfill the needs of the dominant species. Even though the invading species had the potential to change the schools, the schools and the dominant species did not understand, support, or commit to the innovation as to ensure its sustainability in the long term.

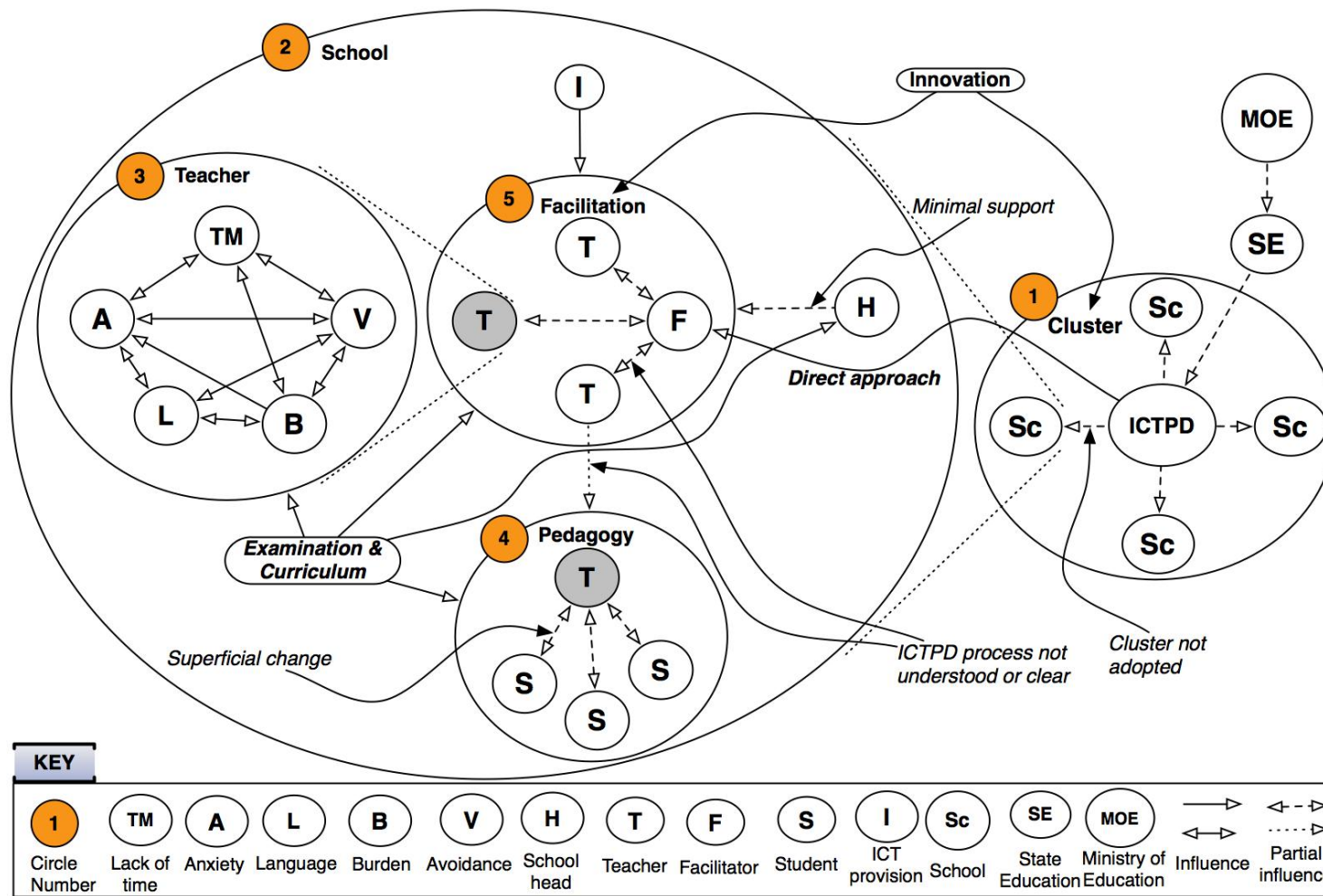


Figure 8.10. An ecological model of an adoption of an ICT professional development programme. The discussion of the four themes are used to trace the adoption of the ICTPD programme at the cluster, school and individual level in reference to the factors found.

The four themes have illuminated some intricacies of these relationships (Figure 8.10) and showed that there was a complex system operating in the adoption process. I provide this figure as the summary for the discussions on the four themes and as a starting point for further discussions incorporating complexity thinking.

8.2.7 Themes: summary

The figure shows that the cluster approach (circle 1) as part of the ICTPD programme, was superficially adopted by the four schools (as the broken arrows show). My discussions earlier have shown that the cluster model was not a viable approach to get schools to share and collaborate. Further, at the cluster level, my findings suggest that the PD strategy of 'training' the state and in-school facilitators did not function in the way envisioned by the implementers. The bottom-up approach, as per the New Zealand ICTPDs, did not work well; the direct approach (as indicated by the arrow from the ICTPD programme in circle 1, to the facilitator in circle 5) became a point of contention. I attribute this mostly to the bypassing of the school heads in the PD facilitation process. This consequently led to the 'minimal' support the school heads gave to the ICTPD programme.

At the ecosystem or school level (circle 2), the in-school PD facilitation model was implemented by the state and in-school facilitators. These facilitators could not 'effectively' facilitate and mentor the teachers that were involved, due to:

1. 'Minimal' support from the school heads.
2. Their lack of knowledge in coaching and mentoring in order to carry out the PD process.
3. The influence of the poor quality of ICT infrastructure on the implementation of ICT challenges.

4. The influence of examinations and the curriculum as major priorities for teachers.
5. The confluence of individual factors (circle 3) that influenced participation and the frequency of ICT challenges.

All of these five factors affected teachers' adoption of the content of the PD. In circle 4 of Figure 8.10, teachers adopted the 'new' ICT skills but did not adopt pedagogy (as the broken arrows show). Thus, teachers' change in practices were superficial, and this is reflected in the work the students did and the way teachers described their 'new' practices.

Teacher factors, though not discussed in detail in the four themes, contributed to teachers' lack of participation in KPEC or the avoidance of KPEC altogether. The factors in circle 3 in this figure were derived from individual factors described in chapter 7 and illustrate that 'avoidance' was an important factor in teachers' decision to adopt or participate. In circle 3, I also show that these five individual factors have different 'relationships'; for example, 'burden' was related to 'the lack of time', which led to 'anxiety' and, thus, fed 'avoidance'. I imply through these findings that the teachers default position on adopting new innovations, such as this ICTPD programme, is of avoidance. The teacher appears at first to attempt to reject the adoption of the ICTPD programme (e.g., Teacher D11), and if not possible, then to do the minimum (e.g., Teacher B9). However, this 'reject or minimum' attitude is a conditional statement. A few teachers, like Teachers C8 and B5, showed their willingness to participate and continue on with KPEC.

I also recognise the importance of 'anxiety' as a factor, with special focus on KPEC as an 'international' ICTPD programme. This factor should be considered to be part and parcel of implementing any international innovations or programmes; anxiety of foreigners can have a debilitating effect on teachers, according to my research. I associate anxiety to, first, educational knowledge (brought by the

foreigner) and, second, to power and status linked to the historical context of colonialism.

In sum, Figure 8.10 provides an overview of the factors that influenced the adoption of KPEC and traces the adoption process at different levels. The decisions iNZed made in implementing the ICTPD programme were based on a number of assumptions, including a PD model which is cluster-based and in-school can be adapted to suit another educational and cultural context. I have shown that both components may not be suitable in the Malaysian context.

Overall, the adoption of KPEC remains at the periphery of the school, i.e., the invading species remains outside the ecosystem. The invading species was not able to co-operate with the species in the ecosystem, took too much energy to implement, did not satisfy the needs of the dominant species, could not compete with existing organisms in the ecosystem, and did not fill a niche for the dominant species and the ecosystem.

8.2.8 Complexity and distance

On reflection, I have found that Tatnall & Davey's (2003) ecological model of training to be somewhat 'linear'; I can trace the processes that led to the adoption of the ICTPD programme, but, with their model, I could not incorporate dualities as a concept in complexity into the four themes. Though Tatnall & Davey argue that the themes could accommodate complexity, as elaborated in section 4.6.5, the themes did not offer an approach to discuss the extent of adoption as a dual condition. Thus, I add *distance* as an associated ecological concept to describe the extent of adoption in relation to KPEC I, as similarly used by Zhao et al. (2002, pp. 482-515) to describe innovation and change.

The addition of *distance* as a perceptual concept to Tatnall & Davey's (2003) four themes is as an approach to further understanding the processes, that teachers

and schools go through in adopting the ICTPD programme. Distance as a concept is included in complexity thinking; similar to Davis & Sumara's (2006) conditions, it provides an approach to discussing the extent to which the innovation has affected change. Thus, I use distance as an analytical concept, which considers:

1. The combination of factors and interactions between species in the ecosystem are in a state of dynamic flux (similar to feedback loops), and can *change* during the adoption of an ICTPD innovation.
2. There are *shifts* that move the species and the ecosystem either towards adoption or non-adoption of the innovation.
3. The contraction or expansion of *space*¹⁰⁴ is part of distance, in which adoption is negotiated by factors and interactions between species in the ecosystem and the innovation.

The concept of distance can, thus, be used to illustrate the extent to which both the ecosystem and the innovation (as the invading species) have either moved or still need to move for the adoption to occur.

8.2.9 Distance between schools

To ascertain the perceptual *distance* between the ecosystem and the invading species, I refer back to the ACOT model, which provided a gauge to measure ICT skills and pedagogical change. Further, I integrate my findings in chapters 6 and 7 and my earlier discussions on the four themes to imply the distance between the schools and the KPEC ICTPD programme, i.e., the *distance* between the species and ecosystem, and the innovation. I have chosen to illustrate distance through four dimensions (they can also be viewed as conditions in complexity) in the change

¹⁰⁴ I associate *space* with two themes, co-operation and filling a niche. Time is not articulated in *distance* because the research examined the innovation at a certain time (a snapshot of the schools and the innovation).

process; these are (a) practices, (b) priorities, (c) structure, and (d) culture. I have derived these four dimensions from the research data.

Before discussing the extent of adoption in each school, I illustrate and explain the concept of distance, as applied in this discussion. Figure 8.11 shows two models, the first, labeled 'basic' and the second, labeled 'ideal'. These two models are illustrated together because they explain the basic concepts related to distance and space (in 'basic') and the movement towards the 'meeting-point' (as indicated) for ideal adoption (in 'ideal').

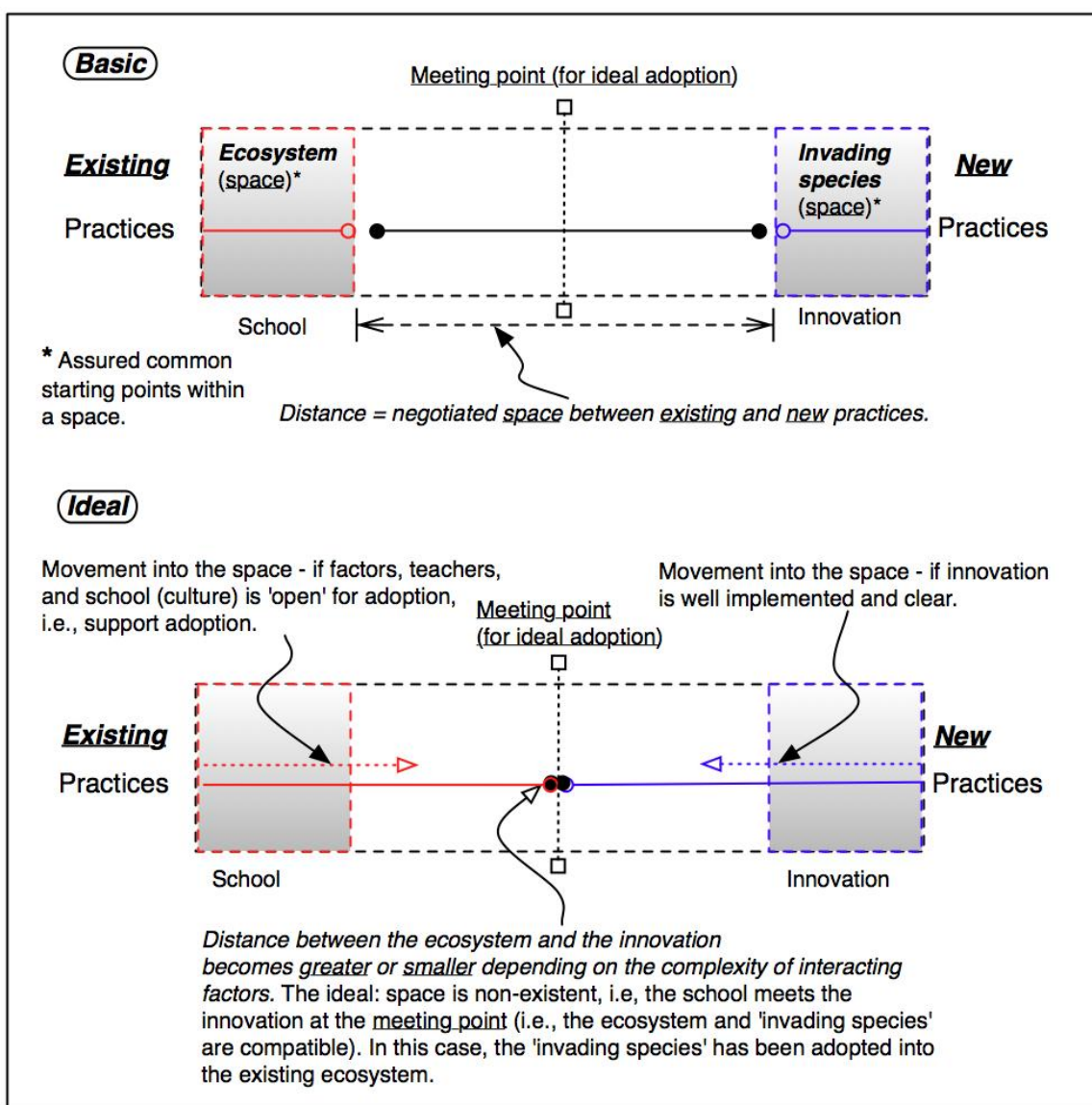


Figure 8.11. The basic and ideal 'models' of distance and space between the ecosystem and the 'invading species'.

The aim of the 'basic' model in Figure 8.11 is to show:

1. Basic components that explain distance and negotiated space (as indicated).
2. Common space and starting points, for the ecosystem and 'invading species' (on the left and right 'boxes', as shown in 'basic' and 'ideal' models).
3. The meeting point for 'ideal' adoption (at the centre of the negotiated space).

In the 'ideal' model of adoption, the distance between the ecosystem and the 'invading species' is non-existent. In the 'ideal' model, the left arrow (as indicated from the ecosystem space) shows the movement of the point towards the centre. In this case, if the ecosystem and its species are 'open' for adoption, i.e., the school culture supports the innovation (among other complex interacting factors), the ecosystem point moves towards the centre. Vice versa, on the right, the arrow (as indicated) shows the movement from the innovation space towards the meeting point in the middle. This movement is precipitated by the clarity of the innovation and the suitability of the methods used in its implementation.

The movement of both points emanating from the ecosystem and innovation spaces is influenced by the factors discussed in the findings from chapters 6 and 7. In Figure 8.11, I have chosen to illustrate one of the four dimensions, i.e., practice (the other three are priorities, structure, and culture). In this figure, I illustrate the existing practices within the school, e.g., the existing teacher-centred approaches in the research schools (on the left of each model). In contrast, new practices, which were introduced by the innovation, e.g., the student-centred approaches, are illustrated on the right.

The meeting point in the middle (as indicated in both models) represents the ideal adoption. The ideal adoption as shown by the ideal model illustrates that the ecosystem (i.e., school), is compatible with the 'invading species' (i.e., the innovation). The meeting of the ecosystem and the 'invading species' indicates that the 'invading species' has been adopted by the ecosystem. The extent of movement of the points from the existing and new 'spaces' shows the extent of the adoption of the innovation as an 'invading species' by the ecosystem.

The aim of using these figures (Figure 8.11 - Figure 8.16) in discussing distance is to show a dynamic, complex system at play, and highlight the movement, and the extent of the adoption of the innovation. The weakness of these figures (and models within them) relating to distance are: (a) it appears as a static system (two-dimensional representation); (b) it appears to be a linear 'model'; (c) it reduces the ambiguity of multiple starting points, i.e., multiple distances according to the four dimensions (as in Figure 8.12); and (d) it does not show the vertical (between the four dimensions - within the ecosystem) and horizontal (between the ecosystem and the 'invading species' - context of adoption) complexities of interacting factors (not illustrated in these figures).

The following sections illustrate each of the four dimensions according to one case school. I discuss practices, in School A; priorities, in School B; structure, in School C; and culture, in School D, respectively. I selected a dimension according to a school because the findings suggest that certain schools have certain characteristics, which exemplify the dimension in focus. However, I also illustrate the other three dimensions in each school to show the extent of adoption in each. Further, the following discussion on distance uses these terms: teachers as the dominant species; school heads as the keystone species; school as the ecosystem; and innovation as the invading species. I opted to use these terms because they are easier to refer to in the findings.

8.2.9.1 Practice: school A

In this section, I discuss the distance between the existing practices in School A, and the new practices which the innovation introduced as part of KPEC. I illustrate a figure with two models to show the perceptual distance in focus, i.e., practices and multiple dimensions (e.g., priorities). I also illustrate the overall distance of the school and the innovation.

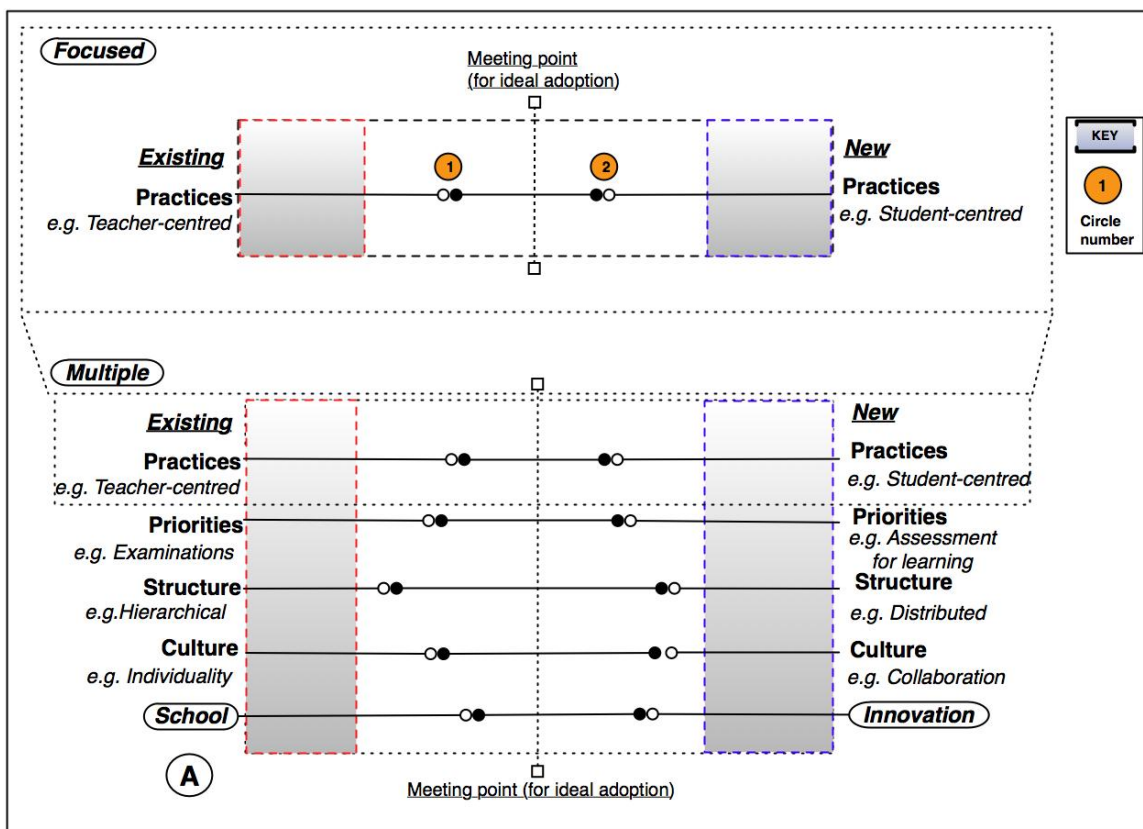


Figure 8.12. Distance, priorities, and multiple distances in School A.

The model labelled 'focused' in Figure 8.12 shows the movement of the practice point (numbered 1), from the existing practices (teacher centred) towards the meeting point. This indicates that School A has made some headway towards adopting the innovation's new practices (e.g., student centred). The factors and characteristics in School A (e.g., better ICT facilities) have moved the practice point towards the centre (numbered 1). Further, most teachers in School A have exhibited

a willingness to adopt ICT because there was support from the school head. The findings show at least one teacher (A6) at the *appropriation* stage, and most teachers at the *adaptation* stage (see section 4.5). Teacher A6, as the state facilitator, has adopted the facilitation process, and has facilitated other teachers in School A. Though it can be argued that this adoption of new practices is superficial, teachers *believed* that they had adopted student centred approaches introduced in KPEC, in implementing the ICT challenges.

The introduction of the new student centred practices by the innovation and its adoption in School A, moves the innovation point towards the meeting point (numbered 2), due to KPEC implementation (e.g., the clarity of the PD, its content, etc.). To clarify, the movement from the innovation 'space' and starting point is based on its relative 'impact' on the school. Overall, a distance still exists (as shown in Figure 8.12) between the existing practices and the new practices. This distance stems from the lack of understanding of the innovation, and the need for knowledge to support change in practices by teachers in school. The KPEC providers did not provide best practices, or exemplars, or knowledge per se, to participating teachers for better adoption. Teacher A10 articulated the need for her to have exposure to knowledge, integrating ICT into teaching and learning, and then shown how these practices might look like in the classroom situation through exemplars. Further, the lack of familiarity with the PD processes meant that Teacher A10 was uncertain of how he should facilitate other teachers in KPEC, in changing their practices.

School B, C, and D's practices (illustrated later in their respective figures) are wider, and further away from the meeting point (for 'ideal' adoption). School B and D's teacher practices remain teacher-centred, as these two schools were solely concerned with the examination. Further, in these two schools, supporting factors are lacking (e.g., badly maintained computer labs).

In Figure 8.12, I also illustrate the other dimensions related to adoption as discussed earlier. These multiple distances (as labelled) show that School A, in

relation to examination, priorities, structure, and culture (discussed in following sections), has the most potential in adopting the innovation in full (as indicated by the distance between the school and innovation in Figure 8.12). The school (as indicated by the last point in the multiple model) shows that it can meet the innovation more readily than the innovation is able to provide. The innovation, as implemented, is 'flawed' and, thus, cannot intersect the meeting point in the centre, even if the school is capable of doing so. Thus, the distance illustrates the extent of the adoption by ecosystem.

This leads to my discussions on distance and priorities.

8.2.9.2 Priorities: school B

In this section, I discuss the distance between the existing priorities, i.e., examinations, in School B, and the new priorities, i.e., assessment for learning, implemented as part of KPEC's focus on student learning. The following figure also shows two models, as similarly illustrated in Figure 8.12.

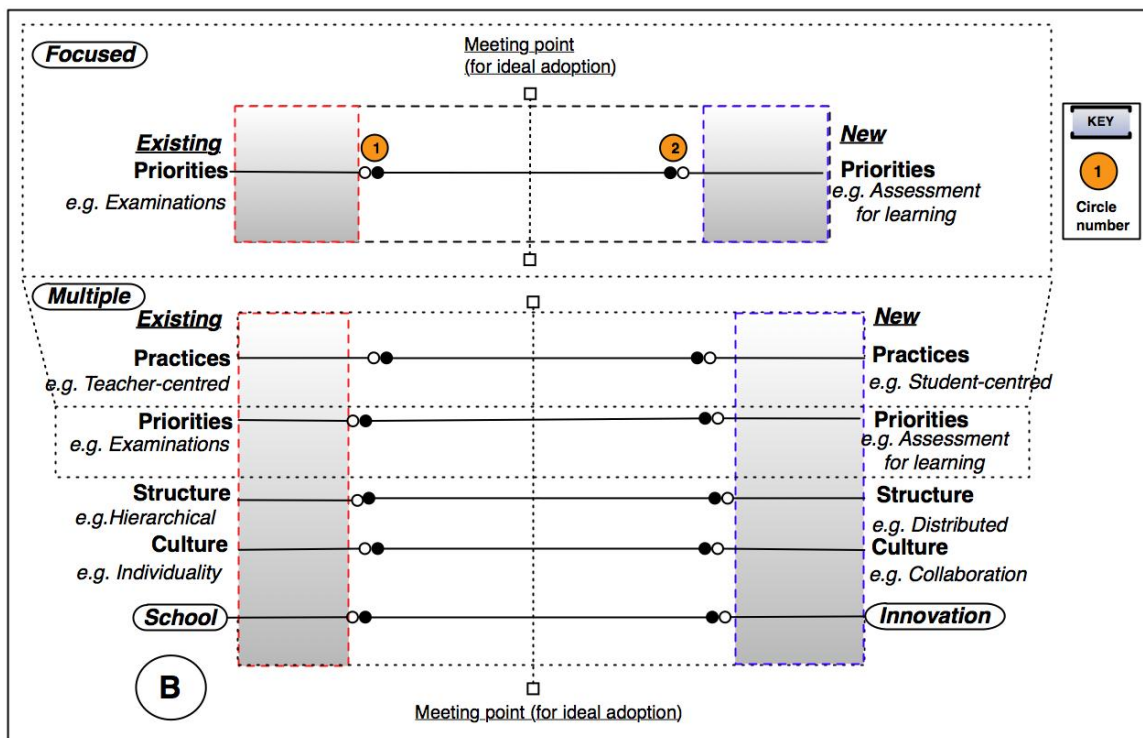


Figure 8.13. Distance, priorities, and multiple distances in School B.

Figure 8.13 illustrates that the distance between the new priorities and the existing is wide (in focused box). School B exemplifies the priority (resources and teachers) given to examinations. School B's priorities are centred on the examinations and curriculum and my findings suggest that the school is focusing on achieving better examination results, as indicated by the school head's interview and Teacher B5 responses. Thus, the school's priorities point (numbered 1) does not move towards the meeting point, but instead remains close to its existing space.

School B's focus is on examinations, as most teachers stated they lacked the time to ensure the curriculum is covered. Further, teachers in this school perceive that ICT does not contribute to better examination results (as discussed earlier in this chapter). The school head stressed the need for the school to perform in examinations, and not on implementing the innovation, which may influence the school's examination results.

The innovation, thus, could not make any headway towards the meeting point (as indicated). This point remains close to the innovation space (numbered 2) as new assessment approaches, e.g., assessment for learning, as part of the student centred practices, was superficially adopted by School B's teachers. In KPEC, the introduction of ICT challenges has not changed teachers' assessment of student learning, as the Nine Planets evidence showed. As such, this component of the innovation has had little influence on the teachers in the school.

The school culture (indicated in multiple - culture point), in terms of teachers' individual characteristics, remains *competitive* in School B. Each teacher defines himself or herself in terms of their performance in delivering examination results. Teacher B5 expressed great concern for this, as she perceived that collaboration is an approach towards better results.

The structure of School B is hierarchical (indicated in the multiple - structure point). The school head determines teachers' interactions, as discussed in co-

operation; she used her power and position to ensure that her teachers concentrated on the school's main priority - the examinations.

Overall, the priorities of the school and its teachers influenced their interactions and moved them away from adopting the innovation. Thus, the distance between the school and the innovation remains wide (the widest among the four schools), and shows the extent of superficial adoption, and 'rejection' of the innovation.

8.2.9.3 Structure: school C

In this section, I discuss the distance between the existing structure, i.e., the hierarchical structure of School C, and the distributed, cluster-based structure (organisation and training) introduced by KPEC. The distance between these two structures shows that KPEC's clustering, as implemented, is incompatible with the existing hierarchies and power balances of the school.

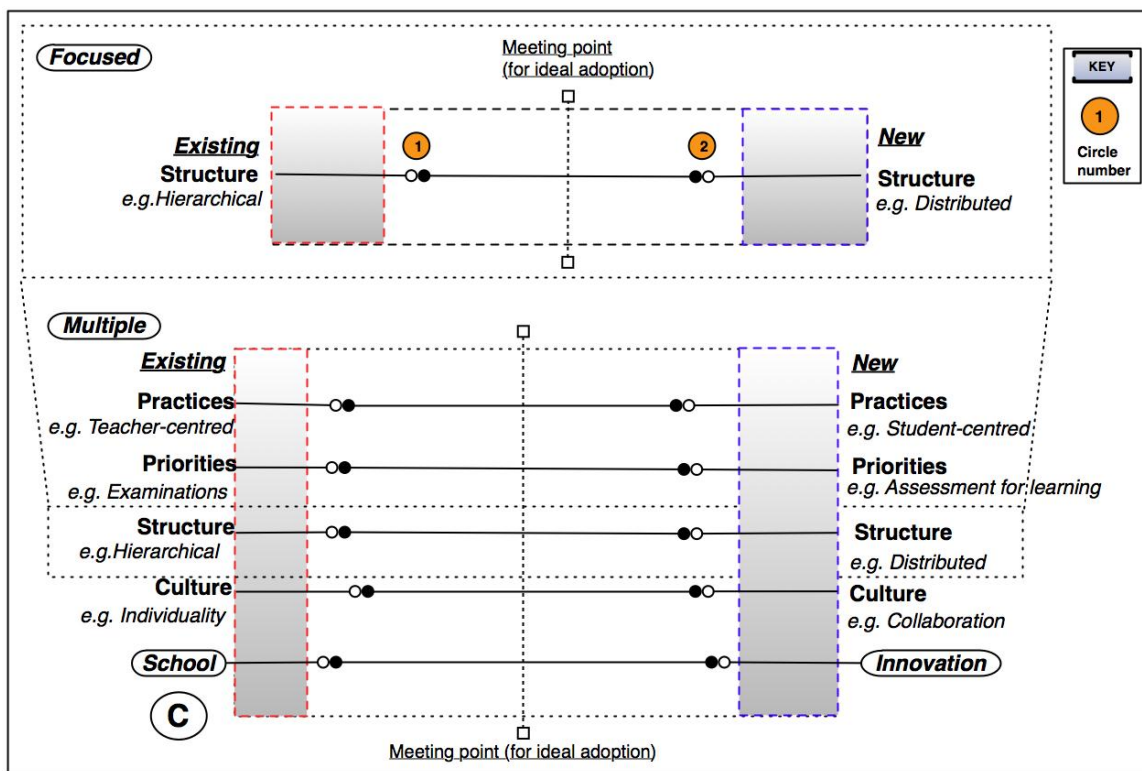


Figure 8.14. Distance, priorities, and multiple distances in School C.

Figure 8.14 shows that the distance in structure between School C and the innovation is fairly wide (as in the focused box). The point (numbered 1) from the existing structure moves slightly towards the meeting point, as the hierarchical structure is less rigid, as findings show, because the school is a secondary school. The innovation's new structure, such as clustering and facilitation structures, moves (numbered 2) slightly towards the meeting point because the school superficially adopted some parts of these new structures. Overall, a significant distance still exists, but not as wide as School B.

Hierarchy and power in this school's structure relate primarily to the school head. The school head in this school acts as a gatekeeper; she affects the extent of adoption in terms of the PD process, and overall implementation. The school head saw the innovation as unimportant at first, and only asked her teachers to participate so that the SEO did not perceive the school to be a laggard in implementing KPEC. As soon as the school head realised that the SEO and the MOE endorsed KPEC, she influenced her teachers to start their ICT challenges. Further, the school head and her teachers perceived that they were in competition with School D; Teacher D3 pointed out that School C carried out ICT challenges after School D started them.

In terms of the innovation's PD facilitation process, *structure* is seen to hinder KPEC's implementation; *power* is related to structure, as it is the way the system ensures *stability* in school. The school head barred the state facilitator from facilitating other schools in the cluster, suggesting that it was not in her interest to do so. In her interview, Teacher C8 expressed dissatisfaction and disappointment with the lack of support, and apathy of the school head, as this conflicted with the objectives of the innovation.

The school head also perceived iNZed's approach of excluding school heads in selecting teachers and implementing the facilitation as circumventing their

position and power. Thus, the school head did not empower the teachers for the PD facilitation to occur in this school and the cluster.

Further, the innovation's cluster structure or hierarchy, as distributed power, became a liability; instead of a structure for collaboration it became a space for conflict and contention. This is because the cluster, as part of the implementation, was unclear in terms of its objectives or purpose. The online system, for example, did not galvanize the need for teachers to collaborate, and only ended up being a resource and support for those who used it. Not many teachers used the online system.

The innovation made little headway into changing the school's culture (Figure 8.14 - numbered 2). The cluster approach taken to implement the PD in KPEC was markedly different than previous training programmes in Malaysia. This school and the other schools in KPEC, due to unfamiliarity, did not adopt the cluster model as an approach for PD; there was no precedence to frame an understanding of how a cluster might function or work to facilitate the PD of teachers.

This shows that, overall, the existing structure, hierarchies, and power created a perceptually wide distance between the schools and the innovation, especially in School C (as shown in model labelled multiple - Figure 8.14).

8.2.9.4 Culture: school D

In this section, I discuss the distance between the existing school culture of School D, and the new culture of collaboration and sharing, introduced as part of KPEC's PD process. School D's teachers range from teachers who are individualistic to teachers who are collaborative.

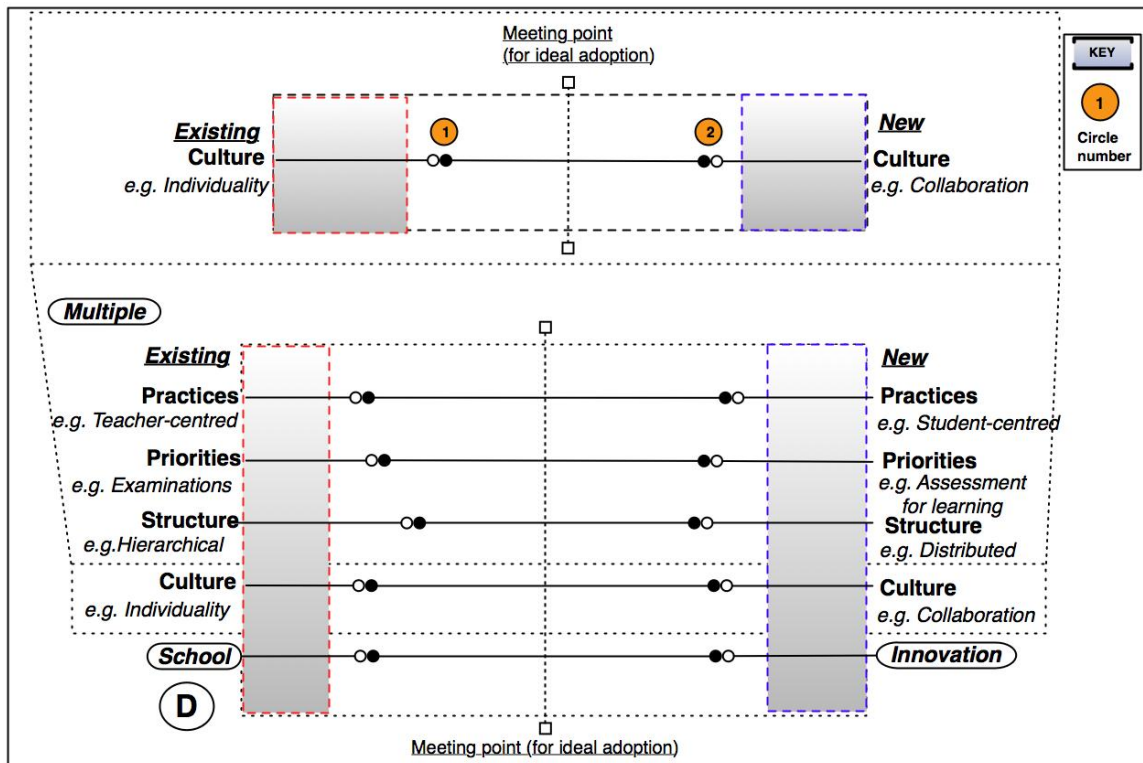


Figure 8.15. Distance, priorities, and multiple distances in School D.

Figure 8.15 shows that the distance in culture is fairly wide between the existing school culture (e.g., individuality of teachers and school), and the new cluster-based culture (e.g., sharing and collaboration), introduced by the innovation. The culture point (numbered 1) moves slightly from its space towards the meeting point. This indicates that the school does have a few teachers who are open to collaboration and sharing (e.g., Teacher D7). The point from the innovation space moves slightly towards the meeting point, indicating that a few teachers have adopted sharing and collaboration (e.g., Teacher D5).

I selected School D to illustrate culture primarily because of Teacher D8, an extreme case of teacher individuality, as discussed earlier in this chapter on private practice teachers (PPT). I associate *culture* to *school*, because, as Mioduser et al. (2002) suggest, school culture plays a role in influencing schools to share innovations collectively.

The teachers in School D, as pointed out earlier in this chapter, did not share or collaborate in implementing the PD facilitation. Each teacher perceived that they were individuals involved in a collective; a characteristic of teachers in Malaysia, i.e., PPT. One teacher in particular, Teacher D8, opted out of participating in KPEC and refused to collaborate. During her interview she stressed that she would do better on her own. Similar to other teachers in KPEC, Teacher D3 did her ICT challenge on her own and did not collaborate with other teachers, i.e., did not share with other teachers the experiences she had developing the ICT challenge (in the 'reflection' process).

The innovation introduced collaboration as part of KPEC's facilitation process. Most teachers in School D, as well as other schools in this research, found collaboration an 'alien' concept because sharing is not part of their school's culture. KPEC's approach in facilitating collaboration (teachers share and collaborate teaching experiences) in the cluster schools via the online system did not change teachers' attitudes in *sharing and collaboration*. Nor did it facilitate the development of communities of practice, part of KPEC's objectives. According to Hartnell-Young (2006), a change in teachers' attitudes is necessary for the development of COP.

Overall, these schools were not accustomed to sharing (see section 8.1.3.2.1.1), and thus, the distance between them and the innovation have stayed fairly wide. School D's *culture* is similar to all four schools and illustrates which innovations may have to provide components that create the *necessity* for sharing and collaboration, and not an online system.

8.2.9.5 Distance: summary

In this section, I summarise the distance between the four schools and the innovation. The distance of each school is based on their 'multiple' models, in the previous four figures. School A has the most potential to adopt the innovation, and School B the least potential to adopt.

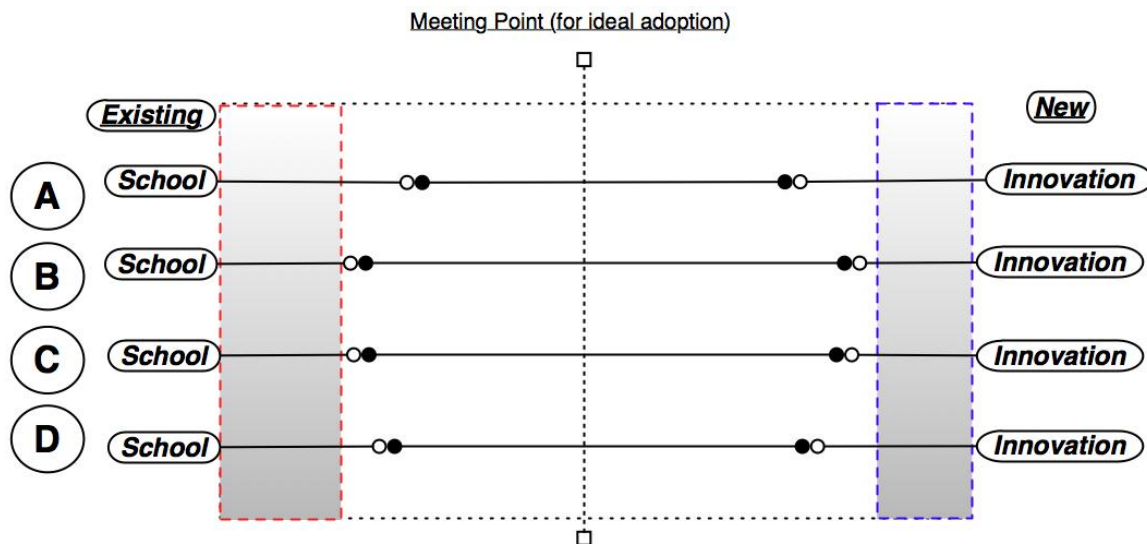


Figure 8.16. Overall distance of schools in relation to the innovation.

Figure 8.16 shows the distance between schools and the innovation, i.e., the extent of adoption of the innovation among the four schools. For different schools, different *negotiated space* exists in their *distance*; schools with shorter distance illustrate that they have negotiated, and accommodated, components of the innovation, or parts of the 'invading species', within the ecosystem. With schools that have a relatively wider *distance*, large *spaces*, which have yet to be negotiated with the innovation, exist. Hence, the innovation has to stake a claim within those spaces for it to be adopted by the species and the ecosystem.

Figure 8.16 shows that School A has partially adopted the innovation's processes and components (shown by the innovation point), and negotiated a space for the innovation in the school. However, the school is constrained by complex factors and dynamic interactions within the ecosystem, which limit the distance in which the school can travel.

Overall, the distance between the school's existing and new practices, priorities, structures, and culture can *change* according to complex factors and dynamic interactions in the schools, and the objectives, implementation, and content

of the ICTPD programme. This dynamic interplay differentiates this concept (in complexity) if compared to Lewin's (1951) force field theory¹⁰⁵(FFT), for example. In FFT, Lewin illustrates: (a) change from the innovation perspective, and (b) change as 'static', i.e., the innovation factors drive towards a desired state in relation to resisting factors. It does not, however, offer dynamic states of change with factors, which are dependent on interactions between species within an ecosystem, and the interacting factors related to the innovation. In this research, distance is perceived from the teachers' and schools' perspective, and the innovation. Further, FFT does not offer a 'contested' space for negotiation to occur between the school (recipient) and the innovation.

8.2.10 Emergence and the adoption of an ICT professional development innovation

The use of the ecological perspective in understanding the adoption of the K-Perak E-learning Cluster (KPEC) innovation illustrates that: (a) the innovation as an 'invading species' did not 'co-operate' with the school due to implementation issues and lack of clarity; (b) the 'effort and satisfaction' of carrying out the innovation did not meet with the teachers' needs in school; (c) the innovation could not 'compete' with priorities in the system, school and individual; and (d) the innovation did not 'fill a need' (academic performance).

The distance between the schools and the innovation suggests that the adoption of the innovation was superficial; the factors and interactions between species in the ecosystem, and also between ecosystems (cluster), affected the adoption of KPEC, as well as factors that were associated with the innovation's structure and processes.

¹⁰⁵ I used Lewin's force field theory in my Masters' thesis as a way to understand factors that support or hinder a development programme.

In the following section I focus on the adoption of the innovation and deal with the findings in terms of the implementation of the cluster model and the adoption of ICT professional development (PD) for teachers.

8.2.11 System level - cluster adoption

In New Zealand, the ICTPD approach is a clustered model of PD in which groups of schools band together to apply and develop their own PD programmes. This bottom-up and collaborative approach worked well in New Zealand, according to Ham et al. (2002). However, the clustering of schools, as per the adaptation and implementation of the New Zealand ICT Professional Development (NZ ICTPD) model, had limited success in KPEC.

The experiences of the schools, school heads, and teachers involved in KPEC suggest that the cluster model did not lead to sharing and collaboration. Further, the perceptions of school heads on KPEC illustrated the lack of interaction between schools in the cluster. The online system that was supposed to bring the cluster together, instead illustrated that barriers still existed, as teachers and school heads rarely used it.

The schools' inherent competitive nature and the status of schools in relation to power and hierarchy partly contributed to the superficial adoption of the cluster model. In reality, the cluster approach, in this context, was only a 'grouping' of schools that were involved in KPEC.

My discussions at this point have implied that the current Malaysian education system and schools are unable to support the cluster concept. However, the cluster approach could be significantly adapted to the Malaysian context. For example, the cluster approach could be adapted to take into account the fact that the school heads hold power. Thus, a version of a cluster model adapted for Malaysian schools could:

1. Be centred around a concern for schools within the geographic area.
2. Be implementable and driven by leadership, which includes school heads and teachers.
3. Be specific in focus, specialising in one area for development.
4. Start small and take small steps towards achieving a larger objective within the cluster.

These suggestions imply that schools should determine the focus of the cluster and develop according to the cluster's plans and objectives, within a certain time frame.

8.2.12 Ecosystem level - professional development

The ICTPD innovation introduced the concept of professional development to teachers in the KPEC programme. In chapters 1, 2, and 4, I explained the conceptual difference between training and professional development (PD). In short, according to Clarke & Hollingsworth (2002), training is 'something being done to teachers' and PD is 'teachers' attempt to improve performance or strategies' (p. 948).

Arguably, the KPEC ICTPD programme was an attempt to implement a completely new approach in teacher development and, showed that teachers and schools in the Malaysian context were not prepared to adopt this approach. Further, the ICTPD facilitation assumed that Malaysian teachers and schools had the pre-requisite knowledge and resources to support the PD approach.

The Malaysian MOE typically carries out training for teachers through the cascade approach. My discussions have implied that teachers are *familiar* with this type of 'training' and its processes (e.g., content and expectations) and *unfamiliar* with PD processes introduced by KPEC. Teachers in my research expected to be 'trained' before they could carry out ICT challenges. Furthermore, as discussed in the previous chapter, the concept of distances (i.e., the distance between the *existing* and the *new*) illustrated the assumptions made on species and the ecosystem.

The implementers of the innovation overestimated the level of knowledge, training, and experiences of teachers and ICT infrastructure in schools. The teachers were 'knowledge-poor', according to Fullan (2003b, p. 6), in relation to implementing the innovation, as indicated by my discussions on factors related to pedagogy and facilitation. Overall, the adoption of the ICTPD facilitation process was superficial, as indicated by KPEC II, which continued with learning ICT skills instead of change in pedagogy.

8.2.13 Summary: adoption of an ICT professional development innovation

The use of Zhao & Frank's (2003) ecological theory with Tatnall & Davey's (2003) 'four themes' have refined my understanding of the adoption of this innovation, and provided me with an approach for describing the complex factors involved, and the dynamic process in which the adoption of PD innovation occurs. By extending these complex factors and the dynamic process in adoption, through using *distance* as a concept in complexity thinking, I have gauged the extent of adoption of the innovation by each school in my research.

I have identified from the research that:

1. The adoption process is influenced by concerns that the dominant species and the keystone species perceive as important. The invading species, as the innovation, has to fill the needs or niche of the species, either satisfying their concerns or else only being superficially adopted. The invading species has to compete for space within the ecosystem for it to survive and be adopted. The innovation has to establish a clear connection to the needs of the teachers and the school. Without linking the innovation to these needs, the innovation risks superficial adoption.

2. Teachers' individual factors, and their interactions with the in-school and state facilitators, and the school head, influenced teachers' adoption of the ICTPD programme. Teachers adopted the new ICT skills more readily than the change in teaching practices, due to the lack of clarity in the PD process. Further, characteristics inherent in the local ecosystem, such as PPT (individuality), limited the adoption process.

3. Introducing a new invading species into the ecosystem, discussed as the distance between the innovation and the school, requires careful consideration of the local ecosystem in which the innovation occurs. In other words, transplanting an innovation into another context is clearly difficult and complex. Furthermore, assumptions made on the 'bottom-up' approach, taken in implementing the PD innovation (i.e., approaching teachers first, instead of school heads), may not be suitable in this context. The clustering of schools emerged to hinder the innovation's adoption, instead of providing it with a structure for implementation.

My research has shown that teachers and schools are complex; they have individual pathways in adoption, depending on complex factors, and dynamic interactions at different levels. Adoption constantly changes, and thus, is not considered to be an 'end-product'; rather, adoption emerges from complex factors and dynamic interactions between species in the ecosystem and the innovation (ICT or ICTPD programme).

In the next chapter, I discuss how the ecological-complexity models inform the emergence of adoption. I use the concept of emergence as an approach to further discuss the implications of my research in Malaysia.

9.0 IMPLICATIONS OF THE RESEARCH

This chapter brings together discussions on the use of the ecological framework and the consequent ecological-complexity perspective in understanding teachers' ICT adoption in teaching and learning, and the adoption of an ICTPD innovation. In chapter 8, I suggested that teachers' ICT adoption in teaching and learning *and* the adoption of the ICTPD programme were complex, non-linear, and dynamic and are not end products, as illustrated in the two ecological-complexity models. Rather than discussing cause and effect in the linear approach, I discussed emergence, i.e., the sum effect of different factors and interactions between units and levels which contributes to the materialisation of innovations, species and niches as an alternative to understanding the complexities in both types of adoption. Note that adoption in this chapter refers to teachers' ICT adoption in teaching and learning and the adoption of an ICTPD innovation, unless differentiated. Along the lines of this alternative discourse, I discuss the practical implications of my research on the school and the teacher.

There are three sections in this chapter: the first section discusses the development from the ecological-complexity perspective in terms of providing an alternative discourse to discuss adoption; the second section focuses on the cultural factors and the adoption of the ICTPD innovation; and the last section discusses the limitations of this research and future research opportunities.

9.1 The implication of the ecological-complexity perspective

My research focuses on understanding teachers' ICT adoption in teaching and learning and the adoption of an ICTPD innovation. My research explores how Malaysian teachers in the case schools adopted ICT and also how the case schools and teachers adopted a professional development programme in ICT. To achieve this dual exploration of adoption as a research theme, an ecological framework was selected with modification according to the focuses outlined. The ecological

framework evolved from the multilevel collection of theories and models which included complexity thinking to an ecological-complexity perspective. This perspective highlighted that teachers' ICT adoption and the adoption of an ICTPD innovation is a complex and interactive process.

The utilisation of complexity thinking within an ecological framework has given me not only a language to describe the two types of adoption but also the methodological direction, which has influenced my analysis of the data. Though the data was essentially snapshots of factors, complexity thinking gave me an approach to unpack the linkages between factors at different levels. My own perceptions of the data changed as a result. Instead of looking at linear cause and effect factors and relationships, I started to think about how different factors in the different contexts changed teachers' ICT adoption in teaching and learning and the adoption of the ICTPD programme. I began to scaffold my thinking on the different interpretations of factors focusing on dichotomies or dualities of adoption. Further, I developed the concept of distance (and space within distance) from complexity so as to understand the extent of adoption of an ICTPD innovation. In consequence, complexity thinking enabled me to perceive multiple possibilities in adoption, from shifts in adoption to degrees of adoption, by linking the complex factors, interactions, and interdependencies between species within the ecosystem and in the system (which includes the exosystem and macrosystem - see section 4.1).

In chapter 8, I demonstrated that the ecological-complexity perspective presents a new approach to understanding and perceiving teachers' ICT adoption in teaching and learning. Instead of relying on linear theories, my research shows that teacher' ICT adoption shifts between states of adoption to non-adoption, depending on the confluence of factors present within an ecosystem. System influences from outside the ecosystem further enable or constrain ICT adoption. The application of complexity thinking in the ecological framework was instrumental in identifying the factors that emerged at each level of adoption and the occurrence of adoption in the ecosystem. Further, complexity thinking underscores that teachers in schools have

different paths in ICT adoption in teaching and learning, depending on interactions and negotiations between them, other teachers, and their schools.

In the adoption of the ICTPD programme, I examined factors according to four themes in my ecological framework and extended the discussion into the *distance* between the innovation and the school as the local context of the implementation of the ICTPD programme. The four themes illuminated the factors and interactions that occurred in the ecosystem, which influenced the *distance*, according to my four dimensions, which in turn influenced the adoption of the innovation. I suggested that the distance between the innovation and the schools showed that the adoption of the ICTPD programme was superficial. The lack of impact of the cluster model suggests clustering of schools may not be a suitable approach for implementing innovations because of structural and cultural factors which are inherent in the Malaysian context.

The major contribution of this thesis is the development of the ecological-complexity perspective (ECP) and the two models associated with the two innovations. The development of the ECP and the models was a gradual process, each chapter building upon ideas discussed in earlier ones and this required the bringing in of literature into the data and discussion chapters, as it supported the progress and further development of ECP and the two models.

The use of the ecological-complexity perspective is meant to be a start of new discourses in ICT adoption, not an end point.

The next section discusses the cultural factors related to the adoption of the ICTPD innovation.

9.2 Innovation anxieties

There were two significant findings related to anxieties in the adoption of KPEC: examination anxiety and anxiety of foreigners.

The first anxiety is the school's or the teacher's anxiety about ensuring that their students perform well in examinations. Schools and teachers were wary of spending time to carry out KPEC, because they perceived it did not cater to or enhance examination performance.

The implication is that examination anxieties are unavoidable in any adoption of any innovation related to teaching. School based assessment has yet to be accepted as a mainstream approach towards assessing students. This implication will continue to be an ongoing matter for the MOE with the implementation of any new innovation.

I did not foresee anxiety of foreigners as a factor that could hinder the innovation, however, teachers were disinclined to participate in KPEC because it was managed and carried out by foreigners. It is not an issue to do with foreigners per se, but is an issue related to culture and related to Malaysia's colonial history. The underlying connotations of power are also linked with the perception that the 'foreigner' is more educated than the 'local' teacher, introducing foreign concepts and ideas that the 'local' teacher does not understand. This is compounded by the use of English as the 'medium of instruction', which created a distance between the local teacher and the foreign facilitator.

To overcome teachers' anxieties related to foreigners providing professional development programmes, I suggest a simple guideline to be applied to all international educational providers. I suggest that international providers of education work either with MOE personnel or local educational providers to ensure that this anxiety is lessened. There should be a balance in composition between

locals and foreign facilitators. Language issues can be balanced by using both English as well as Malay (in this context). The combination of foreigners and locals and the use of two languages should minimise the impact of this factor. However, I recognise that anxiety is part and parcel of implementing an international programme.

9.3 Cultural factors

The discussion on KPEC cluster structure has shown that cultural factors have an influence on the clusters' implementation and outcomes. Schools in the Malaysian context are very different from New Zealand (NZ) schools, e.g., in the way Malaysian schools perceive the value of facilitation and support within the cluster.

The transfer of the innovation from NZ to Malaysia and its adaptation was fraught with challenges. Innovation New Zealand Education (iNZed) took many of the features of KPEC from the NZ ICTPD model. However, in adapting the ICTPD programme to the Malaysian context, iNZed did not foresee a number of cultural differences and factors that influenced the ICTPD programme outcomes. These differences were:

1. Malaysian schools are centralised and thus 'wait' for direction from higher authorities (top-down)
2. Malaysian schools are competitive as they are ranked order according to their performance in the public examinations
3. Malaysian teachers are not accustomed to 'training' each other through mentoring in school; teachers attend courses outside of school which are organised by the external organisations such as the state education office
4. Teacher training is the most common 'approach' taken to train teachers
5. School heads hold power in the school; bottom-up or teacher based initiatives without support or consent from school heads are rare and often fail

6. Malaysian teachers do not participate or share professionally as they compete with each other to gain points for promotion in relation to examination results
7. There is a political need to achieve results quickly; new innovations (especially pilots projects) are given a short time to show its value

Though the structure, processes and content of the KPEC ICTPD programme were primarily the same if compared to the NZ one, the context in which the ICTPD was implemented was largely different. The KPEC ICTPD programme was a unique, first of its kind cluster PD programme implemented by outsiders who did not consider cultural factors, which may have been its Achilles heel.

9.4 Limitations and future research

In this third section, I discuss the limitations of my research and I identify future research that could be carried out in relation to adoption, complexity, and emergence.

This research has several limitations. First, I developed the theoretical framework to be a multi-level and inclusive framework for understanding teachers' ICT adoption. Though justified in detail in the theoretical framework chapter, some researchers might not agree with the choice of models and theories of the multi-theory or multi-model approach taken.

The factors gathered in the research, though aggregated, are dependent on the context of the research, i.e., particular to the ecology. Though the factors that emerged were similar to other findings by other researchers, a different set of cases or schools may uncover different variations or factors.

One other limitation of my research is the roles I played as a researcher. The tensions between insider and outsider roles was an issue I had to contend with. At the start of my research I was perceived as an outsider to the participants in my research. However, even though I was an outsider to them, in many ways I was an insider, as I was a teacher before and I empathised and understood the context and constraints they were in. Though I gradually earned their trust and respect and managed to gather data related to adoption, this duality between insider and outsider roles still persisted. My representations of the 'other', i.e., the teachers' views and perceptions are not without bias; I cannot claim them to be completely neutral. Thus, my representations of them may be influenced by my preconceptions. This bias has had an impact on how I have analysed the data and I acknowledge it as a limitation of this research.

The perspective taken to frame the research in the ecological metaphor and using complexity thinking is very different from the vast amount of literature concerning teachers' ICT adoption in teaching and learning. Although the data are of a rich qualitative nature, the research and its analysis are biased towards the specific perspective.

Extending from my discussions on emergence (see section 8.1.5), there are a number of possibilities for future research. Teachers' adoption of ICT in teaching and learning is either constrained or enabled by interactions between species (factors in the linear sense) within an ecosystem. The ecological-complexity models that I developed are essentially meso-level models instead of micro-models. I suggest new research be carried out to understand how ICT in teaching and learning is perceived across schools, which will extensively add to our understanding of how policies related to ICT are implemented at the system level. Furthermore, this sort of research would enhance our understanding of the interactions that occur at the system level, between schools, and focus on the interactions between keystone species to uncover how and why (emergent) relationships are created between ecosystems.

In the adoption of an ICTPD innovation, I have discussed the perceived 'factors' that support or hinder the adoption of an internationally adapted ICTPD programme. My research could be extended to compare the adoption of local innovations (initiated by the MOE or the state) and internationally adapted innovations. This comparison would be useful to understand how the species and the ecosystem react to different innovations, and the constraints and enablers that emerge from the two different innovations.

The ICTPD programme was brought in from one country, in this case, from New Zealand, as an innovation in professional development to be adopted by schools and teachers in Malaysia. The process, however, was inevitably fraught with issues of compatibility in the new context in which it was being adopted. The method iNZed used to implement the ICTPD programme, for example, was to approach the teachers first instead of the school heads, a step that contributed, as a contextual factor, to the 'failed' adoption of the innovation. I recognise that my findings on the 'failure' of the innovation were based on the dual adoption lens I used in my research. Future research could be carried out using a transfer lens rather than an adoption lens, to understand the dynamics of transferring an innovation from one country to another and the factors that influence its success or failure.

In my research, I have identified a number of cultural factors that affected the adoption of the ICTPD programme. Cultural factors, such as the schools as islands as illustrated in the ECP model (ICTPD), have an influence on the adoption and can derail the implementation of an innovation. A further investigation of how these cultural factors influence the process of adoption would be an area for further research.

Another area for future research is based on emergence in complexity, as a conceptual theme. Figure 9.1 illustrates the different research areas that apply at

different levels, according to emergence. Future research, for example, could be carried out in leadership of emergence, as argued by Lichtenstein & Plowman (2009) in educational organisations so as to further understand its application in the management of schools.

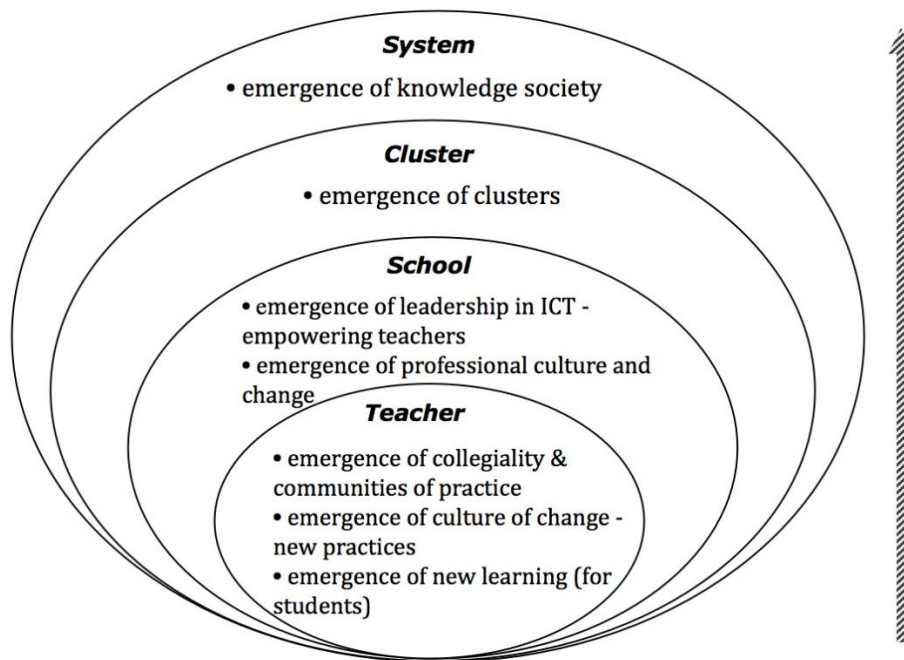


Figure 9.1. New research areas in relation to levels of emergence.

The arrow in Figure 9.1 indicates emergence, according to the levels from the individual to the system.

Educational research in these areas could potentially be useful in providing new perspectives in education by using complexity thinking. Though there is a large body of educational literature on these research areas, complexity thinking adds a different view on, for example, collegiality. Research in collegial relationships in complexity thinking would uncover the intricacies of how and why collegiality emerges or otherwise within teachers in a school.

9.5 Summary

Davis & Sumara (2006) aptly reasoned that complexity thinking used in conjunction with an ecological perspective can provide another discourse among other educational discourses. My research discussions show that my ecological-complexity models can provide an alternative to the linear and formulaic list of factors and models. I started my PhD thinking in the linear, with prescriptive factors that influenced teachers' ICT adoption and innovation, and finished with complexity and emergence. In the end, I have learnt to simplify complexity but not reduce it; achieving simplicity in describing complexity is a difficult process, which requires understanding the significant. Instead of providing an ending, my ecological-complexity journey has reframed my thoughts on ICT, adoption, and education as a whole and offered me a way to start formulating alternative approaches to common education issues I deal with in the MOE.

BIBLIOGRAPHY

- ACOT. (1995). *Teaching learning & technology: A report on 10 years of ACOT research*. Cupertino, CA: Apple Computer Inc.
- Afshari, M., Bakar, K. A., Luan, W. S., Samah, B. A., & Fooi, F. S. (2009). Factors affecting teachers' use of information and communication technology. *International Journal of Instruction*, 2(1), 77-104.
- Anfara, V. A., & Mertz, N. T. (2006). *Theoretical frameworks in qualitative research*. London: Sage Publications.
- Azmi, Z. (2001). *Education in Malaysia: A journey to excellence*.
- Baek, Y., Jung, J., & Kim, B. (2008). What makes teachers use technology in the classroom? Exploring the factors affecting facilitation of technology with a Korean sample. *Computers and Education*, 50(1), 224-234.
- Bazeley, P. (2007). *Qualitative data analysis with NVivo*. London: Sage Publications.
- Becker, H. J. (2000). Findings from the teaching, learning, and computing survey: Is Larry Cuban right? Retrieved from <http://www.crito.uci.edu/tlc/findings/ccsso.pdf>
- Becker, H. J., & Riel, M. M. (2000). Teacher professional engagement and constructivist-compatible computer use. *Teaching, Learning, and Computing: 1998 National Survey. Report #7* Retrieved 16 May, 2008, from http://www.crito.uci.edu/tlc/findings/report_7/startpage.html
- BECTA. (2005). Bedding in: Factors that facilitate implementation and integration of ICT in classroom practice. Retrieved 4th December, 2007, from <http://www.becta.org.uk>
- Bell, J. (2005). *Doing your research project (4th Ed.)*: Open University Press.
- Birbili, M. (2000). Translating from one language to another. *Social Research Update*(31), 1- 6.
- Boshuizen, H., & Wopereis, I. (2003). Pedagogy of training in information and communications technology for teachers and beyond. *Technology, Pedagogy and Education*, 12(1), 149-160.
- Boyatzis, R. E. (2006). An overview of intentional change from a complexity perspective. *Journal of Management Development*, 25(7), 607-623. Retrieved from www.emeraldinsight.com/0262-1711.htm
- Bozeman, B. (2000). Technology transfer and public policy: a review of research and theory. *Research Policy*, 29, 627-655.
- Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge USA: Harvard University Press.
- Burniske, R. W. (2002). Pedagogy of the impressed: Introducing teachers in developing countries to educational technology. *TechKnowLogia – International Journal of Technologies for the Advancement of Knowledge & Learning*, 4(4), 19-23.
- Bush, T., Bell, L., & Middlewood, D. (2010). *The Principles and Practice of Educational Management* (2nd ed.). London: Sage Publications.
- Caldwell, R. (2007). Agency and change: Re-evaluating Foucault's legacy. *Organization*, 14(6), 769-791.
- Christensen, R., & Knezek, G. (2008). Self-report measures and findings for information technology attitudes and competencies. *International Handbook of Information Technology in Primary and Secondary Education* (pp. 349-365).
- Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, 18(8), 947-967.
- Colucci-Gray, L., Camino, E., Barbiero, G., & Gray, D. (2006). From scientific literacy to sustainability literacy: An ecological framework for education. *Science Education*, 90(2), 227-252.

- Conole, G., de Laat, M., Dillon, T., & Darby, J. (2008). 'Disruptive technologies', 'pedagogical innovation': What's new? Findings from an in-depth study of students' use and perception of technology. *Computers and Education*, 50(2), 511-524.
- Corning, P. A. (2002). The re-emergence of "Emergence": A venerable concept in search of a theory. *Complexity*, 7(6), 18-30.
- Cranefield, J. (2009). *Online communities of practice and professional change: A three-tier view of the knowledge embedding process*. Victoria University of Wellington, Wellington.
- Crawford, R. (1999). Teaching and learning IT in secondary schools: Towards a new pedagogy? *Education and Information Technologies*, 4, 49-63.
- Creswell, J. W. (1997). *Qualitative inquiry and research design: Choosing among five traditions*. New York: Sage Publications.
- Creswell, J. W. (2002). *Research design: Qualitative, quantitative, and mixed methods approaches*. New York: Sage Publications.
- Creswell, J. W., & Clark, V. L. P. (2006). *Designing and conducting mixed methods research*. New York: Sage Publications.
- Crossan, M. M., & Apaydin, M. (2010). A Multi-Dimensional Framework of Organizational Innovation: A Systematic Review of the Literature. *Journal of Management Studies*, 47(6), 1154-1191.
- Cuban, L. (2001). *Oversold and underused : Computers in the classroom*. Cambridge, Mass.: Harvard University Press.
- Dall'Alba, G., & Sandberg, J. (2006). Unveiling professional development: A critical review of stage models. *Review of Educational Research*, 76(3), 383-412. doi:[1154282741](https://doi.org/10.1154282741)
- Davis, B., & Sumara, D. J. (2006). *Complexity and education: Inquiries into learning, teaching, and research*. New Jersey: Lawrence Erlbaum Associates.
- De Wolf, T., & Holvoet, T. (2004). *Emergence and self-organisation: A statement of similarities and differences*.
- Delamont, S. (2007). *Handbook of ethnography*. London: Sage Publications.
- Demetriadis, S., Barbasb, A., Molohidesb, A., G. Palaigeorgioua, Psillosb, D., Vlahavasa, I., et al. (2003). "Cultures in negotiation": Teachers' acceptance/resistance attitudes considering the infusion of technology into schools. *Computers & Education*, 41, 19-37.
- Denzin, N. K., & Lincoln, Y. S. (1994). *Handbook of qualitative research*. Thousand Oaks, CA: Sage.
- Dexter, S. (2008). Leadership for IT in schools. *International Handbook of Information Technology in Primary and Secondary Education* (pp. 543-554).
- Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers and Education*, 51(1), 187-199.
- Elliot, J., & Luke, D. (2008). Epistemology as ethics in research and policy: The use of case studies. *Journal of Philosophy of Education*, 42(s1), 87-119.
- Ely, D. P. (1990). Conditions that facilitate the implementation of educational technology innovations. *Journal of Research on Computing in Education*, 23(2), 298-305.
- Eneh, O. C. (2010). Technology transfer, adoption and integration: A review. *Applied Sciences*, 10(16), 1814-1819.
- Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology, Research and Development*, 53(4), 15.
- Eteokleous, N. (2008). Evaluating computer technology integration in a centralized school system. *Computers and Education*, 51(2), 669-686.

- Fleckenstein, K., Spinuzzi, C., Rickly, R., & Papper, C. (2008). The Importance of harmony: An ecological metaphor for writing research. *College Composition and Communication*, 60(2), 388-419. doi:1632041651
- Fullan, M. (2000). *Change Forces: The Sequel*. London: Falmer Press.
- Fullan, M. (2001). *The new meaning of educational change*. New York: Teachers College Press.
- Fullan, M. (2003a). *Change forces with a vengeance*. London: RoutledgeFalmer.
- Fullan, M. (2003b). *The moral imperative of school leadership*. London: Sage Publications.
- Galanouli, D., Murphy, C., & Gardner, J. (2004). Teachers' perceptions of the effectiveness of ICT-competence training. *Computers & Education Journal*, 43, 63-79.
- Gladwell, M. (2000). *The tipping point*. Boston: Little, Brown.
- Glaser, B. G., & Strauss, A. C. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Aldine Publishing Company.
- Goldstein, J. A., Richardson, K. A., Allen, P. M., & Snowden, D. (2007). *Emergence, complexity and organization: E:CO Annual (Vol. 8)*. Mansfield: ISCE Publishing.
- Government of Malaysia. (2007). *Malaysian educational statistics 2006*.
- Granger, C. A., Morbey, M. L., Lotherington, H., Owston, R. D., & Wideman, H. H. (2002). Factors contributing to teachers' successful implementation of IT. *Journal of Computer Assisted Learning*, 18, 480-488.
- Guba, E. G., & Lincoln, Y. S. (2005). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.
- Guhn, M. (2008). Insights from successful and unsuccessful implementations of school reform programs. *Journal of Educational Change*.
- Haddad, W. (2002). Technology and teacher education: Making the connection. *TechKnowLogia – International Journal of Technologies for the Advancement of Knowledge & Learning*, 4(4), 5-6.
- Hallinger, P. (2001). Leading educational change in East Asian schools. *Studies in Educational Administration*, 29(2), 61-71.
- Ham, V. (2005). Clustering schools for teacher development in ICT. In K. W. Lai (Ed.), *e-Learning Communities: Teaching and Learning with the Web*. Dunedin NZ: Otago University Press.
- Ham, V., Gilmore, A., Kachelhoffer, A., Morrow, D., Moeau, P., & Wenmoth, D. (2002). An evaluation of the 23 ICTPD school clusters programme 1999-2001. from <http://www.minedu.govt.nz/index.cfm?layout=document&documentid=11949&indexid=9320&indexparentid=1024>
- Handy, C. (1993). *Understanding organizations* (4th ed.). London: Penguin.
- Handy, C. (1995). *Gods of management* (3rd ed.). London: Arrow Books.
- Hargreaves, D. H. (1994). The new professionalism: The synthesis of professional and institutional development. *Teaching and Teacher Education*, 10(4), 423-438.
- Hartnell-Young, E. (2006). Teachers' roles and professional learning in communities of practice supported by technology in schools. *Journal of Technology and Teacher Education*, 14(3), 461-480.
- Hassan, W. S. (2004). *The use of open source in Malaysian schools*. Sussex, Brighton.
- Hassan, W. S. (2008). KPEC research. In J. Bartlett (Ed.). Wellington.
- Hawkrige, D. G., Jaworski, J., & McMahon, H. (1991). *Computers in Third-World schools: Examples, experience and Issues*. London: Palgrave Macmillan.
- Haydn, T., & Barton, R. (2008). 'First do no harm': Factors influencing teachers' ability and willingness to use ICT in their subject teaching. *Computers and Education*, 51(1), 439-447.

- Haziq, L., Nizam, A., & Shofi, M. (2009, 10th July 2009). PPSMI dimansuhkan? *Utusan Online* Retrieved July 8th, 2009, from www.utusan.com.my
- Higgs, J. (2001). Charting standpoints in qualitative reserch. In H. Byrne-Armstrong (Ed.), *Critical movements in qualitative research*.
- Jamieson-Proctor, R., & Finger, G. (2008). *ACT to improve ICT use for learning: A synthesis of studies of teacher confidence in using ICT in two Queensland schooling systems*. Paper presented at the Australian Computers in Education Conference 2008 (ACEC'08): ACT on IcT. Retrieved from <http://eprints.usq.edu.au/4157/>
- Jansen, J. (2002). Building capacity in the North: Can international cooperation learn? . In A. Thijs, L. Feiter & J. Jan Akker (Eds.), *International learning on education reform: Towards more effective ways of cooperation*. Amsterdam: Vrije Universiteit Printers.
- John, P., & Sutherland, R. (2004). Teaching and learning with ICT: New technology, new pedagogy? . *Education, Communication and Information*, 4(1), 7.
- Judson, E. (2006). How teachers integrate technology and their beliefs about learning: Is there a connection? *Journal of Technology and Teacher Education*, 14(3), 581-597.
- Kane, E. (1995). *Seeing for yourself*. Washington, D.C.: The World Bank.
- Kelle, U. (2005). "Emergence" vs. "Forcing" of empirical data? A crucial problem of "Grounded Theory" reconsidered. *Forum: Qualitative Social Research*, 6(2), 23. Retrieved from <http://www.qualitative-research.net/index.php/fqs/article/view/467>
- Kennewell, S., Parkinson, J., & Tanner, H. (2000). *Developiong the ICT-capable school*. London: RoutledgeFalmer.
- Kessler, G., & Plakans, L. (2008). Does teachers' confidence with CALL equal innovative and integrated use? *Computer Assisted Language Learning*, 21(3), 269 - 282.
- Khalid, F., Nawawi, M., & Roslan, S. (2009). Integration of ICT in Malaysian secondary schools: What conditions will facilitate its use? *The International Journal of Learning*, 15(12), 85-94. Retrieved from <http://ijb.cgpublisher.com/product/pub.30/prod.1983>
- Kilbourn, B., & Alvarez, I. (2008). Root-metaphors for understanding: A framework for teachers and teacher educators of information and communication technologies. *Computers and Education*, 50(4), 1354-1369.
- Kirschner, P., Wubbels, T., & Brekelmans, M. (2008). Benchmarks for teacher education programs in the pedagogical use of ICT. *International Handbook of Information Technology in Primary and Secondary Education* (pp. 435-447).
- Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education*, 49(3), 740-762.
- Law, N. (2008). Teacher learning beyond knowledge for pedagogical innovations with ICT. *International Handbook of Information Technology in Primary and Secondary Education* (pp. 425-434).
- Leach, F. (1999). Tensions between economics and culture in educational aid: lessons for donors. In A. Little (Ed.), *Education, Cultures and Economics: dilemmas for development* (pp. 371-394). New York: Garland.
- Lemke, C., & Coughlin, E. (1998). Technology in American schools: Seven dimensions for gauging progress. Retrieved 31 June, 2008, from <http://www.mff.org/edtech/>
- Lewin, K. (1951). *Field theory in social science*. New York: Harper Row.
- Lichtenstein, B. B., & Plowman, D. A. (2009). The leadership of emergence: A complex systems leadership theory of emergence at successive organizational levels. *The Leadership Quarterly*, 20(4), 617-630.

- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications.
- Loveless, A. (2003). The interaction between primary teachers' perceptions of ICT and their pedagogy. *Education and Information Technologies* 8(4), 313-326.
- Loveless, A., Devoogd, G., & Bohlin, R. (2001). Something old, something new...: is pedagogy affected by ICT? In A. Loveless & V. Ellis (Eds.). London: RoutledgeFalmer.
- Lowther, D. L., Inan, F. A., Daniel Strahl, J., & Ross, S. M. (2008). Does technology integration "work" when key barriers are removed? *Educational Media International*, 45(3), 195 - 213.
- Luckin, R. (2008). The learner centric ecology of resources: A framework for using technology to scaffold learning. *Computers and Education*, 50(2), 449-462.
- Mae, C. F. (2004). ICT in education: Malaysian case study. Retrieved 12 August, 2004, from <http://www.unescobkk.org/index.php?id=1846>
- Marion, R., & Uhl-Bien, M. (2002). *Complexity v. transformation: The new leadership revisited*. Paper presented at the Managing the Complex IVFConference on Complex Systems and the Management of Organizations.
- McDevitt, D. (1998). How effective is the cascade as a method for disseminating ideas? A case study in Botswana. *International Journal of Educational Development*, 18(5), 425-428.
- McGrath, S. (2001). Ecological anthropology. *Anthropological theories* Retrieved 28th January 2008, from http://www.as.ua.edu/ant/Faculty/murphy/ecologic.htm#_jmp0
- Meier, P. S. (2007). Mind-mapping. *Social Research Update*(52), 1-4.
- Melor, Y. (2007). Malaysian ESL teachers' use of ICT in their classrooms: Expectations and realities. *ReCALL : the Journal of EUROCALL*, 19(1), 79-95.
- Merriam, S. B. (1991). *Case study research in education: A qualitative approach*. San Francisco: Jossey-Bass Publishers.
- Merriam, S. B. (2009). *Qualitative research : a guide to design and implementation*. San Fransico, CA: Jossey-Bass.
- Miller, S., Meier, E., Payne-Bourcy, L., Shablak, S., Newmann, D. L., Wan, T. Y., et al. (2003). Technology use as a catalyst for change: A leadership framework for transforming urban teacher preparation. *International Electronic Journal For Leadership in Learning*, 7(12).
- Ministry of Education. (2007). ICT professional development clusters. (8th March 2008). Retrieved from http://www.minedu.govt.nz/print_doc.cfm?layout=document&documentid=7383&indexid=6918&indexparentid=1024&fromprint=y
- Ministry of Education Malaysia. (2006). *National educational blueprint 2006-2010*. Putrajaya: Ministry of Education Malaysia.
- Ministry of Education, N. Z. (2010). ICT professional development clusters - schools. Retrieved 18th October 2010, from www.tki.org.nz/
- Mioduser, D., Nachmias, R., Tubin, D., & Forkosh-Baruch, A. (2002). Models of pedagogical implementation of ICT in Israeli schools. *Journal of Computer Assisted Learning*, 18(4), 405-414.
- Mooij, T., & Smeets, E. (2001). Modelling and supporting ICT implementation in secondary schools. *Computers & Education*, 36(3), 265-281.
- Moser, C., & Kalton, G. (1977). *Survey methods in social investigation*. London: Heinemann.
- Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers & Education*, 51(4), 1523-1537.

- Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: A review of the literature. *Journal of Information Technology for Teacher Education*, 9(3), 319-341.
- Nardi, B., & O'Day, V. (1999). *Information ecologies: Using technology with heart*. Cambridge, Mass: MIT Press.
- Newhouse, P. (2001). Applying the concerns-based adoption model to research on technology in classrooms. *Journal of Research on Computing in Education*, 33(5).
- Newhouse, P. (2002). *The impact of ICT on learning and teaching*. Perth, Western Australia: Western Australian Department of Education.
- Norton, K. (2007). *Evaluation report of the KPerak E-learning cluster No.1 pilot project*: Innovation New Zealand Education Malaysia Ltd.
- O'Connor, D. L., & Ertmer, P. A. (2006). Today's coaches prepare tomorrow's mentors: Sustaining results of professional development. *Academy of Educational Leadership Journal*, 10(2).
- Orlando, J. (2009). Understanding changes in teachers' ICT practices: A longitudinal perspective. *Technology, Pedagogy and Education*, 18(1), 33 - 44.
- Ottaway, R. N., & Cooper, C. L. (1976). Moving towards a taxonomy of change agents. *Management Learning*, 7, 177-186. doi:10.1177/135050767600700304
- Perraton, H., & Creed, C. (2001). *Applying new technologies & cost effective delivery system in basic education*. Paris: Unesco.
- Prestariang Technology. (2006). About BPPT Retrieved 11 April, 2009, from <http://www.prestariang.com.my/bppt/about.php>
- Reddy, N. M., & Zhao, L. (1990). International technology transfer: A review. *Research Policy*, 19(4), 285-307.
- Riel, M., & Becker, H. (2000). The beliefs, practices, and computer use of teacher leaders. Retrieved 8 March, 2008, from <http://www.crito.uci.edu/tlc/findings/aera/aera.htm>
- Riel, M., & Becker, H. J. (2008). Characteristics of teacher leaders for information and communication technology. *International Handbook of Information Technology in Primary and Secondary Education* (pp. 397-417).
- Ringstaff, C., Yocam, K., & Marsh, J. (1996). Integrating technology into classroom instruction: An assessment of the impact of the ACOT teacher development center project. *ACOT Research Report No.22* Retrieved 6 March, 2008, from <http://www.apple.com/education/k12/leadership/acot/library.html>
- Rogers, E. M. (1995). *Diffusion of innovations*. (Fourth ed.). New York: Free Press.
- Rogers, E. M. (2003). *Diffusion of Innovations*. (Fifth ed.). New York: Free Press.
- Sahin, S., & Ham, V. (2010). *Outcomes for teachers and students in the ICT PD school clusters programme 2006-2008 - A national overview*. Retrieved from www.educationcounts.govt.nz/publications.
- Sandholtz, H., Ringstaff, C., & Dwyer, D. (1992a). The relationship between technological innovation and collegial interaction. *ACOT Research Report No.13, 2008*(6 March). Retrieved from <http://www.apple.com/education/k12/leadership/acot/library.html>
- Sandholtz, H., Ringstaff, C., & Dwyer, D. (1992b). Teaching in high-tech environments: Classroom management revisited First – Fourth year findings. *Apple Classrooms of Tomorrow Research*, 10, 1-8. Retrieved from <http://images.apple.com/euro/pdfs/acotlibrary/rpt10.pdf>
- Sandholtz, J., Ringstaff, C., & Dwyer, D. (1997). *Teaching with Technology: Creating Student-Centred Classrooms*. New York: Teachers College Press.
- Sayed, Y. (2001). *Continuing professional development & education policy: Characteristics, conditions & change*. University of Sussex, Brighton.

- Schibeci, R., MacCallum, J., Cumming-Potvin, W., Durrant, C., Kissane, B., & Miller, E.-J. (2008). Teachers, journeys towards critical use of ICT. *Learning, Media and Technology*, 33(4), 313 - 327.
- Schneider, S. C., & Barsoux, J. (1997). *Managing across cultures*. Harlow: Financial Times/Prentice Hall.
- Silverman, D. (2006). *Interpreting qualitative data: Methods for analyzing talk, text and interaction* (3rd ed.). London: Sage Publications.
- Smith, A., & Graetz, F. (2006). Complexity theory and organizing form dualities. *Management Decision*, 44(7), 851-870. Retrieved from www.emeraldinsight.com/0025-1747.htm. doi:10.1108/00251740610680569
- Somekh, B. (2008). Factors affecting teachers' pedagogical adoption of ICT. *International Handbook of Information Technology in Primary and Secondary Education* (pp. 449-460).
- Somekh, B., & Davis, N. (1997). *Using information technology effectively in teaching & learning*. London: Routledge.
- Stake, R. E. (1995). *The art of case study research*. New York: Sage Publications.
- Stake, R. E. (2003). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry* (pp. 134-164). Los Angeles: Sage Publications.
- Stake, R. E. (2005). *Multiple case study analysis*. New York: The Guilford Press.
- State education officer. (2010). KPEC status. In shukry.hassan@vuw.ac.nz (Ed.). Ipoh, Perak.
- Strauss, A. C., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. London: Sage Publications.
- Strauss, A. C., & Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (2nd ed.). London: Sage Publications.
- Subramaniam, K. (2007). Teachers' mindsets and the integration of computer technology. *British Journal of Educational Technology*, 38(6), 1056-1071.
- Tatnall, A., & Davey, B. (2003). ICT and training: A proposal for an ecological model of innovation. *Educational Technology & Society*, 6(1).
- Tearle, P. (2003). ICT implementation: What makes the difference? *British Journal of Educational Technology*, 34(5), 567-583.
- Temple, B., & Young, A. (2004). Qualitative research and translation dilemmas. *Qualitative Research*, 4(2), 161-178.
- Tondeur, J., Valcke, M., & Van Braak, J. (2008). A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of Computer Assisted Learning*, 24(6), 494-506.
- Tondeur, J., van Braak, J., & Valcke, M. (2007). Towards a typology of computer use in primary education. *Journal of Computer Assisted Learning*, 23(3), 197-206.
- Tondeur, J., van Keer, H., van Braak, J., & Valcke, M. (2008). ICT integration in the classroom: Challenging the potential of a school policy. *Computers and Education*, 51(1), 212-223.
- Trinidad, S., Newhouse, P., & Clarkson, B. (2006). *A framework for leading school change in using ICT: Measuring change*. Paper presented at the Association for Active Educational Researchers. Retrieved from <http://www.aare.edu.au/05pap/alpha.htm>
- Twining, P., Broadie, R., Cook, D., Ford, K., Morris, D., Twiner, A., et al. (2006). Educational change and ICT: An exploration of Priorities 2 and 3 of the DfES e-strategy in schools and colleges. The current landscape and implementation issues. Retrieved 2nd August, 2008, from <http://www.becta.org.uk>
- UNESCO. (2008). Education in Malaysia. Retrieved 13th March 2009, from UNESCO Institute for Statistics:

- http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=121&F_Language=eng&BR_Country=4580
- Vandenbergh, R. (2002). Teachers' professional development as the core of school improvement. *International Journal of Educational Research*, 37(8), 653-659.
- VanWynsberghe, R., & Khan, S. (2007). Redefining case study. *International Journal of Qualitative Methods*, 6(2), Article 6. Retrieved from http://www.ualberta.ca/~iiqm/backissues/6_2/vanwysberghe.pdf
- Vekiri, I. (2009). Socioeconomic differences in elementary students' ICT beliefs and out-of-school experiences. *Computers and Education*.
- Wan Ali, W. Z., Mohd Nor, H., Hamzah, A., & Alwi, H. (2009). The conditions and level of ICT integration in Malaysian Smart Schools. *International Journal of Education and Development using ICT*, 5(2), 7. Retrieved from <http://ijedict.dec.uwi.edu/viewarticle.php?id=618&layout=html>
- Wan Zah, W. A., Hajar, M. N., Azimi, H., & Hayati, A. (2009). The conditions and level of ICT integration in Malaysian Smart Schools. *International Journal of Education and Development using ICT*, 5(2), 1-6. Retrieved from <http://ijedict.dec.uwi.edu/>
- Williams, D., Coles, L., Wilson, K., Richardson, A., & Tuson, J. (2000). Teachers and ICT: Current use and future needs. *British Journal of Educational Technology*, 31(4), 307-320.
- Wilson, B., Sherry, L., Dobrovolny, J., Batty, M., & Ryder, M. (2001). Adoption factors and processes. In H. H. Adelsberger, B. Collis & J. M. Pawlowski (Eds.), *Handbook on information technologies for education & training* (pp. 293-307). New York: Springer-Verlag.
- Windschitl, M., & Sahl, K. (2002). Tracing teachers' use of technology in a laptop computer school: The interplay of teacher beliefs, social dynamics, and institutional culture. *American Educational Research Journal*, 39(1), 165-205.
- Wozney, L., Venkatesh, V., & Abrami, P. C. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education*, 14, 120-173.
- Zhao, Y., & Bryant, F. L. (2006). Can teacher technology integration training alone lead to high levels of technology integration? A qualitative look at teachers' technology integration after state mandated technology training. *Electronic Journal for the Integration of Technology in Education*, 5, 53-62. Retrieved from <http://ejite.isu.edu/Archive.html>
- Zhao, Y., & Cziko, G. A. (2001). Teacher adoption of technology: A perceptual control theory perspective. *Technology and Teacher Education*, 9(1), 5-30.
- Zhao, Y., & Frank, K. A. (2003). Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal*, 40(4), 807-840.
- Zhao, Y., Pugh, K., Sheldon, S., & Bryers, J. L. (2002). Conditions for classroom technology innovations. *Teachers College Record*, 104(3).

APPENDICES

Appendix A: Glossary of terms	319
Appendix B: Map of Malaysia	321
Appendix C: Structure of the Malaysian Ministry of Education.....	322
Appendix D: Mindmap (an example with analysis).....	323
Appendix E: Factor sheet	324
Appendix F : Sample of questions (bi-lingual).....	325
Appendix G: Sample question cards	326
Appendix H: Sample of observation protocols.....	327
Appendix I: Journal (notes & questions)	328
Appendix J: Journal (notes)	329
Appendix K: Sample of Nvivo Tree Node.....	330
Appendix L: Sample a simple mind-map on factors related to ICT adoption.....	331
Appendix M: Ethics approval.....	332
Appendix N: Letter of approval from the State Education Office	333
Appendix O: Samples of consent letters in Bahasa Melayu and in English	334
Appendix P: Computer lab	337
Appendix Q: Access centre.....	338
Appendix R:ICT challenge self-assessment rubric	339
Appendix S: ICT challenges.....	340
Appendix T: Sample of student work	341

Appendix A: Glossary of terms

ACOT	Apple Classrooms Of Tomorrow
BECTA	British Educational Communications and Technology Agency
BPPT	<i>Bimbingan Perguruan Professional dalam Teknologi Maklumat dan Komunikasi</i> or Teacher Continuing Professional Development in ICT
CBAM	Concerns-Based Adoption Model
CDC	Curriculum Development Centre
CIE	Computers in Education
COP	Communities of practice
CP	Computerisation Project
DOI	Diffusion of Innovations
ECP	Ecological-Complexity Perspective
EPRD	Economic Planning and Research Department
EPU	Economic Planning Unit
EST	English for Science and Technology
ETEMS	English for the Teaching of Mathematics and Science
GER	Gross Enrollment Rates
iBoard	Interactive White Board
ICAR	ICT Challenge Assessment Rubric
ICT infrastructure	Includes computer labs, connectivity, hardware, etc.
ICT or ICTs	Information Communications Technology
ICTL	ICT literacy or computer literacy
ICTPD	ICT professional development
IET	Information Ecology Theory
INSET	In-service training
iNZed	Innovation New Zealand Education
KBSM	<i>Kurikulum Bersepadu Sekolah Menengah</i> or Secondary School Integrated Curriculum
KBSR	<i>Kurikulum Bersepadu Sekolah Rendah</i> or Primary School Integrated Curriculum
KDP	<i>Komputer Dalam Pendidikan</i> or Computers in Education
KERIS	Korean Educational Research Institute
KPEC	K-Perak E-learning Cluster
KPEC I	K-Perak E-learning Cluster I (March - May 2007)
KPEC II	K-Perak E-learning Cluster II (February 2008 onwards)
KPI	K-Perak Incorporated
KPM	<i>Kementerian Pelajaran Malaysia</i>
LC	Literacy Curriculum
LCD	Liquid Crystal Display
LMS	Learning Management System
LOTi	Levels of Technology Implementation Model
MOE	Ministry of Education (Malaysia)
MS	Microsoft

MSC	Multimedia Super Corridor
MTP	Microsoft Teacher Professional
NCIA	Northern Corridor Implementation Authority
NEDB	National Educational Development Blueprint
NEP	National Economic Plan
NETS	National Education Technology Standards
NOF	National Opportunities Fund
NZ	New Zealand
OUM	Open University Malaysia
PCT	Perception Control Theory
PD	Professional development
PGCE	Post Graduate Certificate of Education
PMR	<i>Penilaian Menengah Rendah</i> or Malaysian Lower Certificate of Education
PPT	Private Practice Teachers
ROA	Reflection-On-Action
SchoolNet	Broadband initiative (see section 2.3.1.4)
SD	Schools Division
SEDO	State Education Office
SEO	State Education Officer
SES	Socio-economic status
SMM	<i>Sistem Maklumat Murid</i> or Student Information System
SPM	<i>Sijil Pelajaran Malaysia</i> or Malaysian Certificate of Education
SS	Smart School
SSC	Smart School Curriculum
STPM	<i>Sijil Tinggi Pelajaran Malaysia</i> or Malaysian Higher Certificate of Education
TIU	Typology of Uptake Model
TMM	Technology Maturity Model
TSS	The Smartising Schools
TTD	Teacher Training Division
UK	United Kingdom
UPSR	<i>Ujian Penilaian Sekolah Rendah</i> or Primary School Assessment
Web 2.0	Web based applications, which focus on collaboration and communications such as Skype, Yahoo Messenger, Blogs & Wikis.

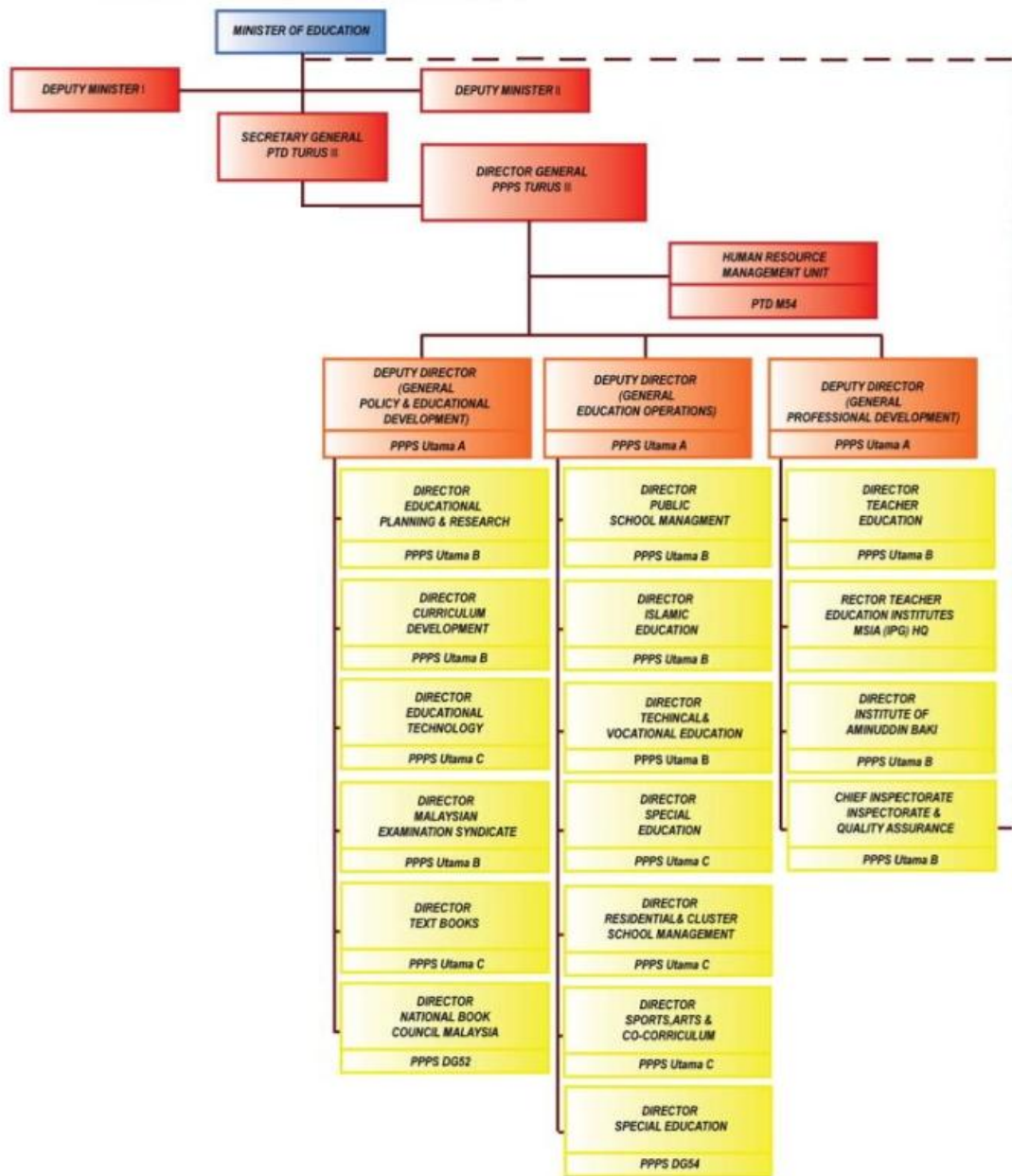
Appendix B: Map of Malaysia



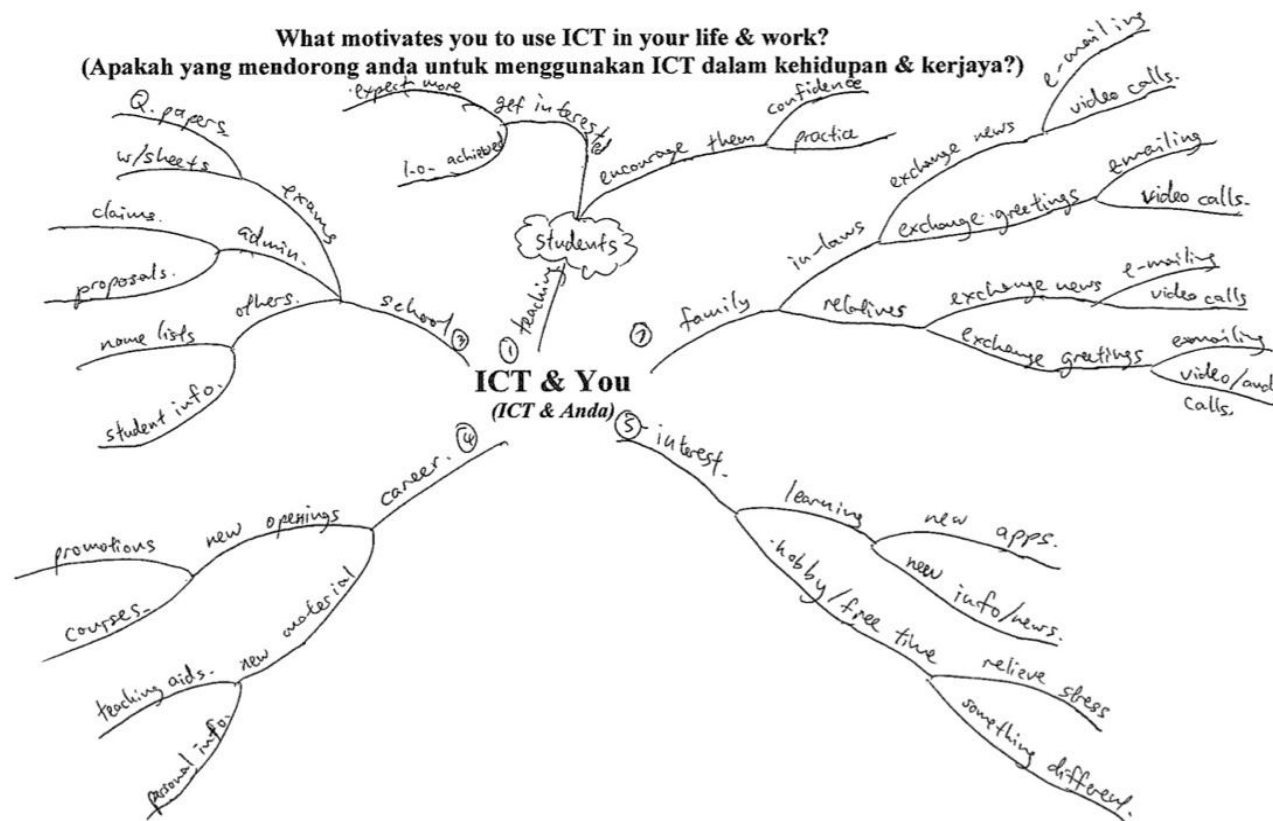
(Source: Google Map: <http://maps.google.co.nz>)

Appendix C: Structure of the Malaysian Ministry of Education

MINISTRY OF EDUCATION MALAYSIA



Appendix D: Mindmap (an example with analysis)



Node count - Main (5) Minor (41)
 Total (46)

Rank

- 1- teaching; Ss more interested, encouraged (W)
- 2- family: keeping in touch, emails, video calls, etc (L)
- 3- school: admin work, exam preparation, documentation, etc (W)
- 4- career; new material, teaching aids, new opportunities, promotions (W)
- 5- interest; lifelong learning, hobbies, entertainment, news (L)

Appendix E: Factor sheet

Factors that you think influenced your use of ICT

	Personal	School
Encourage (+)	<p>① Communication. - Access email & websites to gain information & know about the latest goings-on.</p> <p>② Interest. - Explore new and novel applications / media and information.</p>	<p>①. To encourage / attract students towards the lesson / learning outcome.</p> <p>②. Have to ^{create} / make adjustments to question papers / worksheets / ^{slideshows} etc.</p>
Hinder (-)	<p>①. Budget (Need money to keep on upgrading).</p> <p>②. Time (You spend more time on the computer than being with family or attending to other responsibilities).</p>	<p>①. Facilities (Limited; Broken-down; Virus-infected).</p> <p>②. Time (Other tasks to complete than creating learning aids).</p>

Appendix F : Sample of questions (bi-lingual)

Main Research Questions (Soalan Utama Penyelidikan)


Principal/Head (Pengetua/Guru Besar)

1. As the principal/head of the school, how did you manage the K-Perak Pilot project in your school? (Selaku pengetua/guru besar, bagaimana anda mengurus projek percubaan K-Perak di sekolah anda?)
2. What benefits do you think the K-Perak project brought for the school and teachers? Did it reach its intended outcomes? (Apakah manfaat projek K-Perak kepada sekolah dan guru? Sejauhmana projek itu mencapai hasilnya?)
3. What changes have resulted from the K-Perak Pilot in terms of your teachers' use of ICT? (Apakah kesan projek percubaan K-Perak ke atas penggunaan TMK guru?)
4. What aspects of the project worked *really well* / *did not work very well* at your school? Why? (Apakah aspek projek yang benar-benar berjaya/tidak berjaya di sekolah anda? Mengapa?)
5. What factors supported the ICTPD in the K-Perak cluster? OR What factors have influenced the discontinuance of the K-Perak Pilot? (Apakah factor yang menyokong Per Staf TMK dalam kluster K-Perak? Atau apakah factor yang menyumbang kepada berhentinya projek percubaan K-Perak?)

Facilitators/Mentors/Teachers (Fasilitator/Mentor/Guru)

1. What type of support did the school receive from the district, state and ministry in this K-Perak Pilot? (Apakah bentuk sokongan yang diterima sekolah dari PPD, JPN dan KPM berhubung projek percubaan K-Perak?)
2. How would you describe the support from SED/ MOE/ other parties on this project? (Bagaimana anda melihat sokongan JPN/KPM/pihak lain berhubung projek ini?)
3. What were the major constraints while the project was being carried out? What are the constraints now? (Apakah kekangan utama yang dihadapi semasa pelaksanaan projek ini? Apakah kekangan sekarang?)
4. What level of ICT infrastructure (e.g computers) does the school have to support/carry out the K-Perak Pilot? (Apakah tahap infrastruktur TMK (eg komputer) yang dimiliki sekolah yang menyokong pelaksanaan projek percubaan K-Perak?)
5. What is your/the teachers' background (training) and experience in teaching? (Apakah pengalaman latar (latihan) dan pengalaman mengajar guru?)
6. What role does ICT play in your/teachers classroom teaching/practice? (Apakah peranan TMK dalam konteks kelas/amalan pengajaran anda?)
7. How would you describe your level of ICT competence? (Apakah tahap kompetensi TMK anda?)
8. What roles does the leadership/school/others play in encouraging the use of ICT in subject taught? (Apakah peranan pemimpin/sekolah/pihak lain dalam mengalakkan penggunaan TMK dalam subjek diajar?)
9. What is the level of teacher access to ICT facilities and support? (Apakah tahap akses guru kepada kemudahan dan sokongan TMK?)
10. How were the teachers selected to be facilitators/mentors/teachers in the ICTPD? (Bagaimana guru dipilih menjadi pemudah cara/mentor/guru dalam Per Staf TMK?)


Appendix G: Sample question cards

TE WHARE WĀNANGA TE ŪPOKO O TE IKA A MĀUI
 VICTORIA
 UNIVERSITY OF WELLINGTON

① Could you tell me about KPEC training? (as you remember it)
 - what were your expectations of it?
 (technical / ideas using ICT / T&L enhancement)
 - What was good/not good OR most successful / least successful aspects?


② Could you describe the role of X in the KPEC project? (training)
 - Why do you think you were selected?

VICTORIA UNIVERSITY OF WELLINGTON COLLEGE OF EDUCATION Te Whānau o Ako Pai
 PO Box 17-310, Karori, Wellington, 6147, New Zealand Telephone +64-4-463 9500
 Fax +64-4-463 9649 Website www.vuw.ac.nz/education

TE WHARE WĀNANGA TE ŪPOKO O TE IKA A MĀUI
 VICTORIA
 UNIVERSITY OF WELLINGTON


① What's your background in teaching? ^{how long etc}
 ② What's your personal experience with ICT?
 ③ Do you use a lot of ICT? How confident are you in using ICT in your classrooms?
 - in class - stories → types of ICT use
 - use ICT in class often? Why?
 - tell me the reasons...
 ④ What about ICT in your school? How would you describe the ICT facilities, support, access (labs & class) → stories

VICTORIA UNIVERSITY OF WELLINGTON COLLEGE OF EDUCATION Te Whānau o Ako Pai
 PO Box 17-310, Karori, Wellington, 6147, New Zealand Telephone +64-4-463 9500
 Fax +64-4-463 9649 Website www.vuw.ac.nz/education

TE WHARE WĀNANGA TE ŪPOKO O TE IKA A MĀUI
 VICTORIA
 UNIVERSITY OF WELLINGTON


① How did your principal encourage you in KPEC & ICT in general (school)?
 ② What did your principal do for KPEC/ICT in school?
 - process & plan stories
 ③ What did the faci/mentors/mentees do in encouraging each other (KPEC)?
 ④ In your opinion, what changes occurred during KPEC? Describe

VICTORIA UNIVERSITY OF WELLINGTON COLLEGE OF EDUCATION Te Whānau o Ako Pai
 PO Box 17-310, Karori, Wellington, 6147, New Zealand Telephone +64-4-463 9500
 Fax +64-4-463 9649 Website www.vuw.ac.nz/education

TE WHARE WĀNANGA TE ŪPOKO O TE IKA A MĀUI
 VICTORIA
 UNIVERSITY OF WELLINGTON

- What was most diff. about your role?
 - How would you describe the support for other teachers in school & outside
 → what did they do/s/he do otherwise?
 - What did your school do with other schools (stories)?
 - describe school's commitment in cluster
 - school received anything additional/as part of the project? (provision/ac
 as part of the project?)
 - did JPN/PPD/MOE help in any way?

VICTORIA UNIVERSITY OF WELLINGTON COLLEGE OF EDUCATION Te Whānau o Ako Pai
 PO Box 17-310, Karori, Wellington, 6147, New Zealand Telephone +64-4-463 9500
 Fax +64-4-463 9649 Website www.vuw.ac.nz/education

TE WHARE WĀNANGA TE ŪPOKO O TE IKA A MĀUI
 VICTORIA
 UNIVERSITY OF WELLINGTON

① Could you tell me about KPEC training? (as you remember it)
 - what were your expectations of it?
 (technical / ideas using ICT / T&L enhancement)
 - What was good/not good OR most successful / least successful aspects?

② Could you describe the role of X in the KPEC project? (training)
 - Why do you think you were selected?

VICTORIA UNIVERSITY OF WELLINGTON COLLEGE OF EDUCATION Te Whānau o Ako Pai
 PO Box 17-310, Karori, Wellington, 6147, New Zealand Telephone +64-4-463 9500
 Fax +64-4-463 9649 Website www.vuw.ac.nz/education

Appendix H: Sample of observation protocols

CLASSROOM OBSERVATION PROTOCOL

I. Background Information

A. Observer Information

1. School Name: _____
2. Date of Observation: _____
3. Length of observation: _____ minutes _____ period/s

B. Teacher () Teacher Mentor () Facilitator ()

1. Name: _____
2. Gender: () Male () Female
3. Level (Teacher Background) _____
4. Primary () Secondary ()
5. ICT Skill Level (Teacher Self-Rating): 1 – 2 – 3 – 4 – 5 (Low – High) (* Ask teacher before observation)

II. Classroom Demographics

A. What is the total number of students in the class at the time of the observation?

- () 15 or fewer
 () 16–20
 () 21–25
 () 26–30
 () 31–35
 () 36–40

B. Subject Observed: _____

C. Classroom Type: Class () Lab () Other () _____

E. Scheduled length of class: _____ (minutes)

III. Classroom Context

Rate the adequacy of the physical environment in relation to ICT equipment.

1. Classroom ICT resources:

- () None () Sparse () Adequate () Rich *Photograph Environment for record
 (Code 1- _____) *filename of photo

2. Room arrangement: () Rows (linear) () Pods (groups) () Other _____

*Photograph Environment for record (Code 2- _____) *filename of photo

Appendix I: Journal (notes & questions)

+42 11:30am 15/10 09

English
 Malpas 1 pot 8th cert. i- T5
 TESL Peng. BI 8 yrs (18 yrs)
 - burden - wish experience
 Further Dip Bus (ITM)
 - assign Word
 OUM 1st deg-2008
 excel, anal, web -
 register - online / login - post Qs
 LMS reply
 - assignments & Quiz
 - seldom use - time consuming
 seven though have access
 - use ICT - Yr 6
 not really - concentrate
 - Fractions - more effort
 - $\frac{1}{2} \times \frac{1}{2}$ - good but without
 trouble for labs only Bm & Gs
 not enough time - empty
 find time
 - ask PC & Screen - enter 30 mins
 - one PC -
 - 'OK' - access PPSM1 - other work's
 rec. for comic, pengeluan
 - mentor

- training for ICT
 - trainers fr. NZ
 - how to use ICT Virtual Trip
 Aroaki - audio
 Ps - ask Qs - theme
 - describe - at random
 - ~~Online~~ - discussion - only rps.
 - concentrating in
 - help T - teacher assistant
 - get websites prepared
 - mentee (not teach)
 3 mentors
 - mentor - other workload
 - apart fr. teaching
 - mentor - not use - help -
 - support
 - quite a number - answer
 2X meeting
 - video - copying - Ps to Ps
 - support team
 - attendance survey (then)
 1st Term → KPM unit
 more. screen
 - no much change
 - same approach & time
 - several problems 5-10 - 7 mins
 - educ. benefits - long games
 T's notes + new ideas -
 - point to be bought

Appendix J: Journal (notes)

- 24 laptops fr. PPSMI
6 comots

- encourage to be bought

En. Dzul (Sek. Bestari Cilegon)
converted non-pedagogical teacher
EPLI

Access room
10 computers 1 printer 1 wifi

20c
1 P
1 PC
2/3 Router
Wifi
-kubus
-Net connection
-Schedule
-1 projector

Wifi

Desks & Chairs 3x4

Multimedia Old KDP room converted

16 compaire
14 func. ones
1 projector

→ BM & Eng must use ICT & ICT lab used
→ as part of T&L

Discussion room Comp Lab
Training

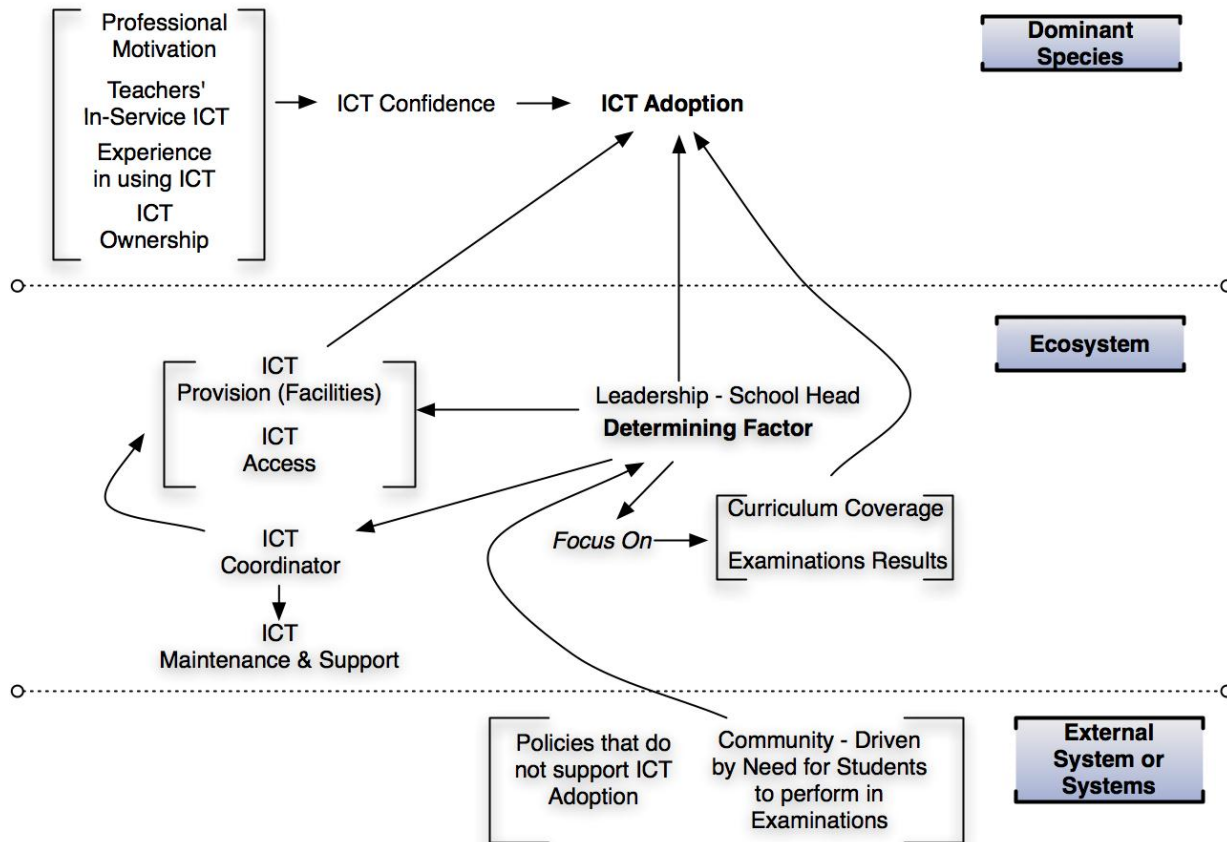
- using online portal
- portal
- laporan blog, email etc
- edit profil
- 2-3 hari
- Explain Jenelid, ajul, Narasi about KPEC
- sepatutnya Narasi tukar Ros
- Rejeki silap from guru PPSMI, Mt, Sc.
- talk from NZ English
- kementerian guru tak nampak
- gap language
- progress could not be explained
- lang. barrier
- tulis tak betul
- aktiviti - labo
- T&L tutor syllabus - biling
- parents - check → finish (7/8 finish syllabus)

Appendix K: Sample of Nvivo Tree Node

Tree Nodes

Name	
[-]	Individual Factors
[-]	ICT Perception
	Advantages - ICT use
	Factors - discourage teachers
	Factors - encourage teachers
	Need for more ICT
[-]	Motivation for Adoption
	Administrative ICT Work
	ICT as Tool or Resource
	ICT Ownership
	Personal Motivation
	Personal Use of ICT
	Professional Need
	Use Email or Web Based or Courseware
	Use of Office Applications
[-]	Teacher's Attitudes
	Class Control
	Curriculum or Syllabus or Textbook
	Efficacy
	Examination
	Help Other Teachers
	Lack of Time
	Mandated to do
	Teacher Workload
	Work with Other Teachers
[-]	Teachers Background
	ICT Training
	Professional Training
	Subjects Taught
[-]	Teacher's Pedagogical Beliefs
	Perceived Learning by Students or Pupils
	Traditional Practice
[-]	Teaching and Learnig
	Classroom Organisation
	Frequency of ICT use - Teaching
	ICT Confidence
	ICT problems - general
	Other Teacher's ICT - View

Appendix L: Sample a simple mind-map on factors related to ICT adoption



Appendix M: Ethics approval



4 August 2008

Wagheeh Shukry Hassan
c/- Postgrad House
Victoria University of Wellington College of Education
33 Campbell Street
Karori
Wellington

Dear Shukry

RE: Ethics application SEDS/2008/27, RM 15783

I am pleased to advise you that your ethics application '**Factors influencing the progression of adoption of Information Communications Technology (ICT) and teacher change in an Information Communications Technology Professional Development (ICTPD) Programme in Malaysian schools**' with the requested amendments, has been approved by the Victoria University of Wellington College of Education Ethics Committee.

Good luck with your research.

Yours Sincerely

A handwritten signature in black ink, appearing to read 'Sue Cornforth', written over a light-colored background.

Dr Sue Cornforth
Co-Convenor
Victoria University of Wellington College of Education Ethics Committee

Appendix N: Letter of approval from the State Education Office



JABATAN PELAJARAN PERAK,
JALAN TUN ABDUL RAZAK,
30640 IPOH,
PERAK DARUL RIDZUAN.

Telefon : 05-501 5000
Faks : 05-527 7273

'KOMUNITI BERILMU PERAK TERBILANG'

J.Pel.Pk.Pend.S4757/Jld.32(62)
Tarikh : 3 September 2008

Wagheeh Shukry Hassan
Room 106, 31 Campbell Street,
Karori Campus,
School of Education Studies,
Faculty of Wellington,
Victoria University of Wellington,
New Zealand, 6012.

Tuan/Puan,

**KEBENARAN UNTUK MENJALANKAN KAJIAN
DI SEKOLAH-SEKOLAH MENENGAH / RENDAH NEGERI PERAK**

Saya diarahkan merujuk surat tuan bertarikh 1 September 2008 yang ada kaitannya dengan surat Jabatan Perdana Menteri UPE :40/200/19/2314 bertarikh 29 Julai 2008 tentang perkara di atas.

2. Sukacita dimaklumkan bahawa pihak Jabatan Pelajaran Perak tiada halangan memberi kebenaran kepada tuan/puan untuk menjalankan kajian "**Faktor Yang Mempengaruhi Perkembangan Proses Adaptasi Teknologi Maklumat & Komunikasi (ICT) dan Perubahan Guru Di Dalam Program Perkembangan Profesionalisme Teknologi Maklumat & Komunikasi (ICTPD) Di Sekolah –Sekolah Di Malaysia**" di SMK Seri Ampang, Ipoh, SMK Matang, Matang, SMK Raja Kelsom, Kuala Kangsar, SK Sri Adika Raja, Gerik, Perak.

3. Kehadiran tuan/puan membuat kajian di sekolah berkenaan tidak seharusnya menjejaskan proses pengajaran dan pembelajaran di sekolah berkenaan.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

(ZAFIAN BIN HJ. KASIM)
Penolong Pendaftar Sekolah
b.p. Pendaftar Sekolah-Sekolah Perak.

- s.k.
1. Pendaftar Sekolah dan Guru
Jabatan Pelajaran Perak
 2. Penolong Pendaftar Sekolah dan Guru
Pejabat Pelajaran Daerah Negeri Perak.

"CINTAILAH BAHASA KITA"
(Sila catatkan rujukan pejabat ini apabila berhubung)

Appendix O: Samples of consent letters in Bahasa Melayu and in English

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui



Faktor yang mempengaruhi perkembangan proses adaptasi Teknologi Maklumat & Komunikasi (ICT) and perubahan guru di dalam Program Perkembangan Profesionalisme Teknologi Maklumat & Komunikasi (ICTPD) di Sekolah-sekolah di Malaysia

Surat Maklumat Guru

Tuan/Puan,

Saya adalah seorang pelajar PhD di Sekolah Pengajian Pendidikan, Universiti Victoria, New Zealand. Kajian kedoktoran saya meneroka faktor-faktor yang mempengaruhi perkembangan adaptasi ICT guru-guru sekolah di Malaysia dan perubahan kepada kaedah pengajaran mereka berikutan darinya. Kajian ini memfokus kepada pemahaman proses adaptasi ICT guru-guru dan perubahan dalam konteks program ICTPD K-Perak setahun selepas pelaksanaan.

Saya mempelawa tuan/puan untuk menyertai kajian saya bagi mendapatkan pandangan tuan/puan tentang **faedah-faedah yang boleh diperolehi dari program K-Perak**. Saya akan menggunakan peta minda dan temu-bual separa struktur dengan guru-guru. Saya juga ingin mempelawa beberapa guru-guru (secara sukarela) untuk satu sesi pemerhatian (pengajaran guru dalam kelas). Saya akan membuat rakaman audio temu-bual dan menggunakan kertas pemerhatian (observational sheet) dan nota bagi pemerhatian dalam kelas untuk penggunaan ICT.

Identiti guru-guru adalah sentiasa sulit dan nama samaran akan digunakan untuk persembahan dapatan kajian. Hanya penyelia-penyelia saya dan saya sahaja akan mempunyai akses kepada data kajian ini. Selain dari tesis saya, hasil kajian ini saya jangkakan akan juga dilaporkan di dalam penerbitan ilmiah serta di persidangan-persidangan yang berkenaan. Walau bagaimana pun saya ingin tegaskan bahawa tidak akan ada maklumat atau imej sekolah atau guru-guru akan digunakan untuk tujuan tersebut. Semua pandangan dan data akan dilaporkan dalam bentuk yang bercampur atau di mana individu atau organisasi berkenaan tidak boleh dikenal pasti. Satu laporan ringkas serta keseluruhan tesis (syarat Hadiah Biasiswa Ijazah Kedoktoran KPM) akan diserahkan kepada Bahagian Perancangan dan Penyelidikan, KPM.

Penglibatan guru-guru adalah sukarela sepenuhnya, oleh itu setiap guru yang terlibat boleh menarik diri dari kajian ini pada bila-bila masa sehingga saya selesai mengumpul data di sekolah berkenaan. Walaubagaimanapun, saya berharap sangat akan penglibatan tuan/puan dalam kajian ini. Setiap guru yang terlibat dalam kajian ini akan diberi kos tuntutan perjalanan sebanyak RM20 (sekali sahaja).

Sekiranya tuan ada sebarang pertanyaan, tuan boleh hubungi saya di Shukry.Hassan@vuw.ac.nz atau penyelia-penyelia saya seperti di bawah. Kajian ini telah diluluskan oleh Jawatankuasa Etika & Kemanusiaan, Victoria University, Wellington dan Bahagian Perancangan dan Penyelidikan, Kementerian Pelajaran Malaysia.

Terima kasih.

Wagheeh Shukry Hassan

Penyelidik:

Wagheeh Shukry Hassan

Room 106, 31 Campbell Street,
Karori Campus,
School of Education Studies,
Faculty of Education,
Victoria University of Wellington,
New Zealand, 6012.

Tel: 0064 04 463 5233 Ext:9845

E-mail: Shukry.Hassan@vuw.ac.nz

Wagheeh Shukry Hassan

Tel: 016-2327766 (Malaysia)

Penyelia:

Barbara Craig

School of Education Studies,
Victoria University of Wellington,
P.O. Box 600, Wellington,
New Zealand 6140.

Tel: 0064 04 463 5404

E-Mail: Barbara.Craig@vuw.ac.nz

Daniel Dorner

School of Information Management,
Victoria University of Wellington,
P.O. Box 600, Wellington,
New Zealand 6140.

Tel: 0064 04 463 5781

E-Mail: Dan.Dorner@vuw.ac.nz

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui



**Factors influencing the progression of adoption of an Information
 Communications Technology Professional Development (ICTPD) Programme in
 Malaysian schools**

Teacher's Consent Form

Please tick the appropriate box to show that you agree to take part in this study:

I have read and clearly understood the information found in the Information Sheet. I am also aware of the time needed from me to participate in this study. I agree to my classroom instruction and interaction to be saved in an electronic form as long as my identity as well as the identity of my pupils is kept secured to the researcher and her supervisors.

I understand that the research findings will be reported in scholarly publications and conferences. I have been assured that no images that may identify either my pupil(s) and/or I will be used for these purposes. I am aware that a brief report of the findings will be given to the Educational Planning and Research Division, Ministry of Education, Malaysia.

I have been provided with sufficient descriptions about this project and I am satisfied with the explanations. I understand the confidentiality of the research and thus will not reveal the identity of the participants in this research, specifically the identity of my school and myself.

I agree to take part in the study.

I do not wish to take part in this study.

Signed: _____

Name of Participant: _____

Date _____

I would like to receive my interview transcription (only available through email). []

Yes [] No

Please send it to the following email address: _____

I would like to receive a brief summary of the findings after the research has been completed.

Please send it to the following address:

Appendix P: Computer lab



(School C - D: 064568)

Appendix Q: Access centre



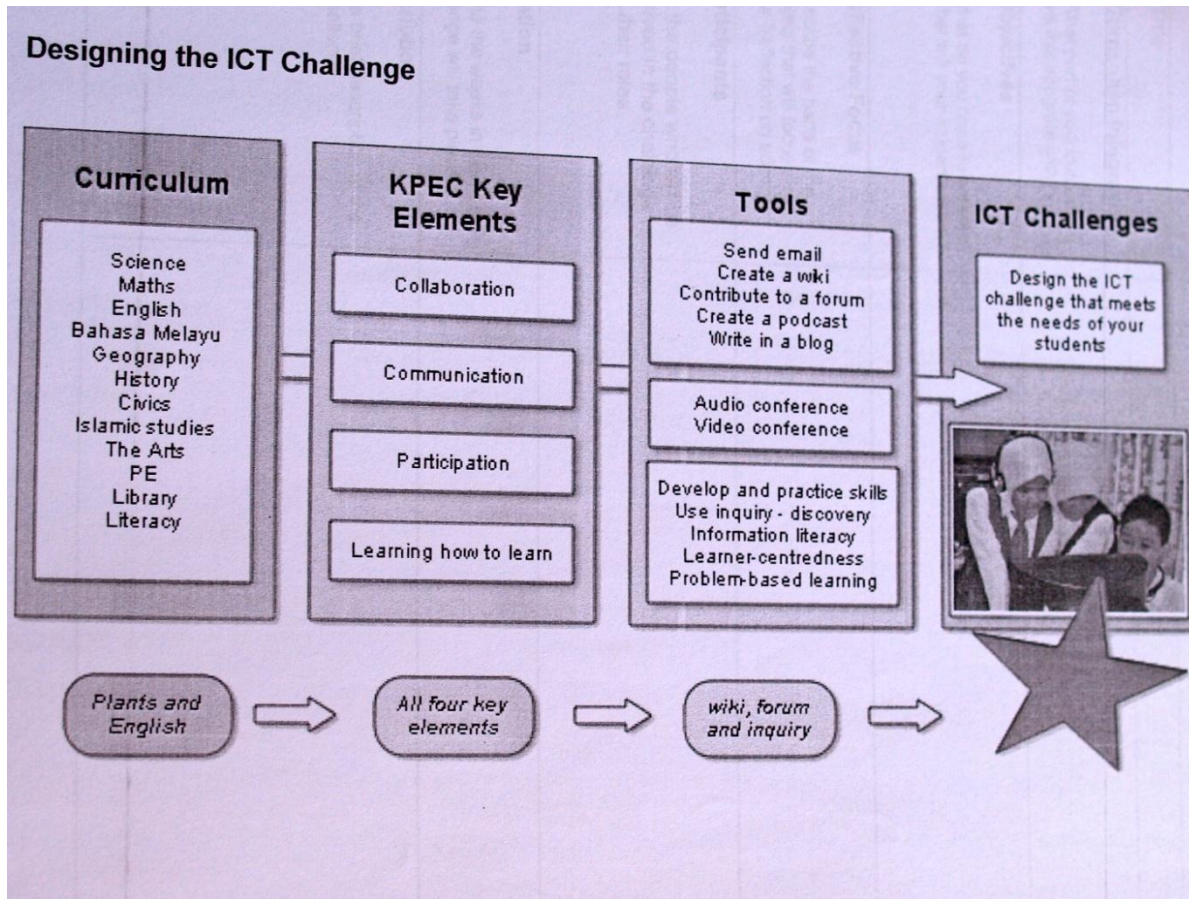
(School B - D: 294298)

Appendix R:ICT challenge self-assessment rubric

CRITERIA	LEVEL 0 – Novice	LEVEL 1: Orientation	LEVEL 2: Transfer/Routine	LEVEL 3: Refinement/renewal
Teacher planning demonstrates appropriate growth potential for teacher in the use of ICT and pedagogical practice.	The ICT challenge primarily focuses on the ICT tool rather than its connection to class/school content or curricular goals. Teacher has experience already with the ICT use that is planned for.	The ICT challenge has some connection to the curriculum. Planned use of ICT practices that are new to the teacher, with a skills focus.	The ICT challenge's technology use specifically connects to curriculum learning needs of students. Planning for the acquisition of ICT skills/knowledge is developmental.	The ICT challenge's technology use allows for diverse curriculum needs of students. Planning for the development of competencies over time, incorporating new or emergent ICT use.
Teacher models appropriate learning behaviours and use of ICT	The teacher directs the students in their learning steps with ICT. The teacher depends on external assistance to set up/operate the ICTs.	The teacher primarily presents and directs the learning for students. The teacher is confident about the use of the ICTs and can problem-solve technical issues independently.	The teacher models and supports students to explore and respond to the curriculum content using ICT tools. The teacher has used the ICT to prepare resources/ for the lesson.	The teacher supports students to choose different learning pathways using ICT, scaffolding and responding to their curriculum content needs. The teacher actively explores and learns using ICTs' with the students.
Students use ICT to support teaching/learning activity	Students complete ICT-based activities provided by teacher or in the text.	Students use ICTs but not yet able to manipulate the technology to express ideas or concepts about their curriculum learning. Students follow instructions from the teacher to complete activity.	Students are confident in the use of ICTs and can manipulate the technology to express ideas or concepts about their curriculum learning. Students' questions are about the curriculum focus of the ICT activity and they can act on feedback.	Students can pursue their own inquiry and initiate the use of ICTs in their curriculum learning, can support each other to learn using ICT and articulate where they need expert help. Evidence of student use of ICT outside classroom hours to support learning.
Students are active in the learning process	Students are passive observers/receivers of information during the ICT experience.	Students respond to teacher questions and engage in activities provided by the teacher and ask for assistance where they need it. Focus is primarily on completion of the activity to the satisfaction of the teacher.	Students are clear about what they are learning in their curriculum focus and why when using ICT. Students ask questions and respond to others – in class or online.	Students work collaboratively with others in groups or online, and are active in the use of inquiry and problem solving strategies. Students involved in aspects of the planning and assessment of the challenge activity.
Teacher uses reflecting on action process to identify strengths/weaknesses and improve on practice	Teachers do not reflect in any structured or explicit way about use of their ICT or its impact on learning.	Teachers reflect on their use of ICTs and can articulate how their students might benefit but are yet to act on this reflection.	A reflecting on action process is completed for each phase of the challenge activity. Clear identification of 'next steps' that are followed through on. Personal achievement and growth is acknowledged.	Innovative ideas and new strategies emerge as a result of successive cycles of the reflecting on action process. New knowledge and ideas are shared with others as a result.

(Norton, 2007, p. 118)

Appendix S: ICT challenges



Appendix T: Sample of student work



Mercury is the closest planet to the [Sun](#) and the eighth largest. Mercury is slightly smaller in diameter than the moons [Ganymede](#) and [Titan](#) but more than twice as massive.

[orbit](#): 57,910,000 km (0.38 [AU](#)) from Sun
[diameter](#): 4,880 km
[mass](#): 3.30e23 kg

In Roman mythology [Mercury](#) is the god of commerce, travel and thievery, the Roman counterpart of the Greek god [Hermes](#), the messenger of the Gods. The planet probably received this name because it moves so quickly across the sky. Mercury has been known since at least the time of the Sumerians (3rd millennium BC). It was sometimes given separate names for its apparitions as a morning star and as an evening star. Greek astronomers knew, however, that the two names referred to the same body. Heraclitus even believed that Mercury and Venus orbit the Sun, not the Earth. Since it is closer to the Sun than the Earth, the illumination of Mercury's disk varies when viewed with a telescope from our perspective. [Galileo](#)'s telescope was too small to see Mercury's phases but he did see the phases of [Venus](#).

Mercury has been now been visited by two spacecraft, [Mariner 10](#) and [MESSENGER](#). Mariner 10 flew by three times in 1974 and 1975. Only 45% of the surface was mapped (and, unfortunately, it is too close to the Sun to be safely imaged by [HST](#)). [MESSENGER](#) was launched by NASA in 2004 and will orbit Mercury starting in 2011 after several flybys. Its first flyby in Jan 2008 provided new high quality [images](#) of some of the terrain not seen by Mariner 10.

Mercury's orbit is highly **eccentric**; at [perihelion](#) it is only 46 million km from the Sun but at [aphelion](#) it is 70 million. The position of the perihelion precesses around the Sun at