



**Transforming teaching through the transformative  
integration of emerging technologies in the ePlay  
MakerSpace: a critical, socio-cultural design-based study**

Isabel Tarling

Supervisor: Associate Professor Dick Ng'ambi

This thesis is submitted for the award of the Doctor of Philosophy in Education  
at the University of Cape Town, School of Education, Faculty of Humanities

February 2018

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

Declaration: I hereby declare that I have read and understood the regulations governing the submission of Doctor of Philosophy, including those relating to length and plagiarism, as contained by the University, and that this thesis conforms to those regulations.

*The financial assistance of the National Research Foundation (NRF) towards this research is acknowledged. Opinions expressed in this study are those of the author and should not be attributed to the NRF.*

# Abstract

Despite South African schools and teachers gaining greater access to the tools, innovations, concepts and advancements of emerging technologies (ETs), the potential of ETs to transform teaching and improve learning remains largely unexploited. The majority of the country's schools are classified as disadvantaged, being resource constrained and functioning in contexts of multiple deprivation and poverty. Learning is severely compromised in many disadvantaged schools, as evidenced by learners' persistent underachievement in standardised national and international assessments. Consequently, improving the quality of teaching especially at primary school level, is identified as a national priority. Three extensive curriculum reforms, intensified teacher professional development, and the provision of ETs, have however not achieved widespread and sustained change to teaching practices. This suggests that existing teacher professional development (TPD) initiatives do not effectively prepare teachers from the country's disadvantaged schools to exploit the transformative potential of ETs, to change their practice and manage change within their complex and dynamic education contexts. Instead, ETs that originate in advanced economies are frequently assumed universally applicable and application-neutral. Informed by this perspective, TPD is designed to prepare teachers to use or teach with ETs, either emphasizing technical skills or competencies to use tools, or in rare cases focussing on the concepts, innovations and advancements of ETs. TPD models that systematically and explicitly prepare South Africa's teachers from disadvantaged schools to exploit the transformative potential of ETs and change their practice is not available.

This study employs a socially embedded, progressive transformation perspective to ET. Accordingly, while it is assumed ETs have the capacity to improve learning, the form and processes of improvement and change to teaching practices are understood as locally developed by teachers. Informed by this perspective, transformative ET integration is conceptualised as contextually embedded, locally developed innovation and knowledge-production to effect change to teaching and improve learning driven by contextually specific

requirements and priorities. The transformative integration of ETs emphasizes the need to develop teachers' dispositions to innovate and create, to experiment and take risks. However, within the field of education in South Africa, teachers' dispositions reflect capacities to reproducing the structures of the field intent on increasing the flow of cultural capital, rather than dispositions of creativity and innovation.

This study employs a critical, socio-cultural design-based theoretical frame and asks how the transformation of teachers' dispositions may translate into their transformative integration of emerging technologies. The ePlay MakerSpace model is conceptualised as providing both inculcation processes and enabling conditions to transform teachers' dispositions. Using a design-based research approach, two iterations of the ePlay MakerSpace model are designed, enacted and formatively evaluated to refine the design principles for the ePlay MakerSpace inculcation processes and enabling conditions. Data is collected through teachers' created artifacts, their reflections and online posts, the formative evaluations of each iteration, and school-visits and interviews with teachers 3 – 4 weeks after each ePlay MakerSpace iteration. The evidence presented indicates that the majority of teachers transformatively integrated ET in their classrooms and/or schools, to address local priorities and solve contextual challenges. Through a retrospective analysis of the data, the process to transform teachers' dispositions was refined, as well as the design framework and design methodology for the ePlay MakerSpace. The study contributes to the development of theory relating to teacher change, and the processes and conditions that support teacher' change.

# Declaration

I declare that this thesis is my own work and that it has not been submitted before, for any purpose, to any other institution.

Signed: Isabel Tarling

Date: 19 February 2018

## Acknowledgements

What an immense privilege it has been to share this journey of discover with so many incredible and generous individuals! Thank you to each one of you for your time and energy, your support and your contribution!

- ◆ Prof Dick Ng'ambi, my supervisor and fellow world-changer, for your tremendous insight, generous feedback and unwavering patience.
- ◆ The CTLI for structural and systemic support, and allowing me to use the CTLI courses as research sites to the benefit of the department, schools, teachers and learners.
- ◆ The many teachers, subject advisers and leaders for participating either in the reference groups or in the ePlay MakerSpace, and allowing me to learn from you.
- ◆ My family and friends, and particularly my daughters, for sharing my dreams and living in hope that 'one day' would eventually arrive!
- ◆ My Craig, for being my rock and anchor in the storms, and for always believing that I would eventually get finished!

*Deo Omnis Gloria!*

## Abbreviations and Acronyms

CAPS	Curriculum and Assessment Policy Statement
CTLI	Cape Teaching and Leadership Institute
DBE	Department of Basic Education
DBR	Design-Based Research
DHET	Department of Higher Education and Training
DOE	Department of Education
ET / ETs	Emerging Technology / Emerging Technologies
HOTS	Higher Order Thinking Skills
ICTs	Information and Communication Technologies
IWB	Interactive Whiteboard
LOTS	Lower Order Thinking Skills
NMC	New Media Consortium
SA	South Africa
TCF	Teaching Change Frame
TIP	Tool Introductory Process
TPACK	Technological, Pedagogical and Content Knowledge
TPD	Teacher Professional Development
TPD4ETs	Teacher Professional Development to prepare teacher to integrate emerging technologies
WCED	Western Cape Education Department

## List of figures

Page reference

Figure 1 Conceptual frame for the study	42
Figure 2 Screenshot from ePlay MakerSpace Data Production website	44
Figure 3 Iteration cycle to identify completely elaborated interventions	83
Figure 4 Screenshot from the website	85
Figure 5 Collaborative Concept Map developed in the ePlay MakerSpace	93
Figure 6 Centre circle on Concept Maps	94
<b>Error! Reference source not found.</b>	116
Figure 8 An extract of the draft framework for the IP Language ICT Integration course	119
Figure 9 Formative evaluation results of IP Language teachers' participation	150
Figure 10 Creativity measured in IP Language teachers' artifacts	165
Figure 11 Creativity measured for School F's teachers' created artifacts	169
Figure 12 A Gr 7 Learners' cartoon (click to follow the link)	171
Figure 13 Creativity measures for School A's teachers' created artifacts	175
Figure 14 Creativity measured in School K's teachers' created artifacts	178
Figure 15 Introducing new tools in the ePlay MakerSpace	186
Figure 16 The Interaction model for Teacher Professional Development	187
Figure 17 First-generation design principles (1gDPs)	190
Figure 19 Formative evaluation indicating IP Language (orange) and FP (blue) teachers' participation	217


Figure 20 Creativity measured in FP teachers' created artifacts	234
Figure 21 FP teachers' self-identified current and goal positions on the TCF	238
Figure 22 Creativity measure of artifacts created by teachers from School F	242
Figure 23 Participation measure by teachers from School F	243
Figure 24 Grade 1 (left) and Grade 3 (right) learners at School O using their own devices in the class	247
Figure 25 Creativity measure of artifacts created by teachers from School O	250
Figure 26 Participation measure of teachers from School O	251
Figure 27 Creativity measure of artifacts created by FP19, FP20, FP12 and FP05	253
Figure 28 Participation measure of FP19, FP20, FP12 and FP05	254
Figure 29 The DBE IQMS process (SACE 2014)	271
Figure 30 Collated results from Bourdieuan coding of CM data from Iteration 1 and 2	275
Figure 32 Bourdieuan coding analysis for Iteration 1 (IP Language) Day 1 and 3 CM data	279
Figure 31 Bourdieuan coding analysis for Iteration 2 (FP) Day 1 and 3 CM data	279
Figure 33 Teachers' journeys of change	285
Figure 34 Mapping the ePlay MakerSpace process	298
Figure 35 Design Principles for the ePlay MakerSpace	303



## List of Tables


Page reference

Table 1 Comparison between Creativity measure in CMs between IP Language and FP teachers	235
Table 2 Collated results from Bourdieuan coding of CM data from Iteration 1 and 2	275
Table 3 Word-frequency analysis in terms of Bourdieuan codes for Iteration 1 and 2	278


# Table of Contents


Abstract.....	2
Declaration.....	4
Acknowledgements.....	5
Abbreviations and acronyms.....	6
List of figures.....	7
List of tables.....	9
<b>Chapter 1</b>  Introduction.....	17
1.1   Background .....	18
1.2   Conceptualising the transformative integration of emerging technologies .....	22
1.3   Teacher professional development and the transformative integration of ETs .....	25
1.4   Theoretical framework .....	28
1.4.1   Critical, socio-cultural theory .....	29
1.4.2   Design theory .....	36
1.5   The research problem.....	39
1.6   Conceptual frame for the study.....	41
1.7   Structure of the thesis .....	43
1.8   Summary.....	45


<b>Chapter 2</b>		Literature Review .....	47
2.1		Theories of teaching change .....	47
2.1.1		Strategies of the field to effect change .....	49
2.1.2		Understanding the scope of change .....	53
2.2		Processes of inculcation to transform dispositions .....	56
2.2.1		The awakening of consciousness .....	57
2.2.2		Training, pedagogic work and transmission .....	64
2.3		Enabling conditions for the transformation of dispositions .....	67
2.3.1		A review of play theory .....	68
2.3.2		Conceptualising ePlay as a unique form of play and the ePlay MakerSpace .....	70
2.3.3		Conceptualising the ePlay MakerSpace inculcation process .....	73
2.4		Global design principles for the ePlay MakerSpace .....	75
2.5		Summary .....	76
<b>Chapter 3</b>		Methodology .....	79
3.1		Developing the Methodology .....	79
3.2		Data production for the study .....	87
3.2.1		Interviews .....	87
3.2.2		Participants' created artifacts .....	92
3.2.3		Reflection .....	95

3.2.4	Formative evaluation .....	96
3.3	Data analysis .....	103
3.3.1	Problem analysis to develop teacher change theory.....	106
3.3.2	Analysis of the ePlay MakerSpace.....	107
3.3.3	Analysis of the research process and methodology .....	108
3.4	Quality of the Research.....	109
3.4.1	Descriptive validity .....	109
3.4.2	Interpretive validity .....	111
3.4.3	Theoretical validity.....	113
3.5	Ethics.....	114
3.6	In summary .....	114
<b>Chapter 4</b>	 ePlay MakerSpace Iteration 1 .....	117
4.1	Problem identification and design of ePlay MakerSpace Iteration 1 .....	117
4.1.1	Problem identification.....	118
4.1.2	Developing the course manual .....	120
4.1.3	Designing Iteration 2 .....	121
4.2	Enactment of Iteration 2.....	123
4.2.1	Challenges in the ePlay MakerSpace venue.....	124
4.2.2	GDP9) Active learning .....	126

4.2.3	1gDP10) Relational learning .....	129
4.2.4	1gDP8) Professional learning .....	131
4.2.5	GDP7) Reflective learning .....	132
4.2.6	GDP11) Transformational learning .....	136
4.3	Formative evaluation and analysis of Iteration 2 .....	140
4.3.1	Evaluating the context of the intervention .....	140
4.3.2	Evaluation of teachers' participation .....	148
4.3.3	Evaluating the design and enactment of the intervention .....	153
4.3.3.1.1	Criteria: Practicality .....	154
4.3.3.1.2	Criteria: Relevance.....	157
4.3.3.1.3	Criteria: Sustainability.....	158
4.3.3.1.4	Criteria: Effectiveness.....	159
4.3.3.1.5	Criteria: Validity .....	159
4.3.4	Formative evaluation of the enactment and implementation procedure .....	160
4.3.5	Evaluating change .....	164
4.3.5.2.1	School F.....	168
4.3.5.2.2	Change at School A .....	173
4.3.5.2.3	Change at School K .....	177
4.4	Elaborating and refining the design principles .....	180

4.5	Concluding comments .....	189
<b>Chapter 5</b>	 ePlay MakerSpace Iteration 2 .....	191
5.1	Problem identification and design of the FP ePlay MakerSpace .....	191
5.1.1	Problem identification.....	192
5.1.2	Developing the course manual .....	193
5.1.3	Designing Iteration 2 .....	194
5.2	Enactment of Iteration 2.....	196
5.2.1	Participants and venue.....	196
5.2.2	1gDP8) Active learning .....	197
5.2.3	1gDP9) Relational learning.....	199
5.2.4	1gDP7) Professional learning .....	204
5.2.5	1gDP6) Reflective learning .....	206
5.2.6	1gDP10) Transformational learning .....	209
5.3	Evaluation and analysis of FP ePlay MakerSpace .....	211
5.3.1	Evaluating the context of the intervention.....	211
5.3.2	Systemic level factors.....	212
5.3.3	Institutional and classroom level factors .....	213
5.3.4	Evaluation participation .....	216
5.3.5	Evaluating the design of the intervention.....	218

5.3.5.1.1	Criteria: Practicality .....	219
5.3.5.1.2	Criteria: Relevance.....	220
5.3.5.1.3	Criteria: Sustainability.....	222
5.3.5.1.4	Criteria: Effectiveness .....	223
5.3.5.1.5	Criteria: Validity .....	224
5.3.5.2.1	Criteria: Procedural strengths .....	225
5.3.5.2.2	Criteria: Procedural weaknesses .....	228
5.3.5.2.3	Criteria: Procedural opportunities.....	230
5.3.5.2.4	Criteria: Procedural threats .....	231
5.3.6	Evaluating change .....	232
5.3.6.2.1	School F: FP04 and FP16 .....	238
5.3.6.2.2	School O: FP11, FP14 and FP15 .....	243
5.3.6.2.3	Additional examples of change: FP19 and FP20, and FP12 and FP05.....	252
5.3.6.2.4	Findings from changes observed .....	257
5.4	Elaborating and refining the design principles .....	259
5.5	Concluding comments .....	266
<b>Chapter 6</b>	 Analysis.....	267
6.1	Refining teacher change theory.....	267
6.1.1	Field and Capital .....	268

6.1.2	Accumulating cultural capital in the ePlay MakerSpace .....	273
6.1.3	Appropriating cultural capital to effect change .....	282
6.2	Refining the design framework for the ePlay MakerSpace .....	288
6.3	Refining the design methodology .....	296
6.4	In summary .....	299
<b>Chapter 7</b>	 <b>Conclusion</b> .....	<b>300</b>
7.1	Key findings.....	300
7.2	Review of the research process .....	307
7.3	The contribution to research .....	309
7.4	Limitations and future research.....	311
7.5	In conclusion .....	312
	References .....	313
	Appendix A) Hyperlinks.....	344
	Appendix B) Concept Mapping Protocol .....	347
	Appendix C) Evaluating Participation .....	355
	Appendix D) Evaluating the model .....	357
	Appendix E) Data analysis process.....	358

# Chapter 1 Introduction

Much hope is placed in ETs generally, and in South African in particular, to support urgently needed change in teaching (Department of Education, 2004; Western Cape Education Department, 2012; Department of Basic Education, 2015) and address persistent challenges to learning in the country's many dysfunctional schools (Christie *et al.*, 2010; Weeks, 2012; Spaull, 2013; Maringe and Moletsane, 2015). ETs are conceptualised as tools, concepts, innovations and advancements utilised in education contexts (Veletsianos, 2010) with the potential to transform learning processes (Belland, 2009). Yet, despite national and provincial initiatives increasing school's access to ETs (Miller *et al.*, 2006; Chigona *et al.*, 2010; Ford and Botha, 2010; Bladergroen *et al.*, 2012; Mooketsi and Chigona, 2016), both in terms of connectivity and devices, the country's learners consistently underachieve in different international benchmarking tests (Mullis *et al.*, 2016a, 2016b, 2016c; OECD, 2016) and national standardised assessments (Spaull, 2013; Masondo, 2016). The continued failure of the majority of South Africa's learners indicates that the greater access to ETs has not translated into changed teaching and learning processes, suggesting that schools and teachers have not exploited the potential of ETs to transform teaching and learning practices.

This chapter serves different purposes. It introduces the study by discussing the urgent need for change to teaching and learning in South Africa and articulating the potential of emerging technologies to support education transformation. This positions the study within and across the fields of emerging technology, education reform and teacher professional development, and develops key constructs used in the study. Somewhat unorthodox, the chapter also introduces and develops the critical, socio-cultural design-based theoretical frame and the conceptual frame for the study. These framings are strategically developed in Chapter 1 to epistemologically articulate and shape how the study is designed and conducted, and how theoretical contributions are developed. The theoretical frame in particular shapes the research problem and the questions the study addresses. Lastly, the

chapter describes the structure of the thesis and rationale for the website that accompanies the thesis.

## 1.1 Background

The South African education system has persistently failed to prepare the country's youth with the skills and knowledge needed to excel in the knowledge society (Christie *et al.*, 2010; Weeks, 2012; Spaul, 2013). Most learners in the country attend township, rural, farming or mining schools (Maringe and Moletsane, 2015) that have limited access to facilities or resources. Such schools are coded at quintile 1 or 2 (Department of Basic Education, 2015) and collect minimal or no school fees, and are collectively referred to as *disadvantaged schools*.

Disadvantaged schools are frequently described as dysfunctional (Taylor, 2008; Weeks, 2012; Spaul, 2013; Maringe and Moletsane, 2015) and lacking a culture of teaching and learning (Christie, 1998; Heystek and Lethoko, 2001; Weeks, 2012). Such dysfunction is frequently typified by loosely bounded timetabling, high absenteeism by both teachers and learners, and low expectations that encourage mediocrity rather than excellence (Christie, Butler and Potterton, 2007; Taylor, 2008; Weeks, 2012; Spaul, 2013). While strong leadership has been shown to positively influence and direct schooling communities towards goals of transformation (Hayes *et al.*, 2004; Christie, Butler and Potterton, 2007; Christie, 2010; Christie *et al.*, 2010), this is not always the case. Instead, many leaders are underqualified, lack leadership skills and are often unable to manage the complexities of multiple deprivation in which they function (Christie, 2010; Maringe and Moletsane, 2015). Rather than improving instruction through designed and targeted strategies (Taylor, 2008), the lack of leadership capacities function to reproduce legacies of dysfunction (Grant, Jasson and Lawrence, 2010; Weeks, 2012) and constrain transformation and improvement of learning.

In addition to institutional and leadership challenges, education researchers (Christie *et al.*, 2010; Hoadley, 2012; Weeks, 2012; Spaul, 2013) question the quality of teaching and

learning in the majority of disadvantaged schools. International benchmarking tests repeatedly find that irrespective of grade or subject area, most of the country's children underperform, displaying limited knowledge and proficiency in Mathematics and Science (Mullis, Martin, Foy and Hooper, 2016a), and finding that 78% of Grade 4 learners cannot read for meaning (Mullis *et al.*, 2016). Such profound underachievement is symptomatic of widespread learning challenges which Spaul (2013) found, typically originate in the Foundation and Intermediate Phases (Grades R – 6). Learning challenges that occur early in a child's schooling career, tend to extend and become insurmountable, serving to "*preclude pupils from following the curriculum at higher grades*" (Spaul, 2013, p. 57). This leads to high drop-out rates (Lehohla, 2016) as a result of learners' failure to progress within the system, while up to 25% of those that remain, fail to achieve a national senior certificate at the end of their school careers (Motshekga in Masondo, 2016).

Education researchers (Christie *et al.*, 2010; Hoadley, 2012; Weeks, 2012; Spaul, 2013), noting ongoing institutional, leadership and teaching challenges, and learners' persistent underachievement, conclude that learning is severely compromised in the majority of South African schools. Correlating learners' persistent underachievement to poor quality teaching especially in primary schools, "*[i]mproving what teachers do in their classrooms*" (Taylor, 2008, p. 21) is identified as a national priority (Taylor, 2008; Christie *et al.*, 2010; Spaul, 2013).

Although the Department of Basic Education has implemented a range of reform initiatives to improve the quality of teaching, these have not led to sustained and widespread change to teaching or improved learning outcomes. Since the fall of Apartheid in 1994, the national curriculum has been completely redesigned three times, leading to the current Curriculum and Assessment Policy Statement (CAPS) (Chisholm and Leyendecker, 2008; Fataar, 2012; Christie, 2016). The CAPS is a tightly-scripted and 'teacher-proof' (Hargreaves *et al.*, 2001; Darling-Hammond, 2010; Fataar, 2012) curriculum, that aims to regulate instructional time and restrict teachers' pedagogic choices in accordance with "*a strict regulatory regime to govern curriculum implementation*" (Fataar, 2012, p. 58). Following international trends of education reform and the standardisation movement (Hargreaves and Fink, 2007) each

curriculum reform added increasingly rigid boundaries to facilitate coverage of all curriculum areas, enforced through bureaucratic processes.

Additionally, the Integrated Quality Management System (IQMS) (SACE, 2014; Department of Basic Education, 2015) was introduced in 2003 and subsequently revised, to monitor and evaluate policy implementation. Teacher professional development and school improvement initiatives (Christie *et al.*, 2010; Fataar, 2012; Hoadley, 2012; Weeks, 2012; Spaul, 2013) have also been prioritised. However, evidenced by learners' persistent underachievement in the past two decades, researchers (Christie *et al.*, 2010; Weeks, 2012; Spaul, 2013) conclude that these reforms have been largely unsuccessful to improve the quality of teaching and learning. Subsequently, much hope is placed in ET integration as potential means to achieve education reform.

ET integration is another systemic reform initiative aimed at improving the quality of teaching and learning (Department of Education, 2004, 2007; Department of Basic Education, 2015) to create "*greater access to learning opportunities and personalised learning experiences*" (Department of Education, 2007, p. 1). National and provincial departments of education have increased schools and teachers' access to devices and connectivity (WCED, 2011; Mooketsi and Chigona, 2016), and in some cases provided teachers with training to use these (Bladergroen *et al.*, 2012; Mooketsi and Chigona, 2016). However, while ETs are increasingly available and valued, respected and treasured in disadvantaged schools, these are often underutilised or locked away (Chigona *et al.*, 2010; Bladergroen *et al.*, 2012; Tarling and Ng'ambi, 2016). A teacher from a township school describes her experience:

*"In my school we have two computer labs. One has about 50 or 60 computers that all work but it is always locked. Nobody ever uses it. On the other side of the school is another computer lab from 'Group X' and they have people who come to work with the kids there every two weeks or so. The teachers send the kids there but they never use our own lab. They just refuse. I am always telling them, 'Come, let me show you how' but they just refuse. They don't want to."* (Tarling and Ng'ambi, 2016, p. 554)

As this teachers' example illustrates, although teachers in her school had gained substantial access to two computer labs with enough computers to allow learners to work independently, these generally remain locked away and unused. Another computer lab was used only when Group X facilitators worked with learners but teachers did not attend the sessions themselves. Bladergroen *et al.* (2012) noted similar non-use of devices in their study, finding that teachers continued employing teacher-centred didactical instruction, using existing pedagogic tools and administrative procedures, and that ETs were perceived as inconsequential to learning (Chigona *et al.*, 2011; Rega and Van Zyl, 2011; Bladergroen *et al.*, 2012).

Although multiple descriptions of non-use are available, pockets of innovation (Tondeur, Forkosh-Baruch, *et al.*, 2016) have been noted. However, where teachers have started using ETs, and comparable to international trends, ETs are typically used to reinforce rather than transform existing teaching and learning practices (Zhao and Cziko, 2001; Ford and Botha, 2010; Glover *et al.*, 2016). Ford and Botha (2010) for instance, found that teachers substituted traditional oral drill-and-practice activities for virtual versions thereof using mobile phones. Thus, while ETs can play a significant role in supporting change to teaching and learning in South Africa, increased access alone does not necessarily translate into improved teaching and learning. The working group on Teacher Professional Development at EDUsummit2015, noted in this regard:

*"...merely providing ICT does not inevitably improve learning, but beyond access, it is how teachers use ICT that makes a difference"* (Tondeur, Forkosh-Baruch, *et al.*, 2016, p. 110)

Researchers (Twining *et al.*, 2013; Tondeur, Forkosh-Baruch, *et al.*, 2016) emphasize the importance of teacher professional development (TPD) to prepare teachers to use ETs to promote 21<sup>st</sup> century learning. However, in light of persistent challenges and failures of TPD models to improve the quality of teaching in South Africa, Chigona *et al.* (2010) urge researchers to first critically examine existing initiatives to achieve ET integration, and to use findings from this to inform change to the design of current TPD models. Similarly, Belland

(2009) argues that ET integration needs to be clearly articulated and defined, to inform the design of change strategies.

## 1.2 Conceptualising the transformative integration of emerging technologies

ET integration is framed in multiple ways (Belland, 2009) indicative of different underlying assumptions and perceptions of ETs. Veletsianos (2010) defines ETs as tools, concepts, innovations and advancements utilised in education contexts. In addition, Belland (2009) notes, ETs have the potential to transform learning processes. Using Avgerou's (2010) work, different assumptions and perspectives regarding ET integration, can be identified within these two key areas of ETs.

Perspectives regarding ETs as tools, concepts, innovations and advancements, can be grouped in terms of a) transfer and diffusion processes; or b) as socially embedded action (Avgerou, 2010). From a transfer and diffusion perspective, ETs are assumed to be mechanistic, decontextualized and application-neutral (Kreutzer, 2009) tools, concepts or innovations. In order to *adopt* (Loucks-Horsley, 1996; Zhao, Kuh and Carini, 2005; Miller *et al.*, 2006; Bhati *et al.*, 2009) or *domesticate* (Donner and Gitau, 2009; Chigona *et al.*, 2010) ETs, a transfer and diffusion perspective emphasizes the need for technical skills or competencies. Transfer and diffusion perspectives, Avgerou (2010) argues, often originate from the advanced economies of North America and Europe, and assumes ETs are universally transferable to the needs of developing countries. In this study, approaches to ET integration that emphasize technical skills or competencies from a transfer and diffusion perspective, are termed *competency-based approaches*.

ET integration framed as socially embedded action, views ETs as situated within local contexts and used by local actors to create shared meanings and practices (Avgerou, 2010). Research using a socially embedded perspective of ET integration, is often grounded in social theory, and sees the ET integration process as dynamic, emergent and evolving over time (Avgerou, 2010). Veletsianos' (2010) development of ETs falls within this approach, as

he conceptualises ETs as knowledge-enabling, constantly evolving and embedded within pluralistic cultural contexts. Similarly, Mishra and Koehler (2006) emphasize ET integration as socially embedded action. Using the TPACK framework, they see ET integration as emerging from the intersection of teachers' technological, pedagogical and content knowledge (Mishra and Koehler, 2006; Koehler *et al.*, 2011). Furthermore, they (Koehler *et al.*, 2011) emphasize the dynamic and perpetually changing nature of ETs, and the need for teachers to develop different kinds of knowledge to meliorate generic tools and create locally applicable and practical applications. In this study, approaches to ET integration that emphasize ETs as socially embedded, knowledge-enabling and innovative action, are referred to *knowledge-based approaches*.

Framings of ET integration that emphasize the transformative potential of ETs, Avgerou (2010) argues, emphasize either a) progressive or b) disruptive perspective. Progressive transformational research frames ET integration as enabling of change, viewing ETs as instruments to achieve economic, social and learning gains (Avgerou, 2010). In order to achieve such gains, progressive transformation perspectives acknowledge the need for change in the way ETs are used as well as the cultural or organisational contexts and structures in which it is applied. Belland's (2009) conception of ET integration draws on a progressive transformation perspective when he defines ET integration as:

*“the sustainable and persistent change in the social system of K-12 schools caused by the adoption of technology to help students construct knowledge”* (Belland, 2009, p. 355).

Belland's (2009) framing of ET integration emphasizes the potential of ETs to support and effect change within the system as means to improve learning. Similarly, Christensen's (1997) definition of *sustaining innovation* supports a progressive transformation perspective when he argues that sustaining innovations increases the performance or improves the output of systems, products or services. A progressive transformation perspective in research seeks to understand the processes and conditions required for ET integration to

effect change and reach expected benefits within existing contexts, systems or organisations.

Avgerou (2010) also identifies a disruptive transformation perspective that views ET integration as *“a contested endeavour or as involving action with unequal effects on different categories of population, and thus... laden with conflict”* (p. 8). Research from a disruptive transformation perspective, typically identifies conflicts, contradictions, (hidden) agendas and power struggles (Avgerou, 2010). A disruptive transformation perspective may for instance emphasize the unequal benefit to different categories of the population (Avgerou, 2010) conceptualised as the digital divide (Warschauer, 2002), challenge the effectiveness or educational value of ET integration (Oppenheimer, 2003; Warschauer, 2003) or contest discourses that emphasize the universal value of ETs (Chigona and Mooketsi, 2011; Bladergroen *et al.*, 2012). Similarly, this perspective questions the ethical, safe and appropriate use of ETs, by learners and users in general, and whether learning is indeed positively impacted by ETs (OECD 2015). Additionally, Christensen’s (1997) definition of *disruptive innovations*, Veletsianos’ (2010) emphasis on the disruptive nature of ETs and Sharples *et al.*’s (2009) definition of disruptions as *“emerging issues that have the potential to lead to behaviours that diverge from the trends”* all fall within a disruptive transformation perspective.

In view of Avgerou’s (2010) four research perspectives, this study combines a socially embedded perspective of ET integration with a progressive transformation perspective. A *socially embedded, progressive transformation perspective* assumes ETs have the capacity to improve learning, but sees the form and processes of improvement and change as locally developed by teachers to serve the needs of their learners and school. Assuming that the transfer and diffusion of *“technologies and improvisations from technologically advanced societies do not work”* (Avgerou, 2010, p. 12), this research perspective emphasizes the need for local improvisation and innovation. This perspective further assumes that change is driven by local needs and priorities and accomplished within existing social, political or administrative conditions. Hence, teachers need to develop capacities to innovate, create and manage change processes, but depending on teachers’ needs, this may also require the

development of different competencies and/or kinds of knowledge. The integration of ETs is then conceptualised as contextually embedded, locally developed innovation and knowledge-production to effect change to teaching and improve learning that is driven by contextually specific requirements and priorities, collectively referred to as *transformative integration of ETs*.

Transformative ET integration can significantly contribute to improving the quality of teaching and learning. Teacher professional development is a crucial element to prepare teachers to transformatively integrate ETs and effect change to current teaching and learning practices.

### 1.3 Teacher professional development and the transformative integration of ETs

It is undeniable that teacher professional development (TPD) is a key element of educational change in general, and specifically through the transformative integration of ETs (Tondeur, Forkosh-Baruch, *et al.*, 2016). Researchers in the field (Fullan, 1995, 2007; Guskey, 2002; Desimone, 2009; Parsons *et al.*, 2013) have identified key features of effective TPD generally, while others (Twining *et al.*, 2013; Tondeur, Forkosh-Baruch, *et al.*, 2016; Pareja Roblin *et al.*, 2018) developed guidelines for TPD that prepares teachers to integrate ETs, referred to in this study as *TPD4ETs*. However, as Chigona *et al.* (2010) notes, existing TPD models have proven largely unsuccessful to prepare South African teachers to integrate ETs and change their practice. This section problematises existing TPD approaches using the four perspectives developed from Avgerou's (2010) work, and identifies the gap in existing knowledge that this study addresses.

TPD4ETs can be classified according to the underlying perspective towards ETs that it supports. TPD4ETs that follows a transfer and diffusion perspective typically emphasize a competency-based approach and develops teachers' technical skill or generic competencies to use specific devices or software (Mishra and Koehler, 2006; Ertmer and Ottenbreit-Leftwich, 2010; Inan and Lowther, 2010; Gibson *et al.*, 2014). Knowledge-based approaches

to TPD depart from a socially embedded perspective, such as the *pedagogy first* approach (Watson, 2001; Glover *et al.*, 2016) or Koehler *et al.*'s (2011) *deep-play model*, and emphasize the development of different kinds of knowledge within local settings.

Although competency and knowledge-based TPD4ETs is widely used, the continued lack of change to teaching and learning raises questions as to its effectiveness to achieve widespread and sustained change to teaching and learning (Chigona *et al.*, 2010; Twining *et al.*, 2013; Tondeur, Forkosh-Baruch, *et al.*, 2016). The design and enactment of TPD4ETs tend to follow the logic that competency-based TPD4ETs prepares teachers to *use* ETs, while knowledge-based TPD4ETs prepare teachers to *teach* with ETs. However, as has been widely argued (Zhao and Cziko, 2001; Chigona *et al.*, 2011; Bladergroen *et al.*, 2012; Glover *et al.*, 2016), despite greater access to ETs and to competency and knowledge-based TPD4ETs, teachers globally and in South Africa continue to either underutilise ETs or to keep it locked away (Ford and Botha, 2010; Bladergroen *et al.*, 2012; Tarling and Ng'ambi, 2016), limiting its potential to transform teaching and learning. It appears that transformation of teaching and learning, although seen as an outcome of either competency or knowledge-based approaches to TPD4ETs, implies rather than explicitly includes capacities to prepare teachers to *transform with ETs*.

Despite greater access to ETs, the persistent lack of widespread and sustained change to teaching in South Africa and globally, suggests that TPD4ETs should more effectively prepare teachers to exploit the transformative potential of ETs. To this end, Tondeur *et al.* (2016) and Twining *et al.* (2013) argue that TPD4ETs should capacitate teachers to manage their own change processes in order to negotiate existing practices, and adapt and change this. Echoing this call, different researchers identify the need to equip teachers as change agents (Samuel, 2008; van der Heijden *et al.*, 2015) or to capacitate teachers to change *despite the system* (Fullan, 1995). Additionally, Hargreaves (2003) emphasizes the need for teachers to develop dispositions of creativity, innovation and ingenuity, and Koehler *et al.* (2011) stress the need for dispositions of risk-taking and experimentation to prepare teachers to manage complex and constantly changing education contexts. However, although many call for teachers to develop dispositions to create and innovate (Watson, 2001; Hargreaves, 2003;

Kampylis, 2010; Koehler *et al.*, 2011; Kampylis, Bocconi and Punie, 2012; Punie, Bocconi and Kampylis, 2012) or to take risks and experiment as means to foster such 21<sup>st</sup> century skills (Fullan, 2013; Tondeur, Forkosh-Baruch, *et al.*, 2016) in learners, few studies seek to understand *how* teachers change existing dispositions in order to develop such new dispositions. Similarly, although calls for change to teachers' practices, beliefs or perceptions are frequent, there appears a gap in literature regarding mechanisms through which teachers change their practice, beliefs or perceptions, or the processes and enabling conditions that can support such change as a function of the transformative potential of ETs.

A further gap in the field of TPD4ETs is identified with regards to the underlying perspectives informing research. Reeves and Reeves criticise the field for conducting isolated studies that focus "*on new things rather than significant problems*" (Reeves and Reeves, 2015, p. 29), arguing that such research has limited impact on effecting change to teaching and learning practices (Reeves, 2006; Amiel and Reeves, 2008; Reeves and Reeves, 2015). TPD4ETs research that focuses on *new things*, the tools, innovations, concepts and advancement of ETs, is typically informed by transfer or diffusion, or socially embedded perspectives (Avgerou, 2010). Although often acknowledging the transformative potential of ETs, the focus on *new things* fails to address the significant problem of understanding how existing teaching practices can be transformed, and the processes and enabling conditions that may support this change process.

Moreover, being informed by a diffusion and transfer perspective, education research generally and specifically with regards to ET integration, tend to normalize concepts, innovation, advancements and tools that originate in advanced economies as universally applicable in developing countries. Bourdieu and Wacquant (1992) emphatically argue against research that assumes dogmatized normalizations of thought through the circumscription of intellectual contexts and empirical terrains. More so, they (Bourdieu and Wacquant, 1992) argue, research that isolates theory and practice, only serves to reproduced such dogmatized normalization, which Bourdieu (1962b in Grenfell, 2008) stresses, robs individuals of the meaning of their action. Thus while researchers (Zhao *et al.*, 2002; Ertmer and Ottenbreit-Leftwich, 2010; Tondeur, van Braak, *et al.*, 2016; Pareja Roblin

*et al.*, 2018) frequently identify constraining or enabling factors impacting pedagogical change to integrate ETs, such accounts rarely understand change to teaching from the contexts of multiple deprivation or dynamic contextual challenges in which South African primary school teachers function. Such research, as Fullan (1992) and Chisholm and Leyendecker (2008) argue, frequently underestimate the scope of change required and ***“how difficult it will be for teachers to implement the changes which will be required in practices, materials, beliefs and skills”*** (Fullan, 1992, p. 55 original emphasis).

This study addresses these various gaps in literature from a socially embedded, progressive transformation perspective. This perspective guided the conceptual development of transformational ET integration to orientate the research, and informed the need to redesign TPD4ETs. However, an additional construct is required to think about, understand and analyse *how* teacher change may occur. In the next section, the theoretical frame for the study is developed and a potential teacher change process conceptualised, towards clarifying the research problem of the study.

## 1.4 Theoretical framework

The theoretical frame is strategically developed at the start of the study to structure all aspects of the research through a critical, socio-cultural design-based framework. The placement of the theoretical frame at the start of the study and before identifying the research problem, is informed by arguments in the field. Researchers variously criticize education research for adding theory almost as an afterthought (Reeves, McKenney and Herrington, 2011), or using theory and particularly Bourdieu’s theory of practice, to bestow gravitas (Reay, 2004) without doing much work beyond that. Instead, Reeves, McKenney and Herrington (2011), argue, theory must play a primary role in shaping the research, to which Cobb, Confrey, diSessa, Lehrer and Shauble (2003, p. 10) add: *“the theory must do real work”*. Since *“the value of theory lies in its ability to produce changes in the world”* (Barab and Squire, 2004, p. 6), the theoretical frame is strategically placed here to inform every aspect of this socially embedded, transformative research project: from clarifying the research problem, the literature review and development of the methodology, to the

iterative development and testing of the ePlay MakerSpace TPD4ETs model and the retrospective analysis. In this way, theory informs every aspect of the study, doing real work to understand change and also to produce it. Additionally, the theoretical frame serves as a reflexive tool to critically interrogate my own unthought-of epistemologies, research dispositions and assumptions regarding the object and process of research and analysis, to increase the interpretive and theoretical validity of the study as a whole.

This study combines critical, socio-cultural theory, and design-theory. A critical, socio-cultural lens enables an understanding of *what is going on and why* in existing practice, in order to imagine how this could be done differently using different tools in different ways (Callewaert, 1999). Design-theory, builds on these imagined ideas and behaviours to generate designs that are iteratively developed and tested to create the enabling conditions for the transformative integration of ETs. The rationale for the inclusion of these components in the theoretical frame is subsequently developed.

### 1.4.1 Critical, socio-cultural theory

Critical and socio-cultural theory forms the first part of the theoretical frame, the unique attributes of both providing particular ways of thinking and analysis. Somekh (2007) argues that socio-cultural theory offers a powerful lens to research and analyse ETs and pedagogic innovation, and means to reflecting on the way in which human action is shaped by cultural, institutional and historical contexts. Complementing socio-cultural theory, critical theory is premised on the social nature of activity and belief, functioning outside of frameworks and patterns of analysis in order to interrogate existing social relations in terms of power and contradictions (Popkewitz, 1999). A critical theory of education for example, has to unambiguously explicate *“the very nature of the phenomenon achieved in theory as opposed to both the established and the oppositional perspective”* (Callewaert, 1999, p. 129). Thus, the critical, socio-cultural theorist examines belief claims, and through reflection and analysis of this, works to identify underlying structures and relationships, leading to an imagined solution or alternate way of thinking.

Pierre Bourdieu's (1984, 1990a, 1998a) logic of practice draws on critical and socio-cultural theory, and forms the first part of the theoretical frame for the study, informing the conceptual development of an individual teacher change process. Different reasons informed the choice to include Bourdieu's theory of practice. Callewaert (1999) and Burbules and Berk (1999) contend that critical theorists should purposefully avoid dichotomizing knowledge, or using arbitrary boundaries that obscure descriptions and explanations of the social world. Instead, they argue, critical theory must lead to an imagined solution, an alternative way of thinking beyond current thought structures and presuppositions (Burbules and Berk, 1999; Callewaert, 1999). Bourdieu's work transcends antagonisms between polarised modes of knowledge while preserving insights gained from each mode (Callewaert, 1999). Instead of antithetical poles, Bourdieu argues against dichotomies such as agency and structure, contending that such polarities are essentially positioned along a continuum between subjectivism and objectivism (Bourdieu 2000; Wacquant & Deyanov 2002; Bourdieu 1990b). Bourdieu (1984, 1990a, 1998a) further breaks with the notion of a practical sense and the possibility to interpret this by programmed objectification, and the meta-description and explanation that forms the object of science. The separation of practical sense and scientific explanation, Bourdieu argues, robs people of the meaning of their actions (Bourdieu, 1962b in Grenfell, 2008) since both form different aspects of human endeavour.

In this study, Bourdieu's thinking tools of habitus, field and capital (1984, 1990a, 1998a) are used to describe and analyse teachers' pedagogic practices and choices within a broader context of the school, community and education landscape, and embedded in historic, cultural and social forces. Field, capital and habitus are assumed relational, inter-dependent and co-constructed, neither being dominant, primary or causal (Thomson, 2008). Teachers function within an existing social space where cultural, social and organisational forces impact their pedagogic choices (Somekh, 2007). Bourdieu conceptualises this social space as the field in which social transactions, interactions and events occur (Bourdieu, 1991; Thomson, 2008). The external social reality of a field is internalised in the habitus of those

operating in the field, and simultaneously forms and operates on agents' habitus, while being shape by the habitus.

A field is structured by the principles and rules that govern the flow of capital, which capital is valued, how it is produced and reproduced, transferred or exchanged, and who manages this (Bourdieu, 1990a). Hierarchies of discrimination based on a system of social domination and subordination are produced, as certain assets or capitals are assigned more worth or value than others, based on arbitrarily assigned principles that constitute the field (Bourdieu, 1986, 1990a). Subsequently, agents are distributed in the field based on their access to and volume of legitimated and valued capital (Bourdieu, 1998a). Those in a position of power typically command a significant volume of legitimated and valued capital, and manage the flow of this capital, either constraining or providing limited access to those with less power. This creates competition within the field as agents vie for and use different strategies to accumulate valued and legitimated capital in order to maintain or improve their position.

Bourdieu (1986) conceptualises capital as accumulated labour distinguishing a) objectified, material or economic capital; and b) incorporated, embodied symbolic capital in the form of cultural (related to knowledge or know-how) or social capital (related to social relations). Material or symbolic capital enables actors in a field to “*appropriate social energy in the form of reified or living labor[sic]*” (Bourdieu, 1986, p. 15). The field of education for instance, mostly values cultural capital, and assigns positions of power within the field to those with high volumes of cultural capital, and positioning those with low volumes of cultural capital in the least powerful positions. Those who command the greatest volume of rare and legitimated forms of knowledge and know-how, are assigned distinction (Bourdieu, 1984), such as the cultural capital to transformatively integrate ETs and improve learning outcomes, in a field where this is not commonly practiced.

Individuals acting within and across fields, internalise and produce the logic of the field and capitals valued therein, within their collective or individual habitus. Bourdieu (1990a, p. 55) conceptualises habitus is “*an acquired set of generative schemes*” or dispositions, that

function below consciousness to produce thoughts, perceptions and actions of individuals and groups which correspond to the conditions of its production. Habitus represents the generative principle through which individuals make objective judgements and classifications, as well as the system of classification (Bourdieu, 1984) through which social practices are produced and reproduced in the field. This conception of habitus bridges dichotomies between structure and agency, macro- and micro-, or external and internal forces (Grenfell, 1995; Reay, 2004; Deer, 2008) and provides a way to explain how the outer social conditions are internalised, and in turn shape external social conditions (Maton, 2008; Moore, 2008; Wagner and McLaughlin, 2015).

The habitus is structured by acquired systems of durable, transposable and generative dispositions “*which incline agents to act and react in certain ways*” (Bourdieu, 1998b, p. 12). Dispositions are both durable and generative structuring structures that shape and structure “*fundamental modes of construction of reality*” (Bourdieu, 1990b, p. 388), beliefs, perceptions and practices (Bourdieu, 1990a; Maton, 2008). Like a fish in water, the individual may remain entirely unaware of the existence of dispositions (Bourdieu, 2000, p. 14), making decisions or forming actions, beliefs and perceptions as if guided by a practical sense or sense for the game. The durability of dispositions provides a means to understand the challenges teachers experience when wanting to change, while the generative nature of dispositions provides the keys to address these challenges and transform dispositions to effect change. The durability of dispositions is discussed first to understand the challenges teachers experience when wanting to change.

Bourdieu (1992) contends that durable and transposable dispositions are instilled and inculcated in individuals through the cumulative exposure over a lifetime to social conditions in various fields, that are structured by and in turn structure beliefs, practices and perceptions (Bourdieu, 1990a, 1991). The primary conditions during childhood inculcate the most durable dispositions (Bourdieu and Passeron, 1977), but dispositions can also be formed and transferred to agents or institutions through pedagogic work, training or inculcation of specific dispositions demanded by a field (Bourdieu, 2000). In this way, different types of dispositions are acquired, such as the scholastic disposition (Bourdieu,

2000) or the disinterested disposition (Bourdieu and Wacquant, 1992), dispositions of creativity and innovation (Hargreaves *et al.*, 2001) or of experimentation and risk-taking (Koehler *et al.*, 2011).

The durability of dispositions are the result of a spontaneous tendency to perpetuate structures that correspond to the conditions under which dispositions were formed (Bourdieu, 1990a, 2000). As a result of this spontaneous tendency, dispositions shape perceptions, beliefs and practices to correspond to the conditions under which these were formed (Bourdieu and Passeron, 1977). Dispositions thus constitute the accumulated product of prior civilizations, social classes or ethnic groups that are socially inscribed into minds (Bourdieu, 1990b) in order to perpetuate these structures and let the past remain *“present and active in the dispositions it has produced”* (Bourdieu, 2000, p. 64). Additionally, dispositions encapsulate potentialities that *“are actualized only in definite conditions”* (Bourdieu, 1990b, p. 388), and not necessarily in others. Teachers may for instance, *“act and react in certain ways”* (Bourdieu, 1998b, p. 12) while in school but act differently in other fields.

South African teachers for instance as Samuel (2008) argues, are products of a teacher-training model that values teachers as transmitters of pre-packaged knowledge. A systemic narrative has fostered *“a dependency on State-driven teaching and learning material”* (Samuel, 2008, p. 11) and framed teachers not as professionals and agents of change, but as agents to be changed. Samuel (2008) contends that teachers internalised this deficit narrative from the field, as a *victim mode* and incapable of improving the quality of teaching and learning on their own. Bladergroen and colleagues (2012) found evidence of this internalised deficit discourse in teachers participating on their study, who portrayed themselves as helpless outsiders who needed external support to advance their personal and professional learning and development. In both Samuel (2008) and Bladergroen *et al.*'s (2012) studies, teachers however saw themselves as active agents outside of school, and fulfilled different leadership capacities in community groups. Thus, actualised within school conditions, teachers displayed dispositions to reproduce and replicate, instead of innovate and create: they reproduced the state-led deficit narrative, saw themselves as primarily

responsible for reproducing the cultural capital valued and legitimised by the field of education, and dependent on externally produced innovation. Bourdieu (1990a, 1991, 1998b, 2000; 1992) extends this discussion with the notion of symbolic violence, where the durability and spontaneous tendency of teachers' dispositions become implicit in reproducing dispositions to perpetuate for instance inequality or deficit discourses.

The durability and spontaneous tendency of dispositions to reproduce the conditions under which it was formed, may lead to a situation of inertia or hysteresis (Bourdieu and Passeron, 1977; Bourdieu, 1990a, 2000; Bourdieu and Wacquant, 1992). Bourdieu (1990a, 1991, 2000) argues that since dispositions tend to reproduce beliefs, perceptions and practices corresponding to the conditions under which it was formed, an individual may experience:

*“inertia (or hysteresis) of habitus which ha[s] a spontaneous tendency... to perpetuate structures corresponding to the conditions of production”* (Bourdieu, 2000, p. 160).

As such, while the individual may recognise the need for change, or even express a desire to change, they keep behaving, believing and perceiving in much the same manner. This results in *“a situation where the field passes you by – leaves you high and dry”* (Grenfell, 2015, personal correspondence) despite the individuals' best intentions to change. For example, while the teachers in Bladergroen *et al.*'s (2012) study expressed the need for change and were positive about the impact ETs can have on education, they did not change their practice even after a years' training and support by the research team. While it is undeniable that other factors impacted their inability to change, the influence of hysteresis is and particularly the spontaneous tendency of dispositions to reproduce the conditions under which it was formed, is evident in this example.

Apart from being durable, dispositions are also generative structures. Bourdieu emphasizes the generative nature of dispositions, emphasizing that sustained change can be achieved through the *“transformation of dispositions”* (Bourdieu and Passeron, 1977, p. 209). Transformation in this sense, drawing on Berger's (2004) work, involves a reshaping of how dispositions are to formed to reshape not only what someone thinks, believes or

experiences the world, but fundamentally “*how he or she thinks about things*” (Berger, 2004, p. 340), sees things, and creates meaning from this.

Dispositions can be practically transformed through secondary pedagogic work that employs different modes of inculcation (Bourdieu and Passeron, 1977). Different modes of inculcation to transform dispositions are identified as: conversion (Bourdieu and Passeron, 1977); the awakening of consciousness (Bourdieu, 1990); inculcation through training, pedagogic work and the transmission through active practice of capacities leading to practical mastery (Bourdieu and Passeron, 1977; Bourdieu, 1990). Conversion is described as “*the complete substitution of one habitus*” (Bourdieu and Passeron, 1977, p. 44) for a new habitus such as would happen when soldiers attend basic training, children attend boarding school or where a cult may remove followers from familiar fields and place them in new social conditions. Since this study is concerned with the transformation of particular dispositions to create and innovate (Hargreaves *et al.*, 2001), take risks and experiment (Koehler *et al.*, 2011), and not the entire substitutions of the habitus, inculcation through conversion is not pursued. Instead, the transformation of dispositions is understood as involving a) conscious awakening, and b) training, pedagogic work and transmission through active practice.

Both the durable and generative nature of dispositions are valuable theoretical frames through which to view individual teacher change as taking place within education fields, structured by valued and legitimised cultural capital. Bourdieu’s critical, sociocultural theory provides the means to understand the challenges teachers experience when wanting to change their pedagogic habitus (Fullan, 1995, 2007; Guskey, 2002; Feldman and Fataar, 2014; Fataar and Feldman, 2016). Additionally, the process of conscious awakening, inculcation and transmission through secondary pedagogic work, frames the potential change process.

Bourdieu frequently defended his theory of practice against claims of determinism, saying such criticism is nothing but “*pharisaical [sic] denunciations*” (Bourdieu, 2000, p. 6) born from “*the weight of habits of thought, cognitive interest and cultural beliefs bequeathed by*

*several centuries of literary, artistic and philosophical worship*" (Bourdieu, 2000, p. 7). It is potentially arguable that dispositions and the habitus that constitute the accumulated product of history, can be reduced to deterministic reproduction. However, this suggests a misreading of the generative nature of dispositions (Bourdieu, 1984, 1990, 2000), and particularly Bourdieu's (1984) insistence that the 'fuzziness' and uncertainty of practice cannot be governed by conscious, systematic rules. Additionally, Bourdieu insists that while individuals may know their own limitations or the constraints of a situation, they may also overcome these constraints and limitations (Bourdieu, 2000) as a function of dispositions to resist (Bourdieu and Wacquant, 1992). It is the task of the critical sociologist to examine enabling conditions under which such dispositions of resistance can be constituted, triggered or effected (Bourdieu and Wacquant, 1992), and informed by this, to design processes and spaces in which such resistance and change can occur. This introduces the need for the second part of the theoretical frame, design theory.

## 1.4.2 Design theory

Design theory complements and also differs from critical, socio-cultural theory. Critical, socio-cultural theory provides a means to identify and understand the underlying structures and relationships between actors functioning within a social field, leading to an imagined solution (Burbules and Berk, 1999; Callewaert, 1999). Design moves from imagined solutions, to iteratively develop, test and refine solutions (Reeves, 2006), producing knowledge that is actionable and open to validation (Sloane, 2006). It is this continuation, from understanding structures and relationships ending in imagined solutions, to the pragmatic development of solutions that have a real-world impact on practice, that informs the decision to include design theory as the second part of this study's theoretical frame.

Elements of critical, socio-cultural and design theory are included in design-based research (DBR). DBR builds bridges between "*many levels, factors and actors*" (van den Akker, 2010, p. 178) to produce research that has a direct impact on policy, practice and further research. Although different terms are used for DBR: design research (van den Akker *et al.*, 2006), educational design research (Reeves, McKenney and Herrington, 2011), design experiments

(Cobb *et al.*, 2003) or design and development research (van den Akker, 2010), all draw on the affordances of design to create pragmatic solutions to educational challenges (Reeves, McKenney and Herrington, 2011). Furthermore, research that uses DBR typically develops methodologies that blend the goals of scientific and/or humanistic approaches with the theory-driven designs of learning environments to understand how, when and why educational innovation works in practice (Design-Based Research Collective, 2003; Sloane, 2006). The bridging-function of DBR is essential to this study to navigate and address complex and dynamic challenges from multiple fields including education reform, teacher professional development (TPD) and teacher change, education technologies and the learning sciences. The study's inclusion of critical, socio-cultural and design theories also impacts the methodological development, requiring further bridging between goals of humanistic and design approaches.

Despite the many commonalities between critical, socio-cultural theory and design theory, epistemological differences set these theories apart. Epistemologically, critical, socio-cultural theory views knowledge as socially constructed (Sloane, 2006) through the interactions, relations and structures between fields and agents functioning therein. In contrast, design theory understands knowledge as incomplete and an outcome of emergent and complex inquiry "*into systems that do not yet exist*" (Sloane, 2006, p. 21). As such, design theory employs a future-orientation, seeing research as a means to create abstractions of *what could be*, rather than what is already in existence.

The future-oriented positioning of design is essential to develop solutions for 'wicked' problems as those identified in the NMC Horizon reports (Johnson *et al.*, 2013, 2014, 2015a; Adams Becker *et al.*, 2016), and think beyond current thought patterns and ineffective processes. Wicked problems typically lack sufficient information to clarify the problem at hand, are very often complex, vaguely articulated, and "*require additional data and insights before solutions will even be possible*" (Johnson *et al.*, 2014, p. 18). Solutions to address wicked problems cannot merely transform, optimize or superimpose existing solutions (Design-Based Research Collective, 2003; van den Akker *et al.*, 2006). In Bourdieu's terms, wicked problems emerge as a consequence of the conditions of the field at a particular time

and space. Employing dispositions that were formed under similar conditions as that which formed the wicked problems, will, under influence of the spontaneous tendency of dispositions, create solutions that tend to perpetuate such conditions. Thus, to address wicked problems requires the transformation of dispositions (Bourdieu and Passeron, 1977), and particularly research dispositions, to not only think differently about the problem, but to change *how* thinking and research of wicked problems is conducted. The future-orientation and epistemology of design that sees knowledge as emerging from the iterative design process provides a useful means with which to purposefully achieve this break with the conditions of the research field, but also to potentially support transformation of research dispositions.

Design theory and the bridging function of DBR, address many of Bourdieu and Wacquant's (1992) concerns regarding research in general. Bourdieu and Wacquant (1992) argue against the splintering of theoretical and research activities into isolated activities, and for research to invert the accepted order by work from practical understanding to identify principles and epistemological rules. The emergent epistemology and iterative nature of DBR, strives to build bridges (van den Akker, 2010) rather than isolate research and theory, iteratively developing actionable and valid knowledge (Sloane, 2006) from a practical understanding to identify design principles. Furthermore, Edelson (2002, p. 107) contends that DBR *"eliminates the boundary between design and research"*, an argument that aligns closely to Bourdieu and Wacquant's (1992) insistence against splintering theory and research.

Epistemologically, a design-orientation aligns with a socially embedded research perspective. Design provides an activity base premised on the epistemology that knowledge emerges from a speculative and exploratory process that leads to dynamic and complex learning outcomes (Design-Based Research Collective, 2003). The design-epistemology supports processes to change existing inadequate systems and structures to more desirable, improved situations (Sloane, 2006). Since knowledge is assumed incomplete, a design-orientation assumes that it is all but impossible to account for all emergent phenomena or to analyse every possible factor or element that may impact a learning system (Design-Based Research Collective, 2003). Instead, knowledge is seen as emerging from the

interaction within the design process and the enactment of the intervention, inverting the order of research and aligning with a socially embedded research perspective.

The emergence of knowledge is also understood, not as a linear, reproduceable process, but as a semi-structured, flexible, fluid and adaptable process that can respond to the changing requirements of the participants and the new lines of inquiry that may emerge (Design-Based Research Collective, 2003). Therefore, the designer-researcher approaches the design and development of interventions, not as once-off input-sessions or activities, but as holistic designs that are enacted within an incomplete knowledge system (Design-Based Research Collective, 2003). Bourdieu's thinking tools of habitus, field and capital are valuable in this regard to overcome dichotomous modes of thinking, and to see the intervention as enacted within existing fields and dispositions, but to also underscore the importance of thinking beyond current research dispositions and thought-processes.

The theoretical frame is therefore conceptualised as being critical, socio-cultural and design orientated. Its purpose is two-fold: a) to develop a clear understanding of *how change to teaching occurs* and the mechanisms teachers draw on to effect change; and b) to guide the iterative design and development of a socially embedded, transformational teaching change model and enabling conditions that draws on this understanding. Bourdieu's critical sociology sees theory and critique as consequences of the logic of practice, rather than determining it. For this reason, Bourdieu's critical sociology forms the theoretical foundation for this study in order to facilitate a richer description and understanding of South African primary school teachers' current practices, as structured by the dispositions of their habitus. Drawing from this rich descriptive understanding, DBR provides the vehicle with which to design, test and refine the teaching change model. This theoretical framing informs all aspects of the research, starting with the clarification of the research problem.

## 1.5 The research problem

Teachers generally and particularly in South Africa, find it challenging to change existing teaching and learning practices and to transformatively integrate ETs (Chigona *et al.*, 2011;

Bladergroen *et al.*, 2012; Mooketsi and Chigona, 2016). Instead, ETs remain on the periphery of teaching and learning, (Miller *et al.*, 2006; Chigona *et al.*, 2010; Ford and Botha, 2010; Bladergroen *et al.*, 2012) despite schools and teachers gaining greater access to devices and connectivity, content and curricular material, and despite teachers recognizing the role and potential thereof for education (Chigona *et al.*, 2011; Rega and Van Zyl, 2011; Bladergroen *et al.*, 2012). Teachers' repeated and widespread underutilisation and/or non-use of ETs, limits the potential thereof to transform existing ineffective pedagogic practices and bring about much needed change to education systems globally and particularly in South Africa.

Since learner achievement is related to the quality of teaching (Christie, 2010), effecting change to the enactment of teaching, especially in the majority of the country's disadvantaged primary schools, is a national priority. However, despite three curriculum reforms accompanied by intensified teacher professional development, widespread and sustained change to teaching and learning practices has not been realized (Christie *et al.*, 2010; Fataar, 2012; Spaull, 2013; Christie, 2016). What is more, as Samuel (2008) and Bladergroen *et al.* (2012) found, teachers participating in their studies, displayed dispositions to conform to, and to reproduce the epistemologies and conditions of the field and perpetuate existing deficit narratives.

The study is situated in South Africa's disadvantaged primary schools and employs a socially embedded, progressive transformation perspective, and a critical, socio-cultural design-based theoretical frame. Informed by this perspective and theoretical frame, the study seeks to understand how teachers' dispositions to conform and reproduce existing practices or beliefs, can be transformed to dispositions to create and innovate, to potentially impact how teachers transform their practice to transformatively integrate ETs.

The study thus addresses the research question:

*How can the transformation of teachers' dispositions effect the transformative integration of emerging technologies in classrooms?*

Three sub-research questions guide the research activities:

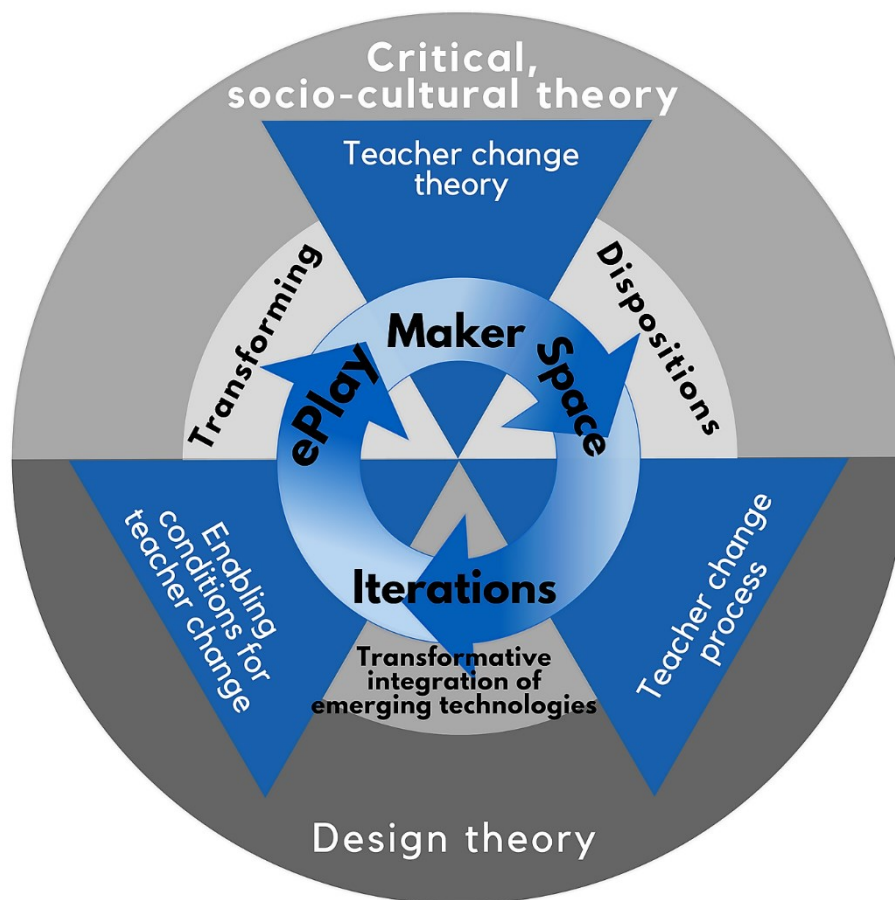
1. *How can teachers' dispositions be transformed through the transformative integration of emerging technologies?*
2. *What processes support the transformation of teachers' disposition to transformatively integrate emerging technologies?*
3. *What conditions enable or constrain the transformation of teachers' disposition to transformatively integrate emerging technologies?*

Teachers' failure to exploit the transformative potential of ETs to effect widespread and sustained change to teaching and learning practices can be considered a wicked problem. ETs are by definition (Veletsianos, 2010) rapidly changing and unpredictable, shape-shifting and not fully understood. Moreover, although change to teaching is widely called for, the actual process of how teachers change or how they may exploit the potential of ETs to transform their practice, is vaguely or ill-defined, further characterising this as a wicked problem (Johnson *et al.*, 2015b; Reeves and Reeves, 2015). Additionally, the inculcation processes to transform dispositions is complex and vaguely understood, confirming the problem of effecting change to teaching through the transformative integration of ETs as wicked problem.

## 1.6 Conceptual frame for the study

The conceptual frame for the study is developed from the theoretical frame and the three research (sub)questions, and illustrated in Figure 1. The two epistemological approaches followed in the study is illustrated by the light and dark grey circles, to indicate the theoretical frame's critical, socio-cultural and design elements. Each theoretical approach is illustrated by two circles, a smaller and bigger circle. The smaller circle illustrates an acknowledgement that this study only draws on a portion of the greater theoretical development.

As a DBR study, the iterative and cyclical design, enactment and formative evaluation process of the research to iteratively develop and refine the ePlay MakerSpace TPD4ETs



*Figure 1 Conceptual frame for the study*

model, is illustrated by the central cycle. Three triangles emerge from the centre of the circle as an outcome of the iteration cycles. The triangles represent the three sub-research questions and the contribution that the study makes to existing knowledge. Flowing from the centre of the circle and deeply steeped in existing theory, warranted theory is developed and refined with each iteration and formative evaluations of the ePlay MakerSpace TPD4ETs model. The triangles move beyond the initial inner circle to illustrate the manner in which the study's theoretical and practical contributions potentially stretch into different areas of each theoretical domain.

The research sub-questions are theoretically aimed at understanding the transformation of teachers' dispositions through the transformative integration of ETs, and the processes and

enabling conditions that support this. These three focus areas develop warranted theory regarding teacher change and the processes and enabling conditions to support teacher change as an outcome of the study.

## 1.7 Structure of the thesis

The thesis includes seven chapters and a website. The first chapter introduces the study and research problem, and develops the construct of transformative ET integration, the critical, socio-cultural and design-based theoretical frame and the conceptual frame of the study. Structured by the conceptual frame, Chapter 2 reviews literature regarding teacher change, and the processes and enabling conditions that support the transformation of teachers' dispositions. The ePlay MakerSpace model for TPD4ETs and global design principles are conceptualised from the literature review. The Design-Based Research (DBR) methodology to guide the iterative development and enactments of the ePlay MakerSpace TPD4ET model is developed in Chapter 3. Two iterations of the ePlay MakerSpace model is reported in Chapter 4 and 5 respectively, each following the iterative DBR process from problem identification and design, enactment, formative evaluation and analysis, with the purpose of refining and elaborating design principles ePlay MakerSpace process and enabling conditions. Chapter 6 reports the retrospective analysis of the ePlay MakerSpace iterations, to refine the understanding of processes to transform dispositions, the design framework and design methodology for the ePlay MakerSpace. The concluding chapter discusses each research question, reviews the research process and articulates the theoretical and practical contribution of the study, as well as identifying limitations and opportunities for further research.

During the two iterations of the ePlay MakerSpace, teachers used various ETs to create online tools. A website, <https://sites.google.com/view/isabeltarlingphddata/home> , was created as a virtual appendix to the thesis. The ePlay MakerSpace process models the transformative integration of ETs, hence the artifacts created for and in the ePlay MakerSpace are mostly available online, using for example Google suite tools, interactive online tools and videos teachers had shared. A website where these could be displayed,

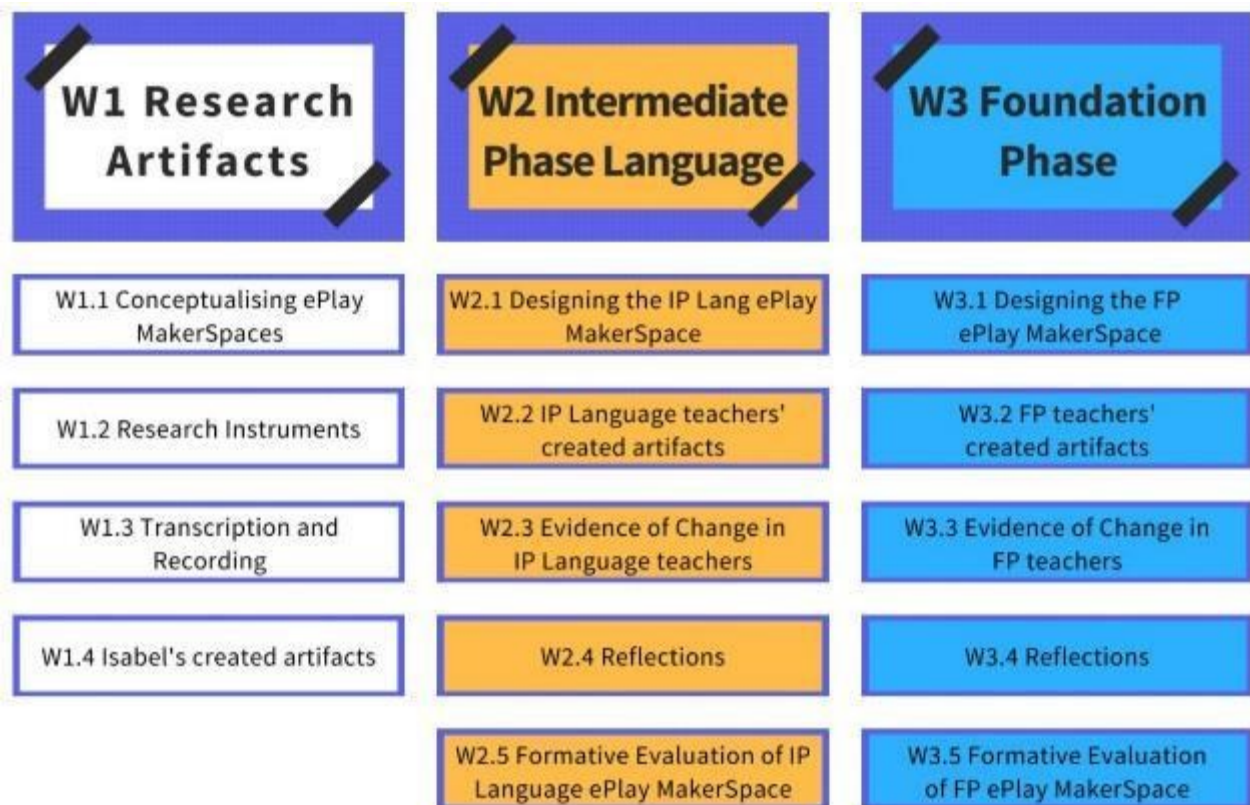


Figure 2 Screenshot from ePlay MakerSpace Data Production website

experienced and engaged with, provided a better option than static screenshots of each item. The website was used also as a research and analytic diary documenting the iterative design of research instruments. As can be seen from the screenshot of the homepage (see Figure 2), the website is divided into three main sections (each section is labelled using the abbreviation W indicating Website content):

- W1 contains the research artifacts;
- W2 relates to Iteration 1 of the ePlay MakerSpace for Intermediate Phase Language teachers; and
- W3 relates to Iteration 2 of the ePlay MakerSpace for Foundation Phase teachers.

Where reference is made to artifacts, hyperlinks to the page on the website, or the artifact are provided, identified with the words (link embedded). A list of artifacts and URLs for each artifact is included as Appendix A for ease of reference.

## 1.8 Summary

Employing a socially embedded, progressive transformation perspective, the study departs from the assumption that ETs have the potential to support transformation to South Africa's education system to improve the quality of teaching and learning in the country's many disadvantaged primary schools. However, despite policy ideals, and increased access in schools, ETs remain largely underutilised or entirely unused in many schools, limiting its potential to support transformation. Instead, while more ETs are currently available in schools than ever before, and despite mounting political, societal and systemic pressure, the majority of South Africa's learners continue to underperform in international and national assessments. This suggests that *what teachers do in their classrooms* (Taylor, 2008) has remained largely unchanged and that extensive education reforms, intensified TPD and greater access to ETs has not translated into improved learning. Using a critical, socio-cultural and design-based theoretical frame, this study asks how the transformation of teachers' dispositions can be achieved through the transformative integration of ETs.

Problematizing current approaches to effect teaching change, may provide insight into the strategies and processes employed to affect change, increase understanding of 'what teachers do in their classrooms', the practical considerations underlying their choices and how sustained and widespread change may be effected. As a result, the study is situated among other, in the field of education change. Moreover, since Spaul (2013) contends, learning challenges that occur in primary school become insurmountable in higher grades, as means to reduce such learning challenges, the study is strategically situated within primary schools, and in particular, in Foundation Phase, and Intermediate Phase language classrooms.

Teacher professional development (TPD) has proven largely unsuccessful to support widespread and sustained change to teaching and learning in South Africa, whether with or without ETs. More specifically, this study problematizes current approaches and models for TPD that aim to prepare teachers to use and teach with ETs, referred to as TPD4ETs, asking how can this be done differently using different tools.

Key constructs were conceptualised to guide the study. Emerging technologies are conceptualised as tools, innovations, concepts and advancements in education contexts that have the potential to transform. The transformative integration of ETs is defined as socially embedded locally developed innovation and knowledge-production, and progressive transformation activity within existing fields, structures and contexts. The outcome of transformative ET integration is changed practices and meaning-making within local schooling or institutional context to support change to teaching and improve learning in schools generally, and particular to this study, South Africa's disadvantaged primary schools.

The next chapter reviews relevant literature regarding teacher change, TPD generally and TPD4ETs, identifying processes and enabling conditions that potentially support teacher change.

## Chapter 2 Literature Review

This chapter reviews literature, demonstrating key debates relating to teaching change, and the processes and enabling conditions to support change to teaching and learning through the transformation of teachers' dispositions. The literature review employs constructs and frameworks developed in Chapter 1, such as the conceptual development of emerging technologies (ETs) and transformative ET integration developed in section 1.2. The conceptual frame from section 1.6 structures the chapter in terms of teaching change theory, processes and enabling conditions that support teaching change, while the literature review is framed by the Bourdieu's theory of practice, the first part of the study's theoretical frame developed in section 1.4.1. Bourdieu's critical, socio-cultural theory of practice provides a language and means to interrogate existing understandings, and explicate the nature of teacher change beyond established and oppositional viewpoints, in order to understand how change to teachers' dispositions and practice can occur. Drawing on this review of literature, the ePlay MakerSpace model is conceptualised as potential mechanism to transform teachers' dispositions.

### 2.1 Theories of teaching change

*“As it stands, the South African education system is grossly inefficient, severely underperforming and egregiously unfair.” (Spaull, 2013, p. 3)*

Change within the South African education system is undeniably and urgently required (Chisholm and Leyendecker, 2008; Weeks, 2012; Spaull, 2013) to address the numerous challenges and failures of the system, as Spaull's findings in the opening quote illustrate. This includes addressing ongoing systemic and institutional challenges, egregious social problems and inequalities (Postma, Spreen and Vally, 2015) and the lack of social equity and justice (Christie, 2016). Much hope is placed in ETs to support urgently needed change throughout the system, and specifically in teaching and learning (Department of Education,

2004; Western Cape Education Department, 2012; Department of Basic Education, 2015). However, despite extensive policy mandates, and systemic and institutional pressure (Vandeyar, 2014; Mooketsi and Chigona, 2016), the persistent underutilisation or non-use of ETs is widely reported (Chigona *et al.*, 2010; Ford and Botha, 2010; Bladergroen *et al.*, 2012; Mooketsi and Chigona, 2016).

Scholars address teachers' persistent underutilisation or non-use of ETs in different ways depending on the research perspective employed. Researchers employing a transfer and diffusion perspective, frequently identify systemic, institutional or teacher-related factors (Miller *et al.*, 2006; Chigona *et al.*, 2010; Mooketsi and Chigona, 2016) or first and second order barriers (Ertmer, 1999; Honan, 2008; Bhati *et al.*, 2009; Sherman and Howard, 2012) that enable or inhibit the integration of ETs. However, Samuel (2008) cautions that change to teaching and learning should start with understanding and recognising *where teachers are*, and critically interrogate *what they do and why*, before designing strategies to improve this. Understanding *where teachers are*, recognising their point of view and making transparent their reasons for current teaching and learning approaches (Baszanger and Dodier, 2004), within social, political and administrative conditions of the field, aligns with a socially embedded, progressive research perspective (Avgerou, 2010) as that employed in this study.

Using Bourdieu's theory of practice, this suggests the need to understand how teachers' habitus functions within the field in order to understand which processes and field conditions may potentially support the transformation of dispositions. This section thus first reviews literature that discusses how the field of education structures and mandates change. Thereafter, literature is reviewed to describe how teachers' habitus respond to existing challenges within the field, in order to understand the scope of change required if they are to transformatively integrate ETs.

## 2.1.1 Strategies of the field to effect change

Educational change researchers approach change from different dimensions, focusing on theories of change (Anderson, 1997, 2010, Fullan, 2005, 2007; Hargreaves *et al.*, 2010; Hargreaves and Ainscow, 2015), systemic change (Fullan and Miles, 1992; Fishman *et al.*, 2003; Evoh, 2007; Darling-Hammond, 2010; Vandeyar, 2014; Christie, 2016) or change at different levels of the education system, for instance school leadership (Fullan, 2001; Gill, 2003; Christie, 2010; Nicholas and Roosmalen, 2016) or through site-based approaches like professional learning communities (Heystek and Lethoko, 2001; Brodie, 2013; Feldman and Fataar, 2014; Watson, 2014; Dufour and Reeves, 2016). However, change to teaching is accomplished by individuals (Anderson, 1997; Hall and Hord, 2001; Gundy and Berger, 2016) and systemic and institutional education reform depend on individual teachers to change (Gundy and Berger, 2016). Therefore, this section reviews literature to understand the systems and processes employed by the field of education to achieve individual teacher change.

Within the field of education, change is understood as a multidimensional process involving systems, organisations and individuals (Gundy and Berger, 2016) that function to increase the volume of capital and maintain or improve the position of the field vis-à-vis the field of power (Thomson, 2008; Grenfell, 2010). The field of education values cultural capital, therefore processes, structures and systems of the field are organised to manage the constitution and flow of legitimised or valued knowledge (Louis, 2010). Since the positions of the field of education within the overall field of power (Bourdieu, 1984, 1998b), is determined by its capacity to increase the flow of legitimised cultural capital measured in terms of learner achievement, teachers' capacity to improve the flow of legitimised cultural capital is prioritised and change processes designed to improve this capacity.

The hierarchical nature of the field is evidenced in the frequent use of top-down change processes (Fullan, 1995; Hall and Hord, 2001; Hargreaves, 2009; Gundy and Berger, 2016) designed to increase the flow of cultural capital in the field. Those most powerful in the field, national or provincial governments, develop standardized curriculum delivery

mechanisms (Samuel, 2008) or assessment processes (Hargreaves and Fink, 2007), or identify externally developed ET tools, concepts or innovations (Avgerou, 2010; Gundy and Berger, 2016) to regulate the flow of legitimised cultural capital in controlled, predetermined and predictable ways (Clarke and Meldrum, 1999). Top-down reforms are driven by systemic policy mandates (Clarke and Meldrum, 1999; Christie, 2010; Gundy and Berger, 2016), while accountability and performativity measures (Hargreaves and Fink, 2007; Lefstein, 2008; Tusting, 2012) produce and reproduce the structure of the field. However, researchers (Hord *et al.*, 1987; Fullan, 1995; Hargreaves and Fink, 2007; Gundy and Berger, 2016) repeatedly criticise top-down education reform approaches in light of its repeated failure (Cuban, 1993; Fullan, 2007; Chisholm and Leyendecker, 2008; van den Akker, 2010) to effect change to teaching and learning (Fullan, 1995, 2005). Such criticisms frequently foreground contradictions between policies and structural requirements of the field (Twining *et al.*, 2013) that inhibit change to teaching and learning.

Inconsistencies between apparent cultural capital valued, and systems operating in the field, often create tensions between reform policies and implementation initiatives (Twining *et al.*, 2013). Hargreaves *et al.* (2001) refer to this as the schizophrenic nature of education reform that require teachers to simultaneously move in opposite directions. In South Africa for instance, the national Curriculum and Assessment Policy Statement (CAPS) (refer to section 1.1) defines the cultural capital valued in the field of education, and accountability and performativity processes structure and regulate the flow of this cultural capital throughout the field. Simultaneously, as means to improve the overall position of the field of education within the field power, policies such as South Africa's Action Plan for 2030 (Department of Basic Education, 2015) or the Guidelines for TPD4ETs (Department of Education, 2007) require that teachers develop 21<sup>st</sup> century skills of creativity, innovation and critical thinking (Fullan, 2013; Twining *et al.*, 2013; Tondeur, Forkosh-Baruch, *et al.*, 2016) to nurture this in their learners. However, the use of an inflexible system of standardisation such as the tightly scripted, teacher-proof CAPS, Hargreaves *et al.* (2001) argue, deprofessionalises and dumbs down teachers, and fails to prepare them with the higher-order thinking and creative problem solving skills needed (Darling-Hammond, 2010)

to “*teach in ways in which they have not been taught themselves*” (Hargreaves *et al.*, 2001, p. 196). Thus, while encouraging the development of 21<sup>st</sup> century skills and emphasizing the need for transformation, the conditions of the field continue to inculcate and reproduce dispositions of conformity and reproduction, rather than innovation, creativity and experimentation needed to transform teaching and learning practices.

Top-down reform initiatives are further criticised for supporting flawed assumptions regarding innovation. Top-down reform initiatives often employ a transfer and diffusion perspective to pedagogic tools, innovations, concepts or advancements that originate in advanced economies, and it is assumed, are universally applicable in developing countries (Avgerou, 2010). From this perspective, reformers (Cuban, Kirkpatrick and Peck, 2001) assume that once externally developed innovations are introduced and teachers see the logic of implementation, they will alter their pedagogic decisions to meet implementation goals (Gundy and Berger, 2016) to improve learning. Consequently, transfer and diffusion of innovations are often measured using tools such as the Concerns-Based Adoption Model (Hord *et al.*, 1987; Loucks-Horsley, 1996; Anderson, 1997, 2010; Gundy and Berger, 2016) to standardize and refine implementation (Gould, 1996). Although researchers (Anderson, 1997, 2010; Hall and Hord, 2001; Fullan, 2013; Gundy and Berger, 2016) contend that clearly defined innovation are more likely to effect change, this is rarely the case with ETs. To the contrary, ETs generally constitute a complex, ill-defined and poorly structured innovation (Anderson, 1997, 2010; Gundy and Berger, 2016), continually presenting opportunities as well as problems and challenges to overcome (Koehler *et al.*, 2011; Gundy and Berger, 2016; Pareja Roblin *et al.*, 2018). Hence, the scope and actual application (Mishra and Koehler, 2006; Chisholm and Leyendecker, 2008) of transformative ET integration and subsequent change to teaching and learning, is difficult to mandate.

Top-down reform is further criticised for assuming that change can be managed and controlled through centralised mandates and processes (Fullan, 1995, 2007; Hargreaves and Fink, 2007; Hargreaves, 2009). Although mandated change, may produce some compliance and short term change (Talbert, 2010), more frequently it results in defensiveness or resistance (Clarke and Meldrum, 1999; Tearle, 2004; Darling-Hammond, 2010) when

teachers' refuse to invest time in change processes, or experience high levels of anxiety regarding change (Talbert, 2010). Moreover, as Fullan (1995) asserts, what really matters to effect change, creative problem solving, critical thinking and committed action, cannot be mandated.

Critics of top-down reform suggest bottom-up change processes as an alternative. A bottom-up approach to change capacitates teachers as change-agents (Jameson, 2006; Vetter, 2012; Lukacs, 2015) or champion teachers (Wenger, McDermott and Snyder, 2002; Warschauer, 2003; Department of Education, 2004; Grant, Jasson and Lawrence, 2010) to change despite the system (Fullan, 2005). This approach may for instance emphasize the need to change teachers' beliefs (Ertmer, 2005; Maria Mama and Hennessy, 2013; Tondeur, van Braak, *et al.*, 2016), attitudes and perceptions (Zhao and Cziko, 2001; Guskey, 2002, 2014; Moolenaar, Daly and Slegers, 2011), regarding innovation and particularly ETs, or capacitate teachers to master skills and prepare them to mentor colleagues (van der Heijden *et al.*, 2015). Preparing teachers with skills and capacities as change agents, suggests a greater emphasis on producing change to teachers' pedagogic habitus, and aligns with a socially embedded, progressive transformational research perspective as that employed in this study.

While it is tempting to conclude that either top-down or bottom-up change process, or variations of this, may provide a 'universal theory of change' within the field of education, Bourdieu argues against this (Bourdieu, 1998b, 2000; Thomson, 2008). Instead, he argues, the interrelationships between the greater field of education, capital valued therein and the collective and individual habitus within each school as subfield (Bourdieu and Wacquant, 1992), are inherently reliant on the reproduction and dynamically evolving conditions of each subfield (Grenfell, 2008; Thomson, 2008). This emphasizes the importance of understanding the existing conditions of the field and the manner in which teachers' respond to these, to understand the scope of change required for teachers to change their practice, before designing models to support locally driven transformation.

## 2.1.2 Understanding the scope of change

Education researchers (Taylor, 2008; Hoadley, 2012; Weeks, 2012) frequently identify the limitations of teaching that constrain learning in South Africa's primary schools. While examples of innovation and excellence are noted (Hayes *et al.*, 2004; Christie, Butler and Potterton, 2007; Grant, Jasson and Lawrence, 2010), in the majority of the country's disadvantaged schools this is not the case. In general, learning in disadvantaged primary schools is dominated by oral traditions and discourse (Hoadley, 2012) that use pedagogies such as chorusing and drill-and-practice which place low cognitive demand on learners (Hardman, 2005; Ford and Botha, 2010; Hoadley, 2012; Spaul, 2013). Classroom interactions typically privilege collectivised, communal learning within the larger group, while providing limited or no opportunities for individualised reading and writing, or individual learner feedback (Hoadley, 2012; Weeks, 2012; Spaul, 2013). In addition to the low cognitive demand on learners, the type of learning in the class is focused on concrete meanings rather than abstract thinking and symbolic manipulation essential for example, to develop algorithms for mathematical problem solving (Hardman, 2005; Hoadley, 2012) or higher order thinking. Furthermore, curriculum delivery is often compromised, slow paced and lacking coherence (Taylor, 2008; Chigona *et al.*, 2011; Hoadley, 2012; Mooketsi and Chigona, 2016) while high absenteeism, and a lack of scheduling and punctuality, erodes instructional time (Christie, Butler and Potterton, 2007; Ford and Botha, 2010; Hoadley, 2012; Weeks, 2012). Although these scholars variously study *what teachers do in their classrooms* (Spaul, 2013) to understand deficiencies that constrain learning, Samuel (2008) implores researchers to ask *why*, and to make transparent teachers' reasons for current teaching and learning approaches (Baszanger and Dodier, 2004). Thus, this section reviews literature to understand the underlying reasons that inform teachers' pedagogic choices in order to understand the scope of change required if they are to transformatively integrate ETs.

Multiple and unremitting complexities relating to language (Kasule and Mapolelo, 2005; Christie, Butler and Potterton, 2007; Spaul, 2013) profoundly impact teachers' pedagogic

decisions. The language of learning and teaching (LOLT) used in schools, for example English (Kapp, 2004; Kasule and Mapolelo, 2005; Mesthrie, 2006; Spaul, 2013), may rarely be spoken in learners' and many teachers' homes or communities (Christie *et al.*, 2010; Mooketsi and Chigona, 2016). Hence, while some schools follow a full-emersion approach and teach in English from Grade 1, others stagger the introduction of English, and learners receive home-language teaching between Grade 1-3, before switching to English in Grade 4 (Department of Basic Education, 2011a, 2011b). Therefore, while Grade 1 – 3 learners need to learn to compute, read and write, they also need to gain sufficient proficiency in English to be able to access learning (Department of Basic Education, 2011a, 2011b). The early switch from home language to English as LOLT, has been criticised as detrimental to learning, as learners frequently fail to develop the cognitive language skills needed for higher order thinking and demanding cognitive interactions (Kapp, 2004). This is evident in the significantly lower achievement of learners whose LOLT is different to their home language, compared to their peers who speak the same language at school and at home (Christie, Butler and Potterton, 2007; Taylor, 2008).

Teachers in the majority of disadvantaged South African primary schools, compensate for and manage the reality of learners' lack of proficiency in the LOLT, using often criticized pedagogic approaches. Although learners in Grade 4 are expected to have gained proficiency in the LOLT (Department of Basic Education, 2011a, 2011b), this is not often the case, and learners are frequently unable to develop cognitive language skills (Kapp, 2004) needed to engage in higher cognitive interaction, reasoning and thinking. When the greater majority of learners in a class lack proficiency in the LOLT, teachers may therefore choose to rely on oral discourse, chorusing and drill-and-practice (Hardman, 2005; Ford and Botha, 2010; Hoadley, 2012; Spaul, 2013), or collectivised, communal learning (Hoadley, 2012), despite this placing low cognitive demand on learners, as a means to engage learners in producing language while at the same time attending to curricular demands. Teaching may also focus on learning that draws on concrete meanings (Hoadley, 2012), images or concrete experiences to compensate for learners' developing proficiency in LOLT. Thus while critical thinking and reasoning, problem solving, collaboration and communication are hallmarks of

21<sup>st</sup> century learning, to develop such skills requires cognitive language skills (Kapp, 2004) and cognitively demanding interaction, which may be severely compromised by learners' limited proficiency in LOLT. Despite gaining proficiency in the LOLT in higher grades, the learning that is lost as a result of low proficiency in LOLT in Grades 4 - 6, contributes to the learning deficiencies Spaul (2013) identified, and which, if left undiagnosed, grow and exclude learners from learning in higher grades.

In addition to challenges regarding LOLT, the contexts of multiple deprivation in which many disadvantaged schools function and their limited access to resources, often results in a failure to attract well-trained staff (Mooketsi and Chigona, 2016). Schools therefore often appoint inexperienced, newly qualified or unqualified teachers (Taylor, 2008; Christie *et al.*, 2010; Mooketsi and Chigona, 2016) with a limited command of pedagogic and content knowledge (Shulman, 1987). Since many teachers "*have not mastered the curricula they are expected to teach*" (Spaul, 2013, p. 25) they tend to teach what they know, and when confronted with unfamiliar sections of CAPS, they either ignore this or let learners memorise segments of the textbook, limiting curriculum pacing and coverage (Christie, Butler and Potterton, 2007; Taylor, 2008; Hoadley, 2012). Lacking subject-specific conceptual understanding and pedagogical knowledge (Taylor, 2008; Christie *et al.*, 2010; Mooketsi and Chigona, 2016), teachers may employ inappropriate pedagogies, such as memorisation of text, often leading to misconceptions and long-term learning deficits (Spaul, 2013). Moreover, teachers "*are often unaware of their own learning deficits*" and fail to understand the pedagogic demands of the curriculum (Spaul, 2013, p. 29). Consequently, they tend to overestimate learners' achievement or their own performance (Spaul, 2013) in IQMS ratings, which as Christie *et al.* (2010) note, compromises the results of monitoring and evaluation tools.

Additionally, teachers functioning within disadvantaged primary schools often have limited access to ETs, even when these are available at the school. Frequently, too few devices are available to support learning in large classes (Miller *et al.*, 2006; Chigona *et al.*, 2010; Ford and Botha, 2010; Mooketsi and Chigona, 2016), with 10-20 devices typically having to be shared among multiple classes each with 40 or more learners (Miller *et al.*, 2006; Chigona *et*

*al.*, 2010; Ford and Botha, 2010; Mooketsi and Chigona, 2016). Since timetabling in disadvantaged schools is often a challenge (Taylor, 2008), and human resources are limited to monitor and manage access, or even to charge and maintain devices, access may not be regulated, leading to sporadic use of ETs, with limited impact on learning (Ford and Botha, 2010). Resource deprivation also limits schools' access to the internet due to high data costs (Chigona and Mooketsi, 2011; Rega and Van Zyl, 2011; Walton and Pallitt, 2012; Mooketsi and Chigona, 2016), while mobile network coverage in rural areas are often inadequate (Rega and Van Zyl, 2011). Although pockets of innovation with regard to mobile learning are emerging (Donner and Gitau, 2009; Ford and Leinonen, 2009; Ford and Botha, 2010), many schools continue to ban mobile phone usage (Ford and Leinonen, 2009; Ford and Botha, 2010). Responsible use policies are often suggested (Oliver, R. and Herrington, 2001; Zhao *et al.*, 2002; Johnson *et al.*, 2013, 2015b, 2016) to prepare users to responsibly use mobile devices, but such policies are rare in many disadvantaged schools.

The literature reviewed emphasize the extensive scope of change required to improve the quality of teaching in South Africa's disadvantaged primary schools. The interplay between the conditions of the field of education and systemic demands in terms of standardisation, accountability and performativity, and conditions of multiple deprivation, challenges regarding LOLT, and limited access to ETs even when these are available at school, impact teachers' pedagogic choices. The interplay between the field and teachers' pedagogic habitus adds further complexity in terms of limited training and experience, content, pedagogical and technological knowledge. Understanding the extensive scope of change required, emphasizes the need for a socially embedded, progressive transformation perspective to prepare teachers to change through the transformative integration of ETs in disadvantaged South African primary schools. The next section reviews literature regarding teaching change processes.

## **2.2 Processes of inculcation to transform dispositions**

*"Policy-makers increasingly recognize that schools can be no better than the teachers and administrators who work within them."* (Guskey, 2002, p. 381)

As Guskey notes in the opening quote, the quality of learning in any school depends on the quality of teaching taking place. However, as Hargreaves *et al.* (2001) argue, current teacher-proofing processes deprofessionalise and dumb down teachers, serving to inculcate dispositions of conformity and reproduction. Instead of teacher-proofing processes, Darling-Hammond (2010) stresses the need to *invest in quality teaching* by among other, developing teachers' dispositions of creativity, innovation and ingenuity (Hargreaves, 2003), risk-taking or experimentation (Koehler *et al.*, 2011). Thus, to improve the quality of teaching in South Africa's disadvantaged primary schools requires the transformation of teachers' existing dispositions (Bourdieu and Passeron, 1977; Bourdieu, 1990) of conformity and reproduction, to dispositions of creativity, innovation, risk-taking and experimentation. The transformation of teachers' dispositions, as discussed in section 1.4.1, can be achieved through processes of inculcation involving the awakening of consciousness (Bourdieu, 1990), training, pedagogic work and/or the transmission through active practice of capacities leading to mastery (Bourdieu and Passeron, 1977; Bourdieu, 1990). The next two sections reviews literature regarding teacher learning as processes of inculcation aimed at awakening consciousness, and the training, pedagogic work and transmission of capacities through TPD/4ETs.

### **2.2.1 The awakening of consciousness**

The transformation of teachers existing dispositions of conformity and reproduction, to dispositions of creativity, innovation, risk-taking and experimentation, can be achieved through different processes of inculcation. In literature inculcation processes relating to the awakening of consciousness are associated with different forms of learning and reflection. Fullan (1995) for instance argues that change is a journey or process involving teachers learning, which for Hargreaves *et al.* (2001) involves both intellectual and emotional work. Alternatively, Opfer and Pedder (2011) argue, conscious awaking requires problematising existing ways of being and believing to bring teachers to the edge of their meaning-making systems, which can be achieved through reflection. Literature regarding reflection and teacher learning is thus reviewed.

The awakening of consciousness occurs for Opfer and Pedder (2011), through the interaction and intersection of knowledge, beliefs, practises and experiences. They (Opfer and Pedder, 2011) argue teachers need to confront and problematise (Fataar and Feldman, 2016) their existing ways of being and believing (Hargreaves *et al.*, 2001), and from this produce cognitive conflict or dissonance between their perception of the ideal and their current capabilities, approaches or perceptions (Fullan, 2001; Opfer and Pedder, 2011). The cognitive conflict or dissonance that arises from problematising existing practices, beliefs or perceptions (Opfer and Pedder, 2011), brings teachers to the *edge of chaos* (Fullan, 2001; Opfer and Pedder, 2011) where creativity resides, and where higher levels of adaptability, mutation and experimentation can lead to unique and novel solutions (Fullan, 2001). At the point of chaos, dissonance and disequilibrium that arises between teachers' current capabilities, skills, beliefs and knowledge, and the ideal, provides the impetus to change "*what they believe, know, and know how to do*" (Opfer and Pedder, 2011, p. 388). Although a theoretically sound description of conscious awakening, researchers have questioned various elements of this approach and its applicability for teachers in developing countries.

Conscious awakening through dissonance and cognitive conflict relies on teachers' capacities to problematise and reflect on existing practice, processes that cannot be assumed universal or inherent in teachers. Reflection is widely recognised (McWhinney and Markos, 2003; Berger, 2004; Hicks, Berger and Generett, 2005; Tinsley and Lebak, 2009; Herrington, Parker and Boase-Jelinek, 2014) as a tool to bring teachers to the edge of chaos and allow individual teachers and groups to examine, reinterpret and reassess existing beliefs, practices and experiences (Tennant, 2005). However, O'Sullivan (2002) cautions that western reflective approaches cannot be assumed relevant to all teachers. In her work with Namibian teachers, O'Sullivan (2002) found that teachers who have not been exposed to the practices and theory of reflection, struggled to reflect on their pedagogic practices, beliefs or experiences. This finding echoes the challenges Fataar and Feldman (2016) experienced in their work with teachers from disadvantaged schools in South Africa. They note:

“...we discovered that the teachers seemed unable to provide clear descriptions of their actual pedagogical practices. Instead, they displayed a limited vocabulary to problematise and discuss the central aspects of their teaching.” (Fataar and Feldman, 2016, p. 103)

In order to achieve conscious awakening, it may be more beneficial to develop teachers' capacity to problematise existing practices and reflect on particular pedagogic techniques, rather assuming that such capacities are already in place. Hargreaves *et al.* (2001) suggest that TPD/4ETs should be systematically designed and to make the intellectual and emotional work of learning explicit. Explicit and systematic *reflective learning* is thus suggested for inclusion in a potential TPD4ETs model, as means to achieve conscious awakening. This may include activities in which teachers can problematise existing practice in order to revise and rethink educational beliefs, practices or perceptions (Hargreaves *et al.*, 2001; Vetter, 2012; Pareja Roblin *et al.*, 2018) and uncover values and interests (Vetter, 2012). However, as Fataar and Feldman (2016) indicated, language adds an additional complexity to reflection in TPDETs. English, although not always teachers' home language, is generally the LOLT in TPD/4ETs in the Western Cape province where this study is situated. However, reflection often requires higher cognitive language skills (Kapp, 2004), and the vocabulary or linguistic proficiency to articulate central aspects of teaching. Hence, to mediate reflective learning, the Teaching Change Frame (TCF) (Tarling and Ng'ambi, 2016) is suggested as potential reflective tool, providing teachers with descriptors and the vocabulary to describe their current teaching and learning practices as situated within or across the different quadrants of the TCF.

The awakening of consciousness can also be achieved through different forms of teacher learning which researchers (Guskey, 2002, 2014; Darling-Hammond *et al.*, 2009; Twining *et al.*, 2013; Tondeur, van Braak, *et al.*, 2016) identify as essential to improve the quality of teaching (Fishman *et al.*, 2003; Penuel *et al.*, 2007; Desimone, 2009; Parsons *et al.*, 2016). Teacher learning is understood as socially embedded activities (Avgerou, 2010) and contextually situated in teachers' daily lives and working conditions (Desimone, 2009, 2011; Opfer and Pedder, 2011) and based in discourse and community practice (Lave and Wenger,

1991; Putnam and Borko, 2000; Opfer and Pedder, 2011). Teacher learning involves processes of self-organisation through which the individual habitus constructs meaning and structures new dispositions, and processes of enculturation (Cobb, 1994; Desimone, 2009) through which the individual interacts with others and participates in cultural practice, inculcating shared meaning within the collective pedagogic habitus.

Different forms of teacher learning are identified in research. Learning that emphasizes teachers' content and pedagogical knowledge (Desimone, 2009; Parsons *et al.*, 2013) is collectively referred to as *professional learning*. The purpose of professional learning is twofold (Twining *et al.*, 2013): to support and enhance existing teaching practices, aligning with structures of the field to increase the flow of cultural capital; and to develop new understandings of the role of knowledge, the teacher and learners, and even the school in transformation of learning (Koehler *et al.*, 2011; Twining *et al.*, 2013; Glover *et al.*, 2016). Since teachers learn most effectively when they actively engage (Putnam and Borko, 2000; Garet *et al.*, 2001) with materials and pedagogical processes "*that reflect how they should teach*" (Opfer and Pedder, 2011, p. 385), identifying the need for *active learning* (Desimone, 2009; Parsons *et al.*, 2013). Through active learning, teachers manipulate and experience physical and virtual materials and tools, the actual application of transformative ET integration (Twining *et al.*, 2013; Tondeur, Forkosh-Baruch, *et al.*, 2016), and develop different perspectives at more complex levels (Major and Ayrton, 2016). Active learning also includes opportunities for teachers to develop teaching plans and resources that are contextually relevant to their needs (Hargreaves *et al.*, 2001; Tondeur, Forkosh-Baruch, *et al.*, 2016). Engagement in active learning fosters commitment (Meyer, 2010) and buy-in (Parsons *et al.*, 2016) and having experienced and learnt from the actual application of transformative ET integration, teachers may be more open to implementing TPD4ETs-goals in their classrooms.

Additionally, conscious awakening can be achieved through *relational learning* (Meyer, 2010) and learning to collaborate. While active and professional learning may involve greater intellectual work, relational learning may involve more emotional work (Hargreaves *et al.*, 2001). Researchers (Twining *et al.*, 2013; Parsons *et al.*, 2016; Tondeur, Forkosh-

Baruch, *et al.*, 2016) emphasize the need to use ETs to foster cultures of sharing and collaboration at local level, and across locations using social networks to share ideas and examples of good practice (Tondeur, Forkosh-Baruch, *et al.*, 2016), encourage collegial support and increase the likelihood of ongoing growth and change (Parsons *et al.*, 2016). Collaborative cultures can develop a shared meaning of change in general (Hargreaves *et al.*, 2001) and specific to this study, how transformative integration of ETs may impact existing teaching and learning practices and experiences, curriculum delivery and assessment (Hargreaves *et al.*, 2001; Vetter, 2012; Pareja Roblin *et al.*, 2018). Although the strengths and value of professional collaboration are widely acknowledged (Lortie, 1975; Hargreaves *et al.*, 2001; Darling-Hammond, 2010; Talbert, 2010; Twining *et al.*, 2013), deep-seated traditions of teacher isolation (Lortie, 1975; Fullan, 1995; Hargreaves *et al.*, 2001) limit collaboration between teachers (Hargreaves *et al.*, 2001; Talbert, 2010; Twining *et al.*, 2013). As with reflective learning, it is therefore suggested relational learning be explicitly and systematically included in TPD4ETs, that not only prepares teacher to collaborate, but to share, interact and support each other using online collaborative tools.

A fifth process to achieve conscious awakening, *transformational learning* (Meyer, 2010), remains largely unexplored in literature. Footprints of transformational learning are strewn throughout educational change literature. Fullan (1995) calls for the development of core capacities of creative thinking, committed action and skills needed to contend with the forces of change. Similarly, Hargreaves *et al.* (2001) associate the intellectual work of change with high levels of creativity, technical skills and knowledge to solve open-ended questions and alter existing teaching and learning practices. Although often conflated, Bateson and Martin (2013) define creativity as capacities to generate original and novel ideas and behaviours using divergent thinking processes, and innovation as using convergent thinking processes (Guilford, 1956, 1957, 1958, 1966) to develop practical steps to implement creative thoughts and behaviours. Dispositions to create and innovate as suggested by Fullan (1995) and Hargreaves *et al.* (2001), capacitates teachers to be adaptable, flexible and fluent (Torrance, 1993; Sternberg, 2006; Bateson and Martin, 2013) when confronted with challenges, to create novel solutions and practical steps to

implement such solutions. Hence, professional, active and relational learning should be designed to develop teachers' ability to create and innovate as means to develop dispositions of creativity and innovation. However, evidence from the repeated failure to effect largescale and sustained change teaching and learning practices, globally and in South Africa, suggests that an emphasis on creativity and innovation may not be adequate to prepare teachers to change.

In order to prepare teachers to change, a conscious awakening process of transformational learning is suggested that deliberately, explicitly and systematically prepares teachers to change. Although reflective learning may bring teachers to the edge of chaos (Fullan, 2001; Opfer and Pedder, 2011), once at the edge, there appears an assumption in literature that teachers are capable of designing, enacting and managing change processes. Instead, the process of change, Berger (2004) argues, is captured in the journey from the edge of chaos and every step beyond that. Berger (2004) describes the process of change as a movement from what is known across an uncharted, undefined space, the *liminal zone*, to the not-yet-known and un-experienced. Transformation, she argues, surpasses the superficial adding of knowledge or skills, but concerns a redefinition of the way that one knows and a re-shaping of how meaning is made (Berger, 2004; Hicks, Berger and Generett, 2005; Baily, Stribling and McGowan, 2014), requiring "*changes not just what [someone] thinks, but how he or she thinks about things*" (Berger, 2004, p. 340). Transformational learning involves the systematic and explicit inclusion of processes within a TPD/4ETs design, to a) bring teachers to the edge or threshold (Berger, 2004) of their meaning-making systems, b) support their crossing of this threshold into the liminal zone, and c) support their journey across the liminal zone that systematically and explicitly prepares teachers to plan and manage change processes following their engagement in the TPD/4ETs. Hence, transformational learning not only supports the transformation of teachers' dispositions within the TPD/4ETs process, but also thereafter, increasing the sustainability of change (Tondeur, Forkosh-Baruch, *et al.*, 2016).

Transformational learning is an emergent process. Although Hargreaves *et al.* (2001) argue teachers should articulate clear reasons for change, and describe, alone or in a group, what

changed practices look like in their classrooms, it may not be feasible for teachers, who have rarely if ever experienced transformational ET integration, to envision the actual application and complex changes it may require. Instead, Fullan (1995) argues, complex changes such as transformative ET integration, create dynamic and complex conditions which cannot be known at the start of the change journey, but become evident as each new step in the journey is taken. Only through experience gained as part of the change journey, can those immersed in the journey take ownership of their part therein, and can shared visions and strategies emerge, that are in turn dynamically “*shaped and reshaped given the complexity of change*” (Fullan, 1995, p. 30).

Transformational learning also involves emotional work (Hargreaves *et al.*, 2001). Teaching is an emotional, caring profession with Hargreaves *et al.* (2001) noting that virtually all aspects of teachers’ work is in one way or another connected to emotional and relational goals. Fullan (1995) notes that in any change process some teachers may be invigorated by the complexity and excited by the opportunity, while for others change may be loaded with anxiety and fear brought on by uncertainty and risk of potential embarrassment or challenges (Pareja Roblin *et al.*, 2018). The uncertain and vaguely articulated goals of the emergent transformational learning process through the liminal zone, may potential increase teachers’ exhilaration and excitement, but also anxiety and fear (Fullan, 1995, 2001; Berger, 2004). These emotions are referred to as the weight of change, and since, “[h]ow teachers conduct and express themselves emotionally always matters” (Hargreaves *et al.*, 2001, p. 137), teachers’ emotional experiences as the weight of change should be supported within the design of the TPD/4ETs.

The literature reviewed in this section, described the complexity the awakening of consciousness as involving reflective, professional, active and relational learning, while the case was made for the inclusion of transformational learning as well. The design of a potential TPD4ETs model for South Africa teachers, may for instance include as Hargreaves *et al.* (2001) suggest, collaborative activities in which teachers work together to plan lessons or pedagogic activities that transformative integrates ETs in practice (Pareja Roblin *et al.*, 2018). Working collaboratively, teachers may reflect on and reflect in (Vetter, 2012) their

learning to articulate how they experience change, and using the TCF (Tarling and Ng'ambi, 2016) as tool, they may reflect on their existing knowledge, practices and beliefs. Additionally, Hargreaves *et al.* (2001) suggest teachers should articulate how changed practice will be enacted, and, selecting a focus area, decide what bitesize chunk they want to address within the greater complexity of transformative ET integration to start their change journey. Professional and active TPD4ETs should provide teachers with opportunities to create and innovate using ETs, while transformational learning can be explicitly and systematically included to provide teachers with an experience of the process of change, and prepare them to plan and manage sustained, self-directed change through their own transformative integration of ETs. In the next section, literature is reviewed to gain insight into existing TPD4ETs that largely employ training, pedagogic work and the transmission of capacities.

## 2.2.2 Training, pedagogic work and transmission

*“...merely knowing how to use technology is not the same as knowing how to teach with it”* (Mishra and Koehler, 2006, p. 1033)

Training, pedagogic work and the transmission through active practice of capacities leading to mastery (Bourdieu and Passeron, 1977; Bourdieu, 1990) as that taking place within TPD/4ETs, is identified as a second mode of inculcation that may lead to the transformation of dispositions. Scholars widely acknowledge the necessity of TPD in general (Fullan, 1995, 2007; Parsons *et al.*, 2013; Gundy and Berger, 2016) and TPD4ETs (Twining *et al.*, 2013; Tondeur, Forkosh-Baruch, *et al.*, 2016) to improve the quality of teaching (Darling-Hammond, 2010). With reference to Mishra and Koehler's opening statement, existing TPD4ETs can be broadly classified as either training teacher to *use* ETs following a competency-based approach, or using pedagogic work and transmission strategies to prepare teachers to *teach with ETs* employing a knowledge-based approach (refer to section 1.2). This section reviews literature regarding existing TPD4ETs.

A competency-based approach to TPD4ETs, also referred to as technology training (Ertmer and Ottenbreit-Leftwich, 2010; Inan and Lowther, 2010; Gibson *et al.*, 2014), aims to develop teachers' skills and competencies to use and apply ETs. Competency-based approaches to TPD4ETs align with a generic, application-neutral and decontextualized understanding of ETs (Honan 2008; Warschauer 2007; Czerniewicz & Brown 2005) informed by a transfer and diffusion perspective (Avgerou, 2010). Hence, TPD4ETs-training typically develop teachers' competencies to use and apply hardware or decontextualized software applications (Warschauer, 2003; Sherman and Howard, 2012) for instance MS Word or PowerPoint.

Evidenced by the widespread underutilisation and unsophisticated use of ETs in classrooms, researchers (Zhao *et al.*, 2002; Tondeur, Van Braak and Valcke, 2007; Harris, Mishra and Koehler, 2009) question the effectiveness of competency-based TPD4ETs-training. TPD4ETs-training is often facilitated as content-neutral, stand-alone events (Mishra and Koehler, 2006; Honan, 2010; Tondeur, van Braak, *et al.*, 2016) to develop general, application-neutral technical skills (Kreutzer, 2009). Such training assumed generic, application-neutral technical skills are universally applicable in diverse contexts (Warschauer, 2003; Mishra and Koehler, 2006; Harris, Mishra and Koehler, 2009) and can be inserted into the daily activities of classrooms (Honan, 2010; Twining *et al.*, 2013), regardless of subject or grade (Warschauer, 2003; Mishra and Koehler, 2006; Harris, Mishra and Koehler, 2009), learners or teachers' prior-experiences (Twining *et al.*, 2013), socio-economic context, beliefs or perceptions (Mishra and Koehler, 2006; Twining *et al.*, 2013). Furthermore, generic, application-neutral TDP4ETs fail to account for the rapid rate of technology change (Hargreaves, 2003; Mishra and Koehler, 2006; Castells, 2009; World Economic Forum, 2014) and how this impacts the corpus of knowledge and related pedagogical knowledge required (Twining *et al.*, 2013). The facilitation of TPD4ETs-training is also questioned, with Twining *et al.* (2013) arguing that trainers frequently model unsophisticated uses of ETs that lack breadth, variety and depth, and which teachers then tend to replicate (Zhao *et al.*, 2002; Tondeur, Van Braak and Valcke, 2007; Harris, Mishra and Koehler, 2009). Therefore, both Twining *et al.* (2013) and

Tondeur *et al.* (2016) advocate for TPD4ETs facilitators to model the transformative integration of ETs that reflect the pedagogical possibilities and sophisticated applications.

Knowledge-based TPD4ETs offer an alternative approach to TPD4ETs-training. Knowledge-based TPD4ETs are generally informed by a socially embedded perspective (Avgerou, 2010) and rely on pedagogic work and transmission of capacities to develop teachers' understanding of the connections, interactions, affordances and constraints between technology (T), pedagogy (P) and content (C), represented by the TPACK framework (Mishra and Koehler, 2006). In contrast to content-neutral, generic competency-based TPD4ETs-training, knowledge-based TPD4ETs capacitate teachers to appropriate ETs for teaching relevant discipline knowledge.

Two knowledge-based TPD4ETs models are reported in literature. The "*pedagogy before technology*" (Watson, 2001; Glover *et al.*, 2016, p. 995) model emphasizes the development of teachers' pedagogical knowledge and higher order thinking skills, before exploring ways to use ETs in teaching. However, Twining *et al.* (2013) argue against separating pedagogy and technology, which Koehler *et al.* (2011) note, may prevent teachers from discovering new, or experimenting with existing ETs. As an alternative, Koehler *et al.* (2011) developed the deep-play knowledge-based TPD4ETs model for their masters' degree students (most of whom were in-service teachers). Deep-play uses the learning technology by design (LT/D) framework as instructional technique to develop technological, pedagogical and content knowledge (Koehler *et al.*, 2011). Reflection is included to encourage participants to reflect on their learning, as well as strategies to continue learning and exploration (Koehler *et al.*, 2011), correlating to reflective learning goals. Transmission of capacities through active practice is achieved in the deep-play process as participants integrate pedagogy that develops 21<sup>st</sup> century learning skills, using design as a transdisciplinary cognitive tool to creatively meliorate ETs for pedagogic purposes (Koehler *et al.*, 2011). Both the pedagogy first and deep-play models emphasize the need for pedagogical work and transmission of capacities through which teachers can make meaning of and develop grade and subject-specific pedagogic tools to integrate ETs into their classrooms, correlating with goals of professional and active learning. Koehler *et al.*'s (2011) emphasis on play in particular

resonates with Kasule and Mapolelo's (2005) findings that play can mediate multiple challenges and dynamic complexities within South African learning contexts.

This section of the literature review identified five learning processes to awaken teachers' consciousness, and reviewed existing approaches or models of TPD4ETs that use either training, or pedagogic work and transmission as modes of inculcation. The review provides insight to guide the design of a potential TPD4ET that may transform the dispositions of teachers from South Africa's disadvantaged schools to transformatively integrate ETs.

## 2.3 Enabling conditions for the transformation of dispositions

Teachers do not arrive at TPD/ETs as 'empty vessels' to be filled with knowledge, skills and competencies (Hargreaves *et al.*, 2001), but carry within their habitus accumulated histories and cultures, practices, values and beliefs. Tondeur *et al.* (2016) stress the importance of designing an environment in which TPD/4ETs takes place, that is sensitive to and acknowledging of such differences, and which creates enabling conditions to support teachers' emotions, differences and different emergent goals and visions of change within the transformational change journey. Koehler *et al.* (2011) suggest play as a possible mechanism to create the enabling environment in which the transformation of teachers' dispositions can take place.

Various scholars (Meyer, 2010; Koehler *et al.*, 2011; Brabazon, 2016; Major and Ayrton, 2016) employ play as a pedagogic tool in business and adult education. Within South African contexts, Kasule and Mapolelo (2005) note, play and games provide a scaffold for participants with diverse skills, competencies and capacities, and from different linguistic and sociocultural backgrounds, to negotiate meaning and learning. Bourdieu (2000), using Plato's phrase, *spoudaiôs paizein*, argues that play within pedagogic work, offers an opportunity to *play seriously*, freeing learning from contextual realities and constraints. It is through serious play, that the conditions can be created to embody and inculcate dispositions to conduct "*challenges, tests and problems similar to real situations but leaving*

*the possibility of seeking and trying out solutions in conditions of minimum risk*" (Bourdieu, 2000, p. 17). In this final section of the chapter, literature regarding play is reviewed, to inform the conceptualisation of ePlay as a unique type of play that takes place within a MakerSpace context, and which creates the enabling conditions in which the transformation of teachers' dispositions can take place.

### 2.3.1 A review of play theory

Play theorists (Huizinga, 1949; Sutton-Smith, 2001; Sicart, 2014) widely agree that while it may be relatively easy to identify activities as 'play', the concept is ambiguous, contradictory and difficult to define. Play includes activities as varied as toddlers' object and exploratory play, sports, adventure and recreational games, therapeutic activities for children, the disabled or elderly, rhetoric and performances on stage by dramatic actors and talented musicians, gambling and gaming. While play is often assumed the opposite to 'serious' activity and work (Wong and Logan, 2016), Meyer (2010) argues against such a dichotomy supported by Brown and Vaughn (2009) who state: *"the opposite of play is not work - the opposite of play is depression"*. Alternate attempts to define play or to capture what defines behaviour as 'play', include for instance:

*"Playing is a form of understanding what surrounds us and who we are, and a way of engaging with others. Play is a mode of being human."* (Sicart, 2014, p. 1)

In this definition, Sicart (2014) however fails to capture the ambiguous and contradictory nature of play, being at once positive and negative, humiliating and exhilarating, or dominating or submissive. Similarly, totalitarian and normative statements concerning play, such as that from the United Nations, tend to view play through a Eurocentric lens as a natural condition of childhood, a child's right, and beneficial to society (Wong and Logan, 2016). In his seminal work on play, Huizinga too falls prey to this totalitarian view when stating that: *"civilization arises and unfolds in and as play... and culture itself bears the character of play"* (1949 Foreward). As Wong and Logan (2016) however point out, this view negates sections of society who never engage in play, or see it as frivolous or even

disturbing. One cannot therefore assume that a dominant view of play is or has been possible at any one time in history.

Other scholars describe characteristics of play. Sutton-Smith (1999) identifies different rhetorics or genres of play, including for instance humour, skill, risk and contestation, fantasy and pretense. Recognizing the autotelic nature of play, Eberle (2014) considers its dynamic character and posits six basic elements that unfold in play: anticipation and surprise give way to pleasure, and leads to understanding, strength and pose. Pleasure during play is evidenced in intensifying shades of satisfaction, gratification and joy, delight, happiness and fun (among other). Eberle's (2014) findings echo that of other play theorists (Sutton-Smith, 2001; Fullerton, 2014; Sicart, 2014) who argue that players engage in play for its own sake, and while this may seem purposeless or without a set goal, the play becomes an end in itself. Autotelic engagement is autonomous and voluntary, as players self-choose and direct their behaviour and thoughts, choosing when and how to enter the play space, how long they choose to stay or how engaged they choose to be in the play activity (Gray, 2008; Wong and Logan, 2016).

Autotelic, autonomous play is intrinsically motivating (Gray, 2008; Wong and Logan, 2016). Play is generally free from everyday constraints and pressures, routines and rules, provides pleasure and is inherently a fun, enjoyable pastime that provides excitement (Brown and Vaughan, 2009). In this respect, play may empower and capacitate educators to plan and manage their own change process, and continue innovating pedagogic practices that transformatively integrate ETs long after the intervention had ended.

These elements capture play in general, yet at a price: it fails to describe play in different contexts, like that on a football field or in an opera house, nor the contradictions that arise. For example, does an anxious and nervous pianist or actor derive pleasure from their play, or a rugby player from their engagement in the game, their every move microscopically analysed and judged by thousands of fans, referees and coaches? These elements further fail to capture the potential of play to foster imagination, creativity and innovation (Bateson and Martin, 2013) and challenge incongruences and inconsistencies, equilibria and

disequilibria (Sutton-Smith, 1999, 2001) that lead to the generation of novel ideas, behaviours and perspectives. Furthermore, there is little evidence that these elements can be included in an intentional design (Meyer, 2010; Sicart, 2014) to enable creative and imaginative play.

Additionally, the conceptual development of play used in this study, takes cognisance of but does not include various divergent debates from play theory. Acknowledging for instance, that many elements, genres and forms of play exist, for the purposes of this study, only specific play behaviour and thought are considered. The study's scope does not include play research concerned with the physiological evolutionary benefits of animal or human play, or the biological functions thereof (Huizinga, 1949; Pellegrini and Smith, 2005; Bateson and Martin, 2013). Neither is it concerned with the psychological aspects of childhood play or play as therapy (Schaefer, 2003; Schaefer and Kaduson, 2006; Drewes, 2009). As with Bateson and Martin's (2013) work, this study does not focus on rule-governed play such as that in sporting arenas, on stages or in theatres, aggressive, competitive or adventure-based activities or play that is systematically organised, restrictive and regulated such as board games or online games. Instead, ePlay is conceptualised as a specific type of play to provide the conditions in which the transformation of teachers' dispositions can occur.

### 2.3.2 Conceptualising ePlay as a unique form of play and the ePlay MakerSpace

ePlay is conceptualised as a distinct form of play. ePlay is both an inculcation process and a mechanism to create the enabling conditions for the transformation of dispositions through the transformative integration of ET. This conception of play, referred to as **ePlay**, is distinguished through the commonly used e-prefix to indicate a focus on play with ETs. While acknowledging that an ePlay TPD/4ETs model may achieve the transformation of dispositions in a more general sense, for the purposes of this study, the focus remains on the transformation of dispositions to create, innovate, take risks and explore.

A defining characteristic of ePlay is its emphasis on developing dispositions of creativity and innovation. Similar to Bateson and Martin's (2013) conception of playful play, ePlay represents an orientation to play that generates radical and novel approaches to challenges by fostering creativity and innovation through the transformative integration of ETs. This conceptual development of ePlay aligns with evolutionary processes that enable organisms to rapidly adapt to changing environmental conditions by generating novel or uncommon approaches to challenges in their physical and social context (Bateson and Martin, 2013; Bennet and Moriarty, 2016). As noted in 2.2.1, creativity and innovation draw on different thinking processes (Guilford, 1956, 1957, 1958, 1966). Creativity employs divergence to generate novel forms of behaviour and ideas, while innovation employs convergence to identify and develop worthwhile interventions in a practical way (Bateson and Martin, 2013). ePlay is thus conceptualised as a process that develops dispositions of creativity and innovation, accompanied by divergent and convergent thinking processes.

ePlay takes place within a purposefully designed context to create the enabling conditions that support teachers emotionally and carries their weight of change within the liminal zone. The context of ePlay is characteristically playful, free-spirited, light-hearted and pleasurable, encouraging humour and laughter, joking, humorous exchanges and joyous, pleasurable interactions (Bateson and Martin, 2013). This context is also nurturing and supportive, freed from the fear of failure, negativity and pessimism, and encouraging of risk-taking and experimentation. As teachers engage in the ePlay context, playing and manipulating, experiencing and discovering online, cloud-based or office-related ET tools and structures, their minds are "*thinking, manipulating, changing and adapting rules*" (Sicart, 2014, p. 9). In an intuitive freedom to experience, without the fear of failure, teachers may experience a greater openness to new experiences and ideas (Meyer, 2010; Sicart, 2014) and willingness to break rules and habitual ways of thinking, and may enter the liminal zone possibly without conscious thought or action. Within the liminal zone they may start create novel and unconventional thoughts and behaviours supported by the safe and nurturing conditions that carry their weight of change.

The purposefully-designed contexts for ePlay supports dynamic, emergent and active learning, such as that in a MakerSpace. Although the concept is relatively new in the field of educational technology, scholars particularly in Library Sciences, are increasingly researching MakerSpaces as incubators of innovation and creative problem solving (Hlubinka *et al.*, 2013; Forest *et al.*, 2014; Morocz *et al.*, 2015; Adams Becker *et al.*, 2016). MakerSpaces offer conducive conditions to transform how, when and why learning occurs, who participates in the active learning process, and how this participation is framed. Emergent and organic collaboration and interactions are encouraged in MakerSpaces, as well as cross-disciplinary problem solving (Johnson *et al.*, 2016) and the erosion of strict boundaries between 'learner' and 'teacher' (Kurti, Kurti and Fleming, 2014). Since MakerSpaces provide contexts for participants to manipulate and experience tools, both physical and virtual, and emphasizes inquiry, exploration and discovery using imagination, creativity and innovation, they align with the goals of ePlay.

The **ePlay MakerSpace** is thus conceptualised as a purposefully designed context in which teachers experience transformative ET integration in a fun-filled and playful atmosphere, where risk-taking, exploration and discovery (Hughes, 2001; Hohmann, 2005; Chesbrough, 2006; Meyer, 2010; Bateson and Martin, 2013), are encouraged, and teachers often rely on intuition and improvisation (Hughes, 2001; Meyer, 2010; Reid and Wood, 2016) to create and invent pedagogic solutions to transformatively integrate ETs. Players in the ePlay MakerSpace pursue their own interests and curiosities, bringing their own enthusiasm and energy (McArdle *et al.*, 2016) in an autotelic, autonomous manner that is intrinsically self-motivating (Sutton-Smith, 2001; Fullerton, 2014; Sicart, 2014). They are actively engaged in experiencing, interpreting, solving problems and taking risks, designing, experimenting, building and rebuilding structures, processes or techniques, whether to solve an authentic, immediate and pressing problem (McArdle *et al.*, 2016) or to simply enjoy playing. The ePlay MakerSpace thus provides an opportunity for teachers to develop and practice new skills and competencies, thoughts and thinking processes, often exposing teachers to possibilities that may seem beyond their existing experiences, skills or capabilities.

Players in the ePlay MakerSpace are typically from diverse contexts and range in skill, competencies and the command of different kinds of knowledge. Hence, novices may play side-by-side with experienced players, each deriving pleasure from their engagement in the ePlay MakerSpace. Similarly, a more experienced player may coach a novice player, or observe the other's play, get thought-seeds from behaviours or designs, and try out new ideas or skills in different ways (Reid and Wood, 2016), inculcating and potentially transforming dispositional structures in both parties. Therefore, interaction between players is encouraged, teachers are frequently reminded of their experience and professional standing, and empathy rather than condemnation is leveraged to understand the contexts in which they operate. It is suggested, that the greater interpersonal, relational learning nurtured between players, may carry the weight of change beyond the capacities of the facilitator(s) and disperse this between participants.

### 2.3.3 Conceptualising the ePlay MakerSpace inculcation process

Following the logic that “[p]lay, unlike other forms of expression, can be designed” (Sicart, 2014, p. 26), the ePlay MakerSpace is designed as an inculcation process to transform teachers’ dispositions within the liminal zone through both the awakening of consciousness and training, pedagogic work and transmission. Therefore, the ePlay MakerSpace process facilitates:

- **Reflective learning** using the TCF (Tarling and Ng’ambi, 2016) as tool with which teachers can describe and problematise their pedagogic practices and beliefs; as well as reflective inquiry through which teachers can reflect *in* learning and *on* learning (Vetter, 2012) and *in* change and *on* change;
- **Professional learning**, informed by a knowledge-based approach and which includes the underpinning principles and theories of education (Twining *et al.*, 2013): corresponding to the goals CAPS this includes Bloom’s revised taxonomy (Krathwohl, 2002), and to the goals of the national Action Plan (Department of Basic Education,

2015) an emphasis on 21<sup>st</sup> century skills of creativity and innovation(Watson, 2001; Koehler *et al.*, 2011), critical thinking, collaboration and communication;

- **Active learning** to capacitate teachers to create and innovate using ETs, which may where necessary include competency-based technology-skills training, but is intended to support autotelic, autonomous and intrinsically self-motivating (Sutton-Smith, 2001; Eberle, 2014; Fullerton, 2014; Sicart, 2014) discovery, experimentation and risk-taking;
- **Relational learning** through the systematic and explicit scaffolded introduction of collaboration to build and nurture networks between educators, and using Anderson’s model of interaction (2004a), to prepare teachers to foster different forms of relational learning and provide a frame for planning collaboration in their classrooms;
- **Transformational learning** drawing on elements of reflection, professional, active and relational learning, to systematically and explicitly guide teachers’ change process within the liminal zone, carry their weight of change and help them make sense of their experiences of change; but also to prepare them to manage ongoing and self-directed change using the collaborate design of lesson plans that transformatively integrate ETs, and the deliberate and purposeful planning and management of change within their schools.

In this way, ePlay MakerSpace inculcation process functions to practically transform dispositions, which Bourdieu’s (1977; 1990) suggests, may restructure *how* beliefs, perceptions and practices are structured. The processes manages the discrepancy between policies and the structures in the field (discussed in 2.1.1), as Twining *et al.* (2013, p. 432 original emphasis) suggest, by developing “*teachers’ capacity to use [ETs] in ways that transform practice while preparing them to work effectively within the current system*”.

The ePlay MakerSpace process purposefully nurtures teachers’ autonomous and autotelic ePlay. The intent is to restore to teachers the meaning of their actions (Bourdieu, 1962b in Grenfell, 2008), their professionalism and self-efficacy to manage how they integrate ETs and manage their own change process despite the system (Fullan, 1995). The autotelic,

autonomous nature of the ePlay MakerSpace process also personalizes the experience to the individual's choice, needs and requirements, as engagement in playful learning becomes the motivation to self-regulate behaviour and thoughts (Charko *et al.*, 2016). Thus, being personally relevant, empowering and pleasurable, the ePlay MakerSpace process potentially facilitates high levels of engagement. More so, it is intended to reframe how teachers see themselves, not as hapless victims (Samuel, 2008; Bladergroen *et al.*, 2012), but as actively engaged composers, creators and innovators of meaning or meaning-makers (Khattar and Callaghan, 2016).

Additionally, following their engagement in the ePlay MakerSpace process, teachers may therefore engage in self-regulated, autotelic ePlay, and take greater responsibility for their own continued learning and change process. As teachers take ownership of their change process, this may have a positive impact on their learners, or teachers may choose to use ePlay pedagogies as a mechanism to achieve similar learning goals in their classrooms. The emphasis on creativity and innovation, risk-taking and experimentation in ePlay, further prepares educators to effectively manage a myriad of future potential challenges, rapidly changing contexts and unfamiliar experiences. Additionally, exploiting the spontaneous tendency of dispositions to reproduce the conditions under which these were formed, it is suggested that once dispositions to create and innovate, experiment and take risks, are formed, teachers may likely continue creating, innovation, experimenting and taking risks towards achieving mastery and sustained change.

## **2.4 Global design principles for the ePlay MakerSpace**

The literature review regarding teacher change theories, the inculcation processes and enabling conditions required to transform teachers' dispositions, informed the conceptual development of the ePlay MakerSpace model. Global design principles (GDPs) are identified for the design of the ePlay MakerSpace TPD4ETs model's inculcation processes and enabling conditions.

- 1) The ePlay MakerSpace inculcation processes and enabling conditions transform disposition by capacitating teachers to create and innovate with emerging technologies.
- 2) The ePlay MakerSpace inculcation processes and enabling conditions transforms disposition leading to the restructuring of beliefs, practices and perceptions since the dispositions that formed these are transformed.
- 3) The ePlay MakerSpace creates the enabling conditions to support teachers' entry into the liminal zone to transform teachers' dispositions.
- 4) The ePlay MakerSpace creates and nurtures autonomous and autotelic ePlay.
- 5) The ePlay MakerSpace process is inclusive. Players in the ePlay MakerSpace come from diverse contexts and range in skill, competencies and the command of different kinds of knowledge.
- 6) The ePlay MakerSpace process models sophisticated applications and pedagogical possibilities of the transformative integration of emerging technologies that are chosen to be immediately applicable and relevant to teachers' unique needs.
- 7) The ePlay MakerSpace process provides opportunities for reflective learning.
- 8) The ePlay MakerSpace process provides opportunities for professional learning.
- 9) The ePlay MakerSpace process provides opportunities for active learning.
- 10) The ePlay MakerSpace process provides opportunities for relational learning.
- 11) The ePlay MakerSpace process provides opportunities for transformational learning.

It is not assumed that any of the GDPs are dominant, or that one process should precede another, with number only used for ease of references. Instead the GDPs are assumed to form as holistic approach to TPD4ETs.

## 2.5 Summary

This chapter reviewed literature regarding theories of teaching change, and the inculcation processes and enabling conditions that may support teaching change. Findings suggest that although teacher change is identified as central to education reform efforts, the scope and magnitude of change is often underestimated. As Hargreaves *et al.* (2001) argue, there

appears no end to change addicts' barrage on teachers to implement often vaguely constructed, ill-conceived and contradictory initiatives. Teacher change initiatives tend to underestimate the degree of change required (Fullan, 1995, 2007; Hennessy, Ruthven and Brindley, 2005; Chisholm and Leyendecker, 2008) or overlook how difficult change is to implement (Hargreaves *et al.*, 2001) and how extraordinarily difficult it is to sustain (Hargreaves and Fink, 2007). Moreover, education reformers appear oblivious (Hargreaves *et al.*, 2001) to "**how difficult it will be for teachers to implement the changes which will be required in practices, materials, beliefs and skills**" (Fullan, 1992, p. 55 original emphasis) such as when ETs are introduced into classroom practice (Pareja Roblin *et al.*, 2018).

Drawing on Bourdieu's theory of practice, the magnitude of change was identified as requiring the transformation of teachers' existing dispositions of conformity and reproduction, to dispositions of creativity and innovation (Hargreaves, 2003), risk-taking and experimentation (Koehler *et al.*, 2011). A socially embedded perspective (Avgerou, 2010) guided the review of teachers' existing practices to understand not only *what teachers do*, but *why* (Samuel, 2008) they make certain pedagogic choices despite the low cognitive demand of pedagogic activities. Findings from the review of teachers' practices informed emphasized the extensive scope of change required for South African teachers from disadvantaged primary schools to transformatively integrate ETs.

TPD is acknowledged as a key component to effect change to teaching. However, Chigona *et al.* (2010) question the effectiveness of existing TPD/4ETs models used within South African contexts in view of the widespread and sustained lack of change to teaching and learning practices. The persistent underachievement of most South African learners, and the widespread underutilisation or non-use of ETs, suggest that current TPD/4ETs models may be ill-suited theoretically and pragmatically to South Africa's teachers. While the design of TPD/4ETs may have provided training, pedagogic work or the transmission of capacities, or opportunities for the awakening of consciousness, these processes did not necessarily lead to the transformation of dispositions. As an alternative, based on the review of literature that identified the five key learning processes identified to support conscious awakening,

and using the review of play theory, the ePlay MakerSpace process was conceptualised as a potential TPD4ETs model.

The ePlay MakerSpace TPD4ETs model provides both an inculcation process and the enabling conditions to support the potential transformation of teachers' dispositions. During the ePlay MakerSpace sessions, teachers explore and experience the transformative integration of ETs, playing with tools and ideas, and generating pedagogic solutions (Koehler *et al.*, 2011) to develop dispositions of creativity and innovation (Hargreaves, 2003), risk-taking and exploration (Koehler *et al.*, 2011). The inculcation process includes reflective, professional, active, relational and transformational learning within a safe, nurturing and fun-filled environment, designed to carry the weight of change for teachers. Global design principles (GDPs) were identified to guide the design of two iterations of the ePlay MakerSpace TPD4ETs model reported in Chapter 4 and 5 using the DBR-methodology developed in the next chapter.

## Chapter 3 Methodology

This chapter develops the Design-Based Research (DBR) methodology to structure and guide the design and execution of the research. The development of the DBR methodology is guided by design-theory and epistemology, included in the theoretical frame (see section 1.4.2). Informed by the conceptual frame developed in section 1.6, the DBR methodology focusses research processes, from design to analysis, on developing and refining theory relating to teacher change, and the inculcation processes and enabling conditions to transform teachers' dispositions and achieve change to teaching and learning through the transformative integration of emerging technologies (ETs).

The chapter is structured to first develop the DBR methodology drawing on different characteristics and aspects of DBR. Thereafter the data production instruments are developed, as well as tools to formatively evaluate the context, participants, the design and procedures of each iteration. After developing the analytic frame, measures to ensure the quality of research findings are discussed.

### 3.1 Developing the Methodology

DBR is a holistic interventionist approach (Design-Based Research Collective, 2003) intended to produce research that has a direct impact on education policy, practice and research. Informed by a design-epistemology (see section 1.4.2), DBR appropriates the affordances of design to iteratively imagine, create, enact and test interventions or solutions (Reeves, McKenney and Herrington, 2011) that address current educational challenges (van den Akker, 2010) and advance understanding of teaching, learning and education systems. DBR is based on certain assumptions regarding knowledge, solutions or interventions, and research.

DBR typically address wicked problems from a solution-focused approach. A solution-focused approach assumes that the problem can only be fully understood in relation to "*an ideal target solution*" (Sloane, 2006, p. 34) in order to bring novel ideas, purposes or

solutions into the design space. In this respect DBR corresponds to the core values of the creative process and in particular that of originality and effectiveness (Kim, 2011a; Runco and Jaeger, 2012). A focus on an 'ideal' solution that is devoid of existing constraints, challenges and threats, powerfully infuses purpose and the development of approximations of *near-term solutions* towards long-term development and evolution (Sloane, 2006, p. 30).

Furthermore, DBR, informed by a design epistemology, understands knowledge as incomplete, exploratory or speculative (Sloane, 2006). It is therefore assumed that it is all but impossible to account for all enabling or constraining factors in an educational context (van den Akker *et al.*, 2006) and that factors that may or may not predict outcomes, or prove relevant, is characteristically incomplete (Design-Based Research Collective, 2003). Consequently, interventions or solutions are holistically designed to address practitioners' existing problems, concerns and priorities, while cognisant of the structures and requirements of the field. Solutions or interventions to explicitly or implicitly improve, enhance or benefit the learning process (Kirkwood and Price, 2014), may include teaching products, materials, resources or programmes, or novel procedures, scenarios and inventive processes (van den Akker, 1999; Kirkwood and Price, 2014).

Solutions or interventions are also understood as contextualised (Design-Based Research Collective, 2003) and embedded within larger systems (Sloane, 2006). Thus each research situation is assumed unique, and even though a similar research problem may be addressed in different contexts, DBR acknowledges the need to develop an individualised and contextualised approach to address the specific contexts, needs and problems therein (Sloane, 2006). This approach corresponds to Avgerou's (2010) socially embedded, progressive transformational perspective, and Bourdieu's (1984, 1990) construct of field. In view of the dynamic nature of individual and collective habitus, the fluidity of and interrelations between fields situated within greater fields of influence, theories (Bourdieu, 1990; Thomson, 2008), interventions or solutions are therefore not assumed universally applicable (Design-Based Research Collective, 2003). In a similar vein, Pedgley (2007) argues, since no two contexts are similar, and since the designer-researcher draws on their uniquely

personal, intuitive orchestration of the design process, it is assumed that a design-based research project is near impossible to replicate.

Addressing these various assumptions on which the DBR approach is premised, the DBR community created framing practices and core concepts to describe reasoning, choices and decisions in design (Dorst, 2011) through the use of design principles (Edelson, 2002; van den Akker *et al.*, 2006) to guide the development of solutions and intervention. DBR can be distinguished from other approaches to educational research in the way that it appropriates epistemologies of design theory and the design process as “*a learning process*” (Edelson, 2006, p. 157) and activity base for developing contextual and embedded solutions that have a real-world impact (van den Akker, 1999; Design-Based Research Collective, 2003; Reeves and Reeves, 2015). It also differs from traditional research approaches by assigning different interchangeable roles to the researcher, who designs, participates, observes and evaluates iterative enactments of solutions or interventions, and analyses findings to refine or elaborate design principles. Characteristically, designs are not created in a laboratory, but embedded in natural test-bed contexts (Cobb *et al.*, 2003) and developed through collaboration between the researcher(s), practitioners and experts (Herrington *et al.*, 2007). The collaboration between the researcher(s), experts and practitioners, clarifies the problem and sharpens the research focus, while characterising and/or identifying potential solutions (van den Akker, 1999). Existing research conducted in similar contexts, further defines the research problem and informs possible solutions (Herrington *et al.*, 2007), potentially defining the design context or situating the intervention within existing practice (Gravemeijer and Cobb, 2006) and theory. The collaborative relationship between participants, experts, existing research and the researcher increases the relevance of the educational research and its potential to impact policy and practice (van den Akker *et al.*, 2006).

Design-based research is also characteristically iterative and enacts iterative cycles of testing, implementation and refinement (Cobb *et al.*, 2003; Reeves, 2006; Herrington *et al.*, 2007). The iterative cyclical process commences with the definition and clarification of the design problem being addressed and an articulation of the goals, constraints and resources

available for the project (Edelson, 2002, 2006). Iterative cycles of “*successive approximation*’ or ‘*evolutionary prototyping*’ of the ‘*ideal*’ intervention” (van den Akker, 1999, pp. 8–9) follows in which researchers and practitioners co-construct, evaluate and refine workable interventions.

Initial prototype designs start as ***thought experiments*** (Gravemeijer and Cobb, 2006, p. 55) and are generally speculative, exploratory and imaginative (Cobb *et al.*, 2003; van den Akker *et al.*, 2006; Herrington *et al.*, 2007). Thought experiments envision “*how proposed instructional activities might be realized*” (Gravemeijer and Cobb, 2006, p. 55) when participants or students enact or use these, imagining potential interactions and learning that may take place. Preliminary designs, goals and conjectures grow from thought experiments, leading to the creation of prototype interventions that are often generalising and crudely structured, and which need to be further elaborated and improved (Gravemeijer and Cobb, 2006). Prototype interventions draw on existing design principles, the identification of the teaching and learning problem (Reeves, 2006) in the context in which it occurs, and the priorities and agendas of the participants.

During the initial prototyping stage, following a solution-focus, all potential constraints, challenges and threats are put aside to generate as many possible solutions even if these seem unattainable. The aim is to eliminate non-essential elements of the problem situation and allow for the “*creative emergence of larger purposes and expanded thinking*” (Sloane, 2006, p. 30). The generation of novel ideas and behaviours is a highly creative process since it requires originality, fluency and flexibility (Torrance, 1972a, 1993, Kim, 2006, 2011b), as well as divergent thinking processes (Guilford, 1966). Once a range of possible solutions are generated, these are analysed and compared, leading to the identification of the most appropriate solutions to address the research problem. This requires convergent thinking (Guilford, 1966) and is associated with the innovation of practical steps to solve the problem. Potential solutions are then iteratively tested, evaluated, redesigned and retested within the target area until a sufficient solution is achieved (Burkhardt, 2006).

Initial prototype interventions are referred to as global interventions that are vaguely defined, developed and not yet elaborated. In subsequent iterations, interventions proceed

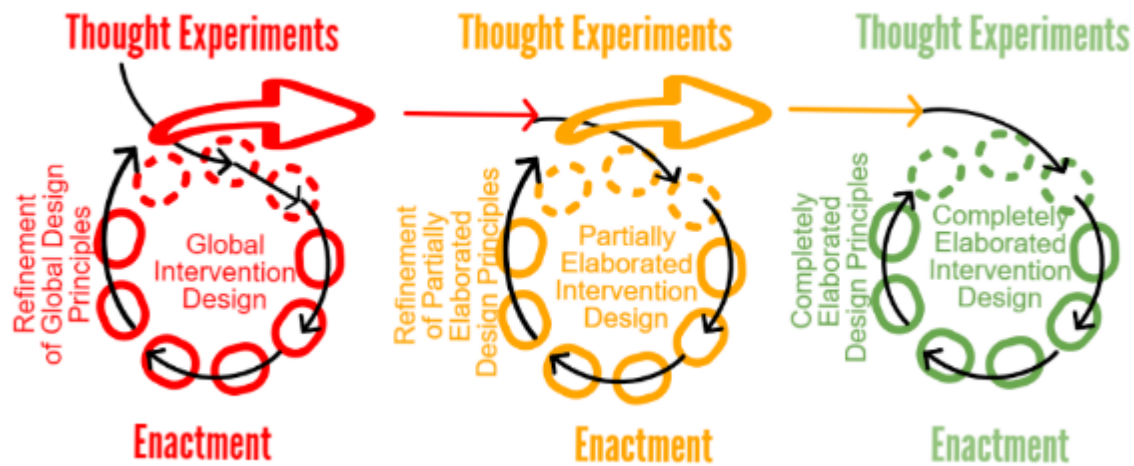


Figure 3 Iteration cycle to identify completely elaborated interventions

through cycles of thought-experiments and enactments, analysis and refinement, each iteration serving to refine and/or elaborate sections of the intervention. As the cycle continues, different aspects of the intervention reach a state of refinement or become “completely elaborated” (van den Akker *et al.*, 2006, p. 126). Although interventions are not assumed to be complete, an intervention can reach a point where it is completely elaborated within a learning space, for instance reaching a point where it is a sustained and seamlessly included in class activities. The iteration cycle and refinement process is illustrated in Figure 3.

The iteration cycle (see Figure 3) combines Gravemeijer and Cobb’s (2006) notion of thought experiments in the enactment of instructional experiments, with McKenney, Nieveen and van den Akker’s (2006) global, partial and completely elaborated solutions (van den Akker *et al.*, 2006). It also resembles Reeves’ (2006) design research process and Euler’s (2017) didactic frame to develop design principles. Although the iteration cycle illustrates three iterations, this is not indicative of a limitation on the number of iterations, but indicates the refinement from global to partial and/or completely elaborated interventions and design principles.

Thought experiments are enacted in learning environments as instructional experiments. The enactment, both as process and the means of enactment, is documented and recorded in order for the researcher-designer(s) to analyse the process, participation and interaction, and the learning that takes place (Sloane, 2006) – comparable to mapping and backward-mapping of the ePlay MakerSpace process (see section 2.3.4). The research context and design space, and the roles of participants within the thought experiment and enactment, are reflected on and refined through the course of the work to clarify and define design elements and activities (Cobb *et al.*, 2003; van den Akker *et al.*, 2006; Herrington *et al.*, 2007). Each iteration sharpens key elements: the problem analysis, design procedure and design solution, and provides contextualised insights (van den Akker *et al.*, 2006) into refinements and elaborations of each design.

Throughout the integration cycle, decisions are made with regard to the problem, the design procedure and the solution under consideration (Edelson, 2002, 2006). The designer-researcher repeatedly moves between decisions regarding anticipatory thought experiments and envisioning how a design may be realized, to choices of how this may be enacted, all the while analysing and reflecting on the process of participation and enactment. Each micro-cycle characteristically includes decisions regarding the design, evaluation and analysis that serve to refine current and future designs of the intervention. Decisions may be based on theoretical underpinnings, and/or the intuition or experience of the designer-researcher or practitioners. The overall impact of these decisions may be reflected in the final product as the outcome of the design, however many critical decisions may remain implicit to the design process. Since such decisions may critically inform the course of the design procedure of subsequent designs, the nature of the design context and/or goals (Edelson, 2002, 2006), it is essential to document and reflect on these decisions.

Attempts to capture the design process as it unfolds is challenging. Pedgley (2007) argues that design decisions often occur in the mind as an outflow of intuitive thought processes, which are difficult to articulate. One way to do this is to elicit an account of the design process after it is completed, however Pedgley (2007) warns that designers reporting on the

design process, tend to inadvertently rationalise the reportage, being eager to portray their efforts in the best possible light. Another means to capture the choices and decisions made in the design process is to use reflective practice (Pedgley, 2007). Through reflective practice the designer uses reflection to reflect *in* the actions taking place when thinking in the moment; as well as to reflect *on* the actions in a retrospective manner (Pedgley, 2007). Retrospective reflection occurs soon after the design process is concluded. The development of the website, [ePlay MakerSpace Data Production](#), as part of this study, provided a tool for retrospective reflection.

A further characteristic of DBR relates to the generation of large quantities of data generally through mixed-method approaches (van den Akker *et al.*, 2006). The magnitude of data collected through a mixed-method approach may potentially overwhelm the researcher-designer(s), leading to the possible exclusion of vital aspects of the data or inaccurate analysis, conclusions and findings in a haphazard attempt to make sense of it all. The challenge is to thoroughly and systematically structure the generation and management of data sets to pave the way for rigorous, reliable, valid and comprehensive analysis of the development and unfolding of “*progressive approximations of ideal interventions in their target settings*” (van den Akker *et al.*, 2006, p. 2). Any voluntary deliberation and all

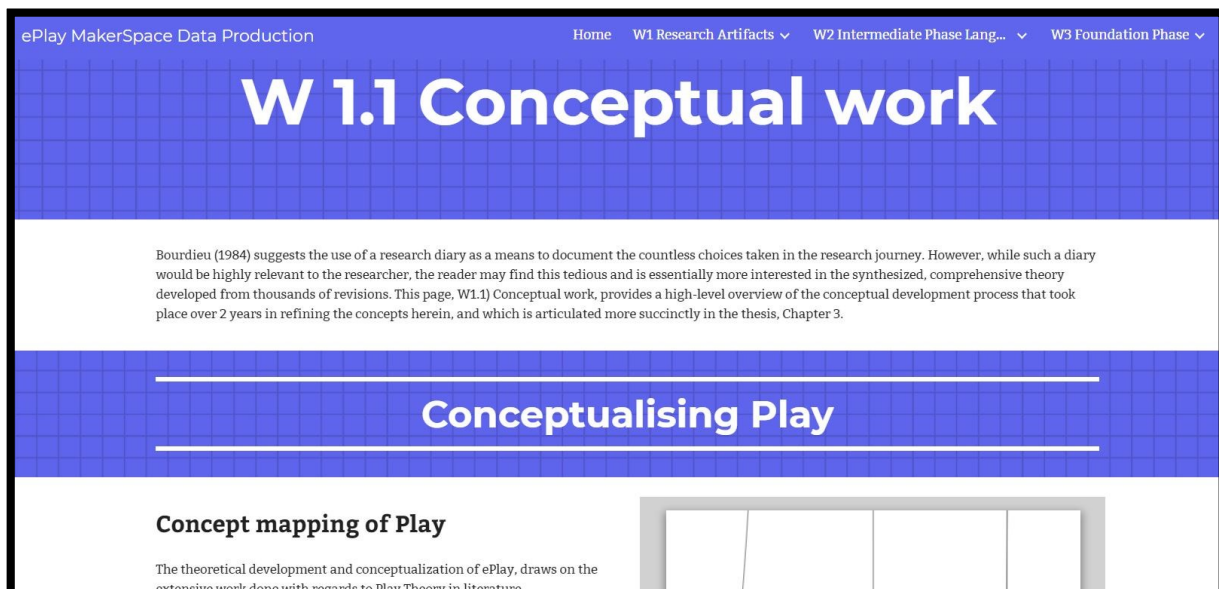


Figure 4 Screenshot from the website

reflections that inform choices and decisions, as well as “*the grounds for particular inferences*” (van den Akker *et al.*, 2006, p. 69) should be recorded. The aim is to construct a map of decisions and choices, from identifying the global design problem to finalising the completely elaborated design principles. This map should allow independent researchers to follow each pathway leading to a claim through the various levels of analysis based on formative evaluations and even to the transcripts of recordings, in order to ascertain the validity and “*empirical grounding for the analysis*” (van den Akker *et al.*, 2006, p. 69). In this study, adapting Bourdieu’s (1984) suggestion of a research diary, the website, [ePlay MakerSpace Data Production](#), provided a means through which to achieve. Figure 4 is a screenshot from the website indicating the use of the website to capture the design process.

This section developed the DBR methodology for the study to iteratively design, enact, test and evaluate the ePlay MakerSpace model as means to transform teachers’ dispositions through the transformative integration of emerging technologies (ETs). The DBR methodology guides the iterative process to develop unique interventions, based on the conceptual development of the ePlay MakerSpace model and global design principles (GDPs) in section 2.3. Each iteration of the ePlay MakerSpace needs to be contextually sensitive and address the immediate and pressing needs of specific groups of teachers from South Africa’s disadvantaged primary schools. The methodology and iteration cycle structure the evolutionary process to refine and elaborate GDPs.

Guided by the methodology, the problem identification and clarification of the study was conducted at two levels. The global problem for the study was identified through unstructured, informal interviews with experts and practitioners in the field of education technologies and teacher development. This included interviews with the former director of the Khanya lab project in the Western Cape, leaders from the Cape Teaching and Leadership Institute, colleagues at the University of Cape Town, and teachers in the field. These interviews foregrounded the challenges teachers experienced to integrate ETs, to change their practice, and the vaguely, ill-defined nature of ET integration for South African schools. A second layer of problem identification involved two reference groups, one for each of the

Foundation Phase and Intermediate Phase Language ePlay MakerSpace iterations. The reference groups included practitioners, experts and district officials who collaboratively identified the unique problems and priorities for each iteration as reported in Chapter 4 and 5 respectively. Consultation with these various groups at both levels critically informed the clarification of the research problem and the design of each iteration of the ePlay MakerSpace.

Using the DBR methodology, the next section develops the data production methods used in the study.

## 3.2 Data production for the study

The DBR methodology structures and guides the design and execution of the study, and focuses all research processes to develop theory (Edelson, 2002, 2006) regarding teacher change, inculcation processes and enabling conditions to support the transformation of teachers' dispositions. As is typical of DBR, multiple data production methods are employed drawing from quantitative and qualitative domains. These methods are used interchangeably, combining different components at different points in the research and *"using methods that link processes of enactment to outcomes"* (Design-Based Research Collective, 2003, p. 7). Data is produced through four main processes: interviews, participants' created artifacts and their reflections, and using van den Akker (1999) and Parson's *et al.*'s (2013, 2016) suggestion, through formative evaluations.

### 3.2.1 Interviews

Interviewing is a widely used and trusted research tool with which to elicit rich descriptions of respondents' life worlds and interpretations of meaning (Benney and Hughes, 1956; Steinar, 1996; Cohen, Manion and Morrison, 2007; Silverman, 2010). Different types of interviews can be used to explore respondents' points of view in order to *"understand and document others' understandings"*, while granting these *"the culturally honored status of reality"* and fair representation (Miller & Glassner in Silverman, 2004, p. 127). During the

problem identification and refinement phase of a DBR study, interviews allow the researcher-designer to elicit the opinions and insights of experts and practitioners. When the solution is designed and enacted, interviews provide a tool to probe participants' ideas, their epistemological beliefs, perceptions and practices, or their experiences and emotions during and after each session.

As a research technique, the qualitative research interview unfolds as a dialectically emergent social interaction between people, using dialogue to create shared meaning (Steinar, 1996; Kalekin-fishman, 2002). Each participant in the interview-interaction has a different grasp of the significance of the interview and their role in it (Kalekin-fishman, 2002). While some interviewees may find the interview a welcome chance to reflect on their own work, or to think through their experiences as a type of cathartic therapy session, others may be mistrusting, unsure or uneasy and employ avoidance tactics to navigate probing questions (Cohen, Manion and Morrison, 2007). Although confidentiality of the interview information may be promised, the interviewee may also remain conscious that the information they supply will potentially be shared on a broader scale. Therefore, interviewees may require different assurances from the interviewer that their contribution will remain anonymous. The interviewer needs to prepare to manage all types of interviewees, their experiences and concerns.

Scholars (Kvale, 1996; Cohen, Manion and Morrison, 2007; Silverman and Marvasti, 2008; Silverman, 2010; Seale, 2011) have extensively investigated and reported on the craft of the interviewer, their theoretical constructs and epistemologies, and techniques of the interview situation. These scholars widely agree that the quality of the data produced during interviews greatly depends on the "*quality of the personal contact*" (Bless, Higson-Smith and Kagee, 2006, p. 116), as this determines how much the interviewee will share, or how open and confident they will be. Deliberating on the nature of the encounter in the pre-interview work is therefore invaluable. Although much has been written on the interview situation, Benney and Hughes' (1956) work remain a clear, pragmatic and functional guide to prepare for the interview situation.

The role of the interviewer in the interview situation, for Benney and Hughes (1956) is governed by the *conventions of equality and comparability*. *Conventions of equality* guide how the interviewer, in a short period, creates interactions that may appear equal, and which allow the interviewee to participate freely (Benney and Hughes, 1956). The aim is to move beyond polite conversation or a mere sharing of factual information (Steinar, 1996), and to create a safe, egalitarian space in which the interviewee can freely share their thoughts or observations (Benney and Hughes, 1956). Although the interview is rarely a reciprocal interaction between equal partners (Steinar, 1996), different techniques can be used to create the appearance of equality. The interviewer mutes or minimizes potential forms of social inequalities that may concern respondents (Benney and Hughes, 1956) such as their appearance and dress-code, even their language or speech patterns, in order to be as inoffensive as the role may permit. Following this, the interviewer initiates the interview by establishing rapport (Benney and Hughes, 1956). Steinar (1996) suggests that empathy can be used as a research instrument to establish rapport and to gain privileged access to the lived-world of the interviewee. Empathy may also create a sense of trust and atmosphere of collaboration in which the interviewee may confidently share subjective and personal contributions with the researcher (Hitchcock and Hughes, 1995). Additionally, Benney and Hughes (1956) add, the interviewer should be encouraging and accepting of the information and expressions of affective responses offered, without judgement or criticism.

The second *convention of comparability* focuses on the interests of the interviewer. The interview is designed to be an information-gathering tool. Especially when diverse individuals are interviewed, their local, concrete and immediate circumstances may constrain efforts to compare results (Benney and Hughes, 1956). Thus, guided by the research aims and prospective outcomes, the interviewer may choose to emphasize specific aspects to achieve greater comparability of data. The interviewer has to negotiate and maintain a balance between the need for comparable data and creating the conversational situation (Benney and Hughes, 1956). In some instances, group interviews or in-depth interviewing may reduce this conflict. Benney and Hughes (1956) however suggest that the interviewer immerses themselves into a community, *“to fit into one of its better-defined*

roles”, at which point they are trusted more and can access “*a valid communication system and hear the kind of messages that the others in the culture hear*” (Benney and Hughes, 1956, p. 142). In this study, this balance was achieved in different ways. Being an ex-teacher and frequent visitor at the CTLI, I fitted into the role of researcher and learning designer, but also a colleague and confidante. On the other hand, being a trusted outsider led to many interviewees sharing confidential or privileged information, or even heartbreak at the loss of a loved-one, trusting that it would be kept anonymous. Empathy in these situations was an invaluable tool to establish rapport and to laugh, reflect or cry with those who needed it.

Unstructured and semi-structured interviews were used in this study as discussed next. Researchers (Desimone, 2009, 2011, Parsons *et al.*, 2013, 2016; Twining *et al.*, 2013; Tondeur, van Braak, *et al.*, 2016) emphasize the need to identify stakeholders’ needs or requirements before designing TPD interventions. Unstructured and semi-structured interviews can be effectively used to identifying stakeholders’ needs or requirements, or to refine a research problem or shared goals. In this study, unstructured interviews with experts, practitioners and colleagues are used to identify and develop a shared meaning for ET integration, the goals and requirements of each ePlay MakerSpace session, and refine a framework for each iteration. Semi-structured interviews are used as research tool after the ePlay MakerSpace session to follow teachers’ change journeys and inquire about their experiences in the sessions.

Scholars variously refer to unstructured, non-scheduled (Bless, Higson-Smith and Kagee, 2006) or informal unstructured (Hitchcock and Hughes, 1995; Cohen, Manion and Morrison, 2007) interviews, but generally agree on similar principles to prepare and conduct unstructured interviews. Although an informal, unstructured interview format may appear to imply that the interview is entirely non-directed, such an approach would be inappropriate for research and could instead be termed a conversation. Instead, in an unstructured interview driven by the convention of comparability (Benney and Hughes, 1956), the interviewer provides structure, but negotiates the interview differently (Hitchcock and Hughes, 1995). The interviewer may for instance ask various open-ended questions regarding broadly defined issues guided by the research aims and prospective

outcomes. The interviewee is free to engage in the questions or choose how much or little they wish to contribute and on which areas in particular they want to focus (Bless, Higson-Smith and Kagee, 2006). Questions emerge from the interviewee's context, and are therefore not pre-determined or worded (Cohen, Manion and Morrison, 2007). At different points the interviewer may intervene to ask for clarification or to focus on certain aspects (Bless, Higson-Smith and Kagee, 2006) unique to the individual and their lived-experiences. In this way the interviewer may explore new avenues of thought that arise or had not previously been considered (Hitchcock and Hughes, 1995). This increases the salience and relevance of questions to particular interviewees (Cohen, Manion and Morrison, 2007), but limits the potential comparability between responses from different interviews.

It may appear that the researcher can engage in an unstructured interview without preparation, however pre-interview work is as important as in semi-structured or structured interviews (Hitchcock and Hughes, 1995). Guided by the research problem, the interviewer needs to define the broad issues under consideration, deliberate on general areas that should be addressed and particularly the nature of the encounter (Hitchcock and Hughes, 1995). Although unstructured interviews can be used with individuals as well as groups, this study uses group unstructured interviews, that require different pre-interview work and approaches. Group unstructured interviews are not only impacted by the interviewer's interests, but by "*the dynamic effects of interaction between people and the way this can affect how views are formed and changed*" (Hitchcock and Hughes, 1995, p. 161).

Unstructured interviews with groups can thus provide a useful tool to develop and observe consensus building, interactional processes and group dynamics (Hitchcock and Hughes, 1995). The interaction between members in a group unstructured interviews may potentially uncover and identify beliefs, perceptions or practices that are considered socially awkward or unacceptable (Hitchcock and Hughes, 1995), such as the questioning of the validity of ETs foregrounded in Bladergroen *et al.*'s study (2012). Unstructured interviews may powerfully contribute to eliciting possibly unconventional questioning or uncover tensions between popular discourse regarding ETs and classroom realities.

Similar to unstructured interviews, semi-structured interviews are flexible and adaptable, and can be conducted with groups or individuals. However, semi-structured interviews are guided by a pre-determined interview schedule to increase comparability of findings (Benney and Hughes, 1956). Semi-structured interviews allow the interviewer more freedom to reorder the order of questions or adapt the wording, or to include additional exploratory questions (Kvale, 1996; Cohen, Manion and Morrison, 2007; Silverman, 2010; Seale, 2011) as needed in the interview situation.

In this study, semi-structured interviews are used after the ePlay MakerSpace iterations to interview teachers about their experiences of the process, their engagement in it, and how they may have changed their teaching and learning practices following their engagement in the ePlay MakerSpace. The interview schedule is included on the website, W1.2.3) Interviews, with anonymised transcriptions of interviews available at W.1.3) Transcriptions.

### **3.2.2 Participants' created artifacts**

The ePlay MakerSpace process capacitates teachers to use ETs to create and innovate pedagogical solutions that are immediately applicable and relevant, as means to inculcate dispositions of innovation and creativity. The artifacts that participants create in the ePlay MakerSpace, produce data that can be analysed in any number of ways and which speak to a range of purposes. This section develops instruments to record and measure for example creativity in teachers' artifacts in keeping with the convention of comparability (Benney and Hughes, 1956).

#### **3.2.2.1 Concept Maps**

Concept Maps (CMs) visually represent knowledge and the inter-relationships between different aspects and concepts. A CM provides a tool with which its creator can elicit, reflect on and make sense of internal learning and thinking processes (Nelson, Lesseig and Slavit, 2016) by visually representing their thought processes in a concept map. As a research tool,

the created CM provides the researcher with a *knowledge representation tool* (Novak and Cañas, 2006), a means with which to see how a participant structures knowledge within a specific domain or across domains, at a specific time or over a longer period (Novak and Cañas, 2006, 2008; Novak, 2010).

In this study, CMs are used as reflective learning tool. Teachers draw CMs in the first session on Day 1 and last session of Day 3 of the ePlay MakerSpace to visually represent how they understand and assign meaning to different aspects of ET integration in general. CMs are included as a means to measure how teachers’ conceptual knowledge regarding ET integration in education develops over the course of their three-day engagement with the ePlay MakerSpace. In order to increase comparability, a predefined structure was developed to introduce teachers to CMs, informed by Nelson, Lesseig and Slavit’s (2016) process.

**Step 1) Word-Association:** as a whole-group, participants use word-association (WA) to generate words for ‘sandpit’, then individually, using a white A4 sheet, are given 60 seconds to generate words for ‘Play’.

**Step 2) WA with ‘ICT Integration in Education’:** On the other side of the A4 white paper, participants are given 5 minutes to generate words associated with ‘ICT Integration in Education’.

**Step 3) Introducing CMs:** some teachers may not be familiar with CMs, therefore the facilitator uses shared-writing pedagogies and participants’ ‘play’ WAs to model the construction of a CM as the example in Figure 5 shows.

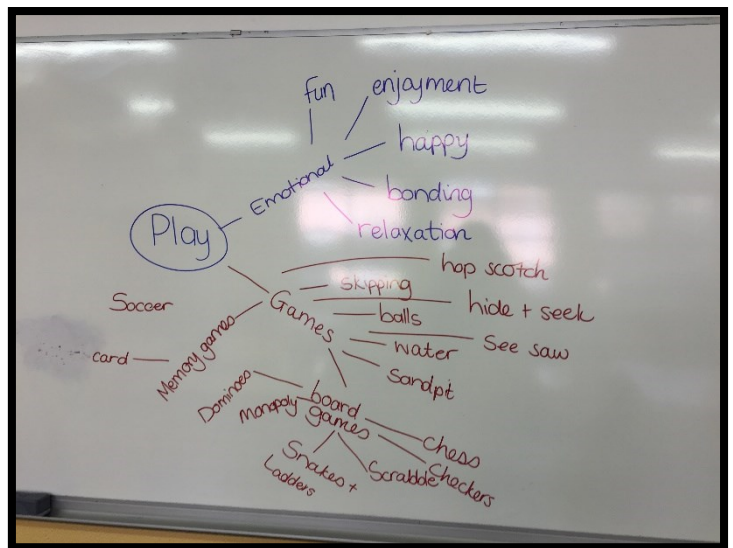


Figure 5 Collaborative Concept Map developed in the ePlay MakerSpace

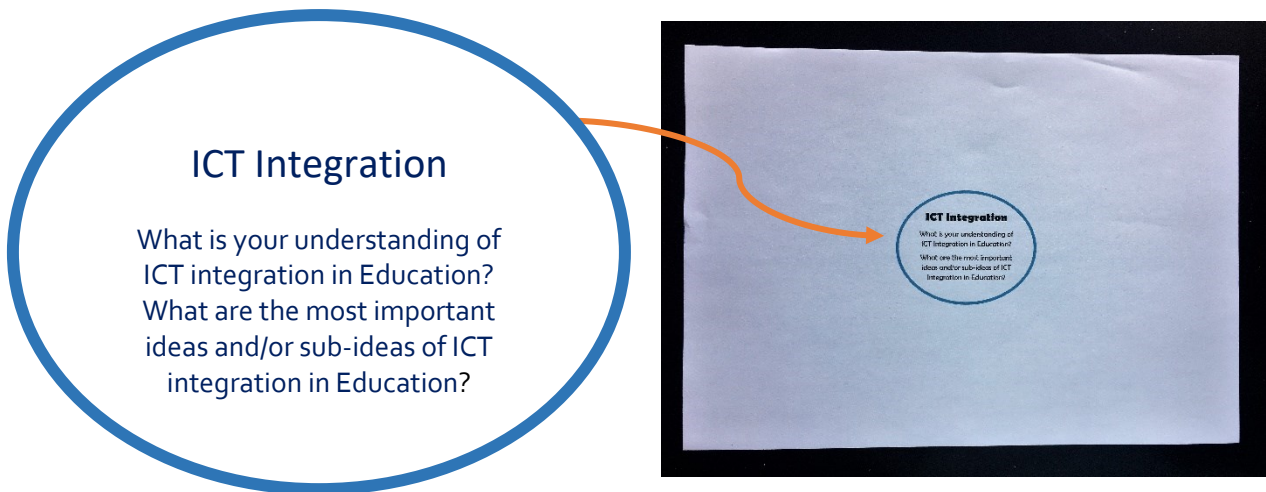


Figure 6 Centre circle on Concept Maps

**Step 4) Participants create CMs:** using their '*ICT Integration in Education*' WAs, participants are given 10 minutes to create their own CMs. Teachers are given a white A4 sheet with the words '*ICT Integration*' and prompting question, as indicated in Figure 6, on which to create their CMs. The template suggests a standardized starting point for teachers' concept maps. When scoring CMs, Besterfield-Sacre, Shuman and Wolfe (2004) noted that it is impossible to score participants CMs when inconsistent formats are used. Hence, the central node increases comparability (Benney and Hughes, 1956) and standardized scoring.

**Step 5) Collection:** Participants' WAs and CMs are stapled together, they write their names on it and it is collected.

**Step 6) Revision of CMs:** On the last day of the ePlay MakerSpace, the CMs are returned to participants, and on the back of their first CMs, they create a new CM of *ICT Integration*.

**Step 7) Digitisation:** The WAs and CMs are scanned and electronically stored in preparation for the CM scoring.

The CM scoring instrument was iteratively developed by combining Besterfield-Sacre, Shuman and Wolfe's (2004) scoring rubric for engineering education, and various other scholars' work on CMs (Novak and Cañas, 2006, 2008; Novak, 2010; Nelson, Lesseig and Slavik, 2016), with the creativity measures developed by Torrance (1972a, 1993) which have repeatedly been validated (Kim, 2006, 2011a; Sternberg, 2006). A rubric to standardize the

scoring of creativity measures, was developed from Torrance's work and tested in three iterations. The analysis of these iterations indicated a high degree of interpretive validity and consistency when creativity in CMs were measured in terms of fluency, flexibility and originality, concurring with Bateson and Martin's (2013) measures of creativity. A G/Form, [ePlay MakerSpace Concept Map Scoring](#) (link embedded) was iteratively developed and tested, and is available on the website, page W1.2.1. A full description of the iterative design of the CM scoring instrument is included in Appendix B.

### 3.2.2.2 Artifacts created by participants

The artifacts created by participants in the ePlay MakerSpace provided an indication of their degree of creativity, and how this potentially changed over time. Creativity is understood as the ability to see and/or make novel links between potentially unrelated items (Bateson and Martin, 2013), ET tools or their uses, beyond the habitual, routinized or typical uses thereof. Informed by the CM refinement of the creativity measure, and Bateson and Martin's (2013) work, creativity in artifacts is measured using fluency, flexibility and originality rather than all six of Torrance's (1972a, 1993) creativity measures.

A G/Form was designed to measure individual participants' creativity as evident in their created artifacts. The form can be viewed at: '[ePlay MakerSpace: Measuring creativity in artifacts](#)' (link embedded) or view it on page W1.2 on the website (including the results from the scoring process).

### 3.2.3 Reflection

Reflective learning is one of the five learning processes included in the e-Play MakerSpace to support conscious awakening and the transformation of dispositions. Reflection engages metacognitive strategies and critical, higher order thinking (Edelson, 2002; Yilmaz and Keser, 2016) in order to problematise existing conditions, practices or beliefs, potentially leading to cognitive dissonance (Fullan, 2001; Opfer and Pedder, 2011). Additionally, by reflection *in* learning and *on* learning processes, the participant may potentially analyse learning conditions, processes and information, and question, collect and interpret data, evaluate it

and report on results (Edelson, 2002; Yilmaz and Keser, 2016). Reflective accounts are therefore highly personal, authentic and representative of teachers' dispositions and potential aspirations (Trevitt and Perera, 2009). Reflection is included as a research tool for the study as individual or group reflections.

Structured reflective inquiry guides participants in groups and individually, to document and record their experiences of change, both positive or negative, and their learning and experiences of the e-Play MakerSpace design and process. Individual and group reflection is included throughout the ePlay MakerSpace process. The CMs provides an opportunity in the first session of the ePlay MakerSpace for teachers to reflect and visually represent their existing conceptual knowledge. Thereafter, using Edmodo, questions are posted to the group that require teachers to reflect on their existing practice, ideal scenarios or their experiences of learning and change. Using the 'reply' function, they respond to the questions and capture their reflections digitally.

Additionally, on the morning of Day 2 and/or 3 of the ePlay MakerSpace, group reflections are conducted in which teachers reflect on the previous days' learning experiences. The group reflections are recorded and where possible, conducted by someone familiar to the teachers and not the facilitator to provide teachers an opportunity to raise questions or make comments that they may feel uncomfortable sharing with the facilitator. Lastly, a final individual reflection of the design process and teachers' experiences of this, is conducted using the G/Form: [CTLI ICT Integration: Course Reflections](#) (link embedded).

### **3.2.4 Formative evaluation**

The vast range of data collected during the iterative design and enactments of the ePlay MakerSpace process, posed a potential challenge with regards to critical and meaningful analysis. Scholars such as van den Akker (1999) and Parsons *et al.* (2013, 2016) propose the use of formative evaluation within research to evaluate iterations in a consistent and standardized manner. Subsequently, formative evaluation is included as a research tool to

holistically evaluate each of the e-Play MakerSpace enactments from social and technical perspectives.

Formative evaluation allows the researcher-designer (and participants where appropriate) to gauge social and technical progress in the research and intervention process (van den Akker, 1999). Socially it provides insight into participants' satisfaction, enthusiasm, their commitment to and ownership of the intervention process (van den Akker, 1999).

Technically, formative evaluation gauges whether the intervention is on track and/or what changes should be made to achieve the intended outcomes (Haslam, 2010). Formative evaluation also exposes potential implementation problems that may cause frustration, leading to redesign and refinement in order to reduce these problems (van den Akker, 1999). In addition, formative evaluation determines whether the different forms of learning are taking place as planned and what (if any) new knowledge and skills teachers are acquiring and how they applied this in their classrooms (Haslam, 2010). Formative evaluation may also shed light on any related changes to the school culture or organisation that may result from teachers' participation in the intervention (Haslam, 2010), or that may be required to facilitate change to pedagogy. Therefore, formative evaluation is a key research activity to inform the iterative refinement and elaboration of intervention designs if these are to have sustained, widespread real-world impact.

The primary purpose of formative evaluation is quality improvement (van den Akker, 1999). Quality is emphasized during the research in terms of validity, practicality and relevance, sustainability and effectiveness (van den Akker, 1999; van den Akker *et al.*, 2006). Improving content and construct validity improves the quality of the intervention: whereas content validity refers to "*the extent that the design of the intervention is based on state-of-the-art knowledge*", construct validity refers to the extent to which "*the various components of the intervention are consistently linked to each other*" (van den Akker, 1999, p. 10). Achieving quality in terms of practicality refers to the extent to which users (and external experts) find the intervention usable and appealing (van den Akker, 1999) and whether the intervention is realistically usable in everyday, naturally occurring test-bed contexts (Cobb *et al.*, 2003; van den Akker *et al.*, 2006). The design should be relevant to those in the target setting and

address participants' needs and wants, and its use should be sustainable over time (van den Akker *et al.*, 2006). Achieving quality in terms of effectiveness refers to the extent to which experiences and outcomes of the intervention are aligned with the intended goals and aims (van den Akker, 1999) and whether the time, effort and resources expended in the intervention is worth the investment (van den Akker *et al.*, 2006).

The use of a standardised formative evaluation tool serves to improve the quality and validity of the research, as well as the practicality, effectiveness, relevance and sustainability of the design. The formative evaluation foregrounds shortcomings, implementation problems, and/or design or procedural concerns. Results from the formative evaluation can then inform the generation of alternative solutions or the refinements of existing designs to improve weaknesses (van den Akker, 1999). A formative evaluation process was subsequently developed to evaluate e-Play MakerSpace iterations.

Design-based research is situated in unique contexts and is dependent on the participation and engagement of individuals in particular roles as they work to develop and enact the design intervention. McKinney *et al.* (2006) frame these areas for evaluation as context, participants and intervention design, concurring with Edelson (2002, 2006). Each of the areas illuminate particular aspects of the design that need to be evaluated.

#### 3.2.4.1 Formative evaluation of the context of the intervention

In order to produce warranted theory, the DBR researcher has to develop a thorough and in-depth contextual understanding (van den Akker *et al.*, 2006) of the context of an intervention. The context of DBR interventions are characteristically situated within authentic natural test-bed education settings (Cobb *et al.*, 2003; van den Akker *et al.*, 2006). Viewing each context as unique and situated within a wider system of fields, DBR projects work to understand how and why an innovation works within a particular context (Design-Based Research Collective, 2003).

Contextual factors shape the goals of each design. This includes local factors such as the school culture and climate, learners' profiles and access to resources, as well as systemic

factors like policies, regulations and curricular demands (van den Akker *et al.*, 2006). The design context is subsequently elaborated by identifying challenges and constraints in the test-bed context, as well as identifying opportunities that may be exploited therein (Edelson, 2002).

A myriad of unpredictable local and systemic factors may potentially change in the course of the intervention's iteration cycles. Institutional changes, learners' interests and circumstances, access to resources, or the school culture may change and positively or negatively impact the implementation. To develop a holistic understanding of the context such changes should ideally be documented and included in the formative evaluation of each implementation cycle; as well as decisions made to address any problem or exploit any opportunities that this may bring about in subsequent design(s).

Collaborating with different institutions, teachers and learners across varying contexts, and often different languages and cultures, may potentially pose logistical challenges to the research. The DBR researcher may need to make *“trade-offs between refinement of a particular innovation to maximize success and generalization of findings from an ultimately highly refined enactment”* (Design-Based Research Collective, 2003, p. 7). Trade-offs need to be recorded and included in the formative evaluation.

The following framework was developed to evaluate the context of each e-Play Makerspace enactment:

- Identify systemic level factors that may impact educators' participation, implementation and/or application of newly learnt skills and knowledge.
- Identify institutional level factors such as resources, culture, leadership or value afforded ET integration, that may impact how participants implement and/or apply newly learnt skills and knowledge.
- Identify classroom level factors that may impact how participants implement and/or apply newly learnt skills and knowledge.
- Identify challenges, opportunities, constraints and trade-offs at each of these levels.

### 3.2.4.2 Formative evaluation of the participants in an intervention

Participants' insights at the different levels and stages of the DBR study augment those of the researcher-designer (van den Akker *et al.*, 2006), being central partners in the intervention process and implementation. The extent to which teachers may choose to participate in the DBR varies, and while some may start enthusiastically and end tired and not-involved, others may start the process slowly but become deeply involved. The varying types of participation may be influenced by participants' beliefs and attitudes towards the intervention, for instance, whether they believe it has benefit to them and/or their students, or whether the learning enacted in the intervention resonates with their own approaches to learning.

It is essential to the success of DBR projects that a collaborative relationship is developed and nurtured between the researcher-designer(s) and participants. A collaborative relationship may be achieved by creating situations where teachers mutually benefit, whether emotionally or strategically (van den Akker *et al.*, 2006). If teachers enjoy what they do, the emotional reward for all stakeholders is likely to encourage collaboration. Equally, if teachers derive benefit from the intervention and specifically the data collection, this may further enhance collaboration. The building of trust is vital to the development of a collaborative relationship (van den Akker *et al.*, 2006). Trust starts with the researcher-designer building empathy with participants' contextual circumstances, their goals and problems, and actively engaging all participants in the various aspects of DBR for collaboration to be democratic and meaningful. In turn, this may transfer to participants taking ownership of the process, being committed to its outcomes and enthusiastically working towards achieving its targets. Participants' satisfaction with the process and its outcomes therefore become an important indicator of these factors.

The following framework was developed to evaluate the participation of participants in ePlay MakerSpace enactments according to the extent to which they:

- a) Take ownership of the process;

- b) Actively engage in the process and in building / making structures;
- c) Are committed and enthusiastic about achieving the outcomes (ET Integration and changing their practices);
- d) Are empowered by their participation in the process, like taking responsibility for their own learning and reflexivity, their willingness to learn and be guided (reciprocity), and collaborating in relational learning in small and large group interactions;
- e) Display creativity, like developing original ideas and/or behaviours, their flexibility in generating novel ways to use tools they were exposed to and/or fluency in identifying or developing relevant ideas;
- f) Engaged in the reflective processes, interrogating their own subjective principles and/or creating space for objective evaluation of their own and others' world views.

Adhering to the convention of comparability (1956), the various elements of the formative evaluation were described in a rubric to standardised evaluation. Additionally, the formative evaluation rubrics limited researcher bias and increased interpretive validity. The formative evaluation tool as included as Appendix C.

### 3.2.4.3 Formative evaluation of the ePlay MakerSpace design

The design of each iteration of the ePlay MakerSpace, needs to be formatively evaluated to ascertain to what degree the design practically and effectively addresses the requirements and goals it set out to achieve.

A formative evaluation for the design of each iteration was consequently developed by combining two types of evaluation:

- Solution design: the design of the ePlay MakerSpace itself
- Implementation procedure: the way in which the ePlay MakerSpace process unfolded and/or how the design was implemented

Criteria for the formative evaluation of the Solution Design draws from van den Akker's (1999; 2006) work and is aimed at improving the quality of the design. This relates to the practicality, relevance and sustainability of the design, as well as its effectiveness and validity. Descriptions of each evaluation item is included in the rubric (see Appendix D) as well as potential questions developed from these.

The formative evaluation for the Implementation Procedure evaluates the Strengths, Weaknesses, Opportunities and Threatens of each iteration of the ePlay MakerSpace makes using a SWOT analysis frame. The SWOT analysis formatively evaluates how each iteration was enacted and the different elements implemented. As can be seen in the rubric (see Appendix D), potential questions are included, corresponding to the description of the evaluation criteria.

In keeping with the principle of comparability (Benney and Hughes, 1956), the design solution and implementation procedure of both iteration of ePlay MakerSpace are evaluated using this formative evaluation.

#### **3.2.4.4 Formative evaluation in terms of design principles**

In addition to the formative evaluations of ePlay MakerSpace participants, the design solution and its enactment and implementation for each iteration, a formative evaluation of the design in terms of the DPS included and used as a parallel analysis of the process. This serves two purposes: firstly, to evaluate the extent to which the design and enactment of each ePlay MakerSpace iteration meets the DPs, and secondly to identify potential refinements to the DPs. The formatively evaluation as parallel analysis therefore allows for the iterative review, refinement and elaboration of DPs following each iterative cycle of the ePlay MakerSpace.

### 3.2.4.5 Capturing Formative Evaluations

A G/Form was developed to capture the different formative evaluations for each iteration: [Formative Evaluation of ePlay Design](#) (link embedded). This is available on the website on page W1.2) Research Instruments.

Individual participants are evaluated using the G/Form: [Formative Evaluation for Participants](#) (link embedded). Results are immediately available on a Google Sheet (G/Sheet) once forms are submitted. Teachers' individual formative evaluation results are then collated to provide an average formative evaluation of the participation in each ePlay MakerSpace session. This is achieved by analysing the individual teachers' results on the G/Sheet of each ePlay MakerSpace, and establishing an average for each session. These averages are then used as the 'Evaluation of Participants in general' for each of the iterations.

## 3.3 Data analysis

DBR provides the context to develop theoretical categories and frameworks (DiSessa and Cobb, 2004), and relies on systematic evaluation and analysis of the research problem, the design of the intervention and the methodologies and design procedures to develop warranted theory. While DBR characteristically sees a close collaboration between the researcher-designer and participants / practitioners, this collaboration needs to be suspended in order for the research-designer to generate knowledge that is neutral and objective (Pedgley, 2007) and open to validation (Sloane, 2006, p. 21). Additionally the suspension of the design-epistemology needs to occur, which Bourdieu (1984, 1991, 2000; 1992) describes as an epistemic break in analysis, where the primary vision of the participants and designer-researcher as participant (in the objectification phase) makes way for the work of the analyst. He states:

*“Since one cannot be content either with the primary vision or with the vision to which the work of objectification gives access, one can only strive to **hold together**,*

*so as to integrate them, both the point of view of the agents who are caught up in the object and the point of view on this point of view which the work of analysis enables one to reach by relating position-takings to the positions from which they are taken.”* (Bourdieu, 2000, p. 189 emphasis in the original)

Following the design, enactment and evaluation phase, it is consequently necessary to employ an epistemic break and employ a structured analytical process associated with the critical, socio-cultural epistemology, in order to objectify the conceptions and processes of the object of research. The epistemic break requires dual processes. Firstly, the researcher needs to integrate the primary vision of participants and an objective, analytic bird’s eye-view or “*quasi-divine viewpoint*” (Bourdieu and Wacquant, 1992, p. 254) perspective. Secondly, the researcher needs to embody the impersonality of the analysis procedures, devoid of their own biases, assumptions and personal beliefs which may be achieved through reflexivity.

A bird’s eye-view position requires the analyst to take an objective position and view the data from interviews, participants created artifacts, reflections and formative evaluations, from an objective distance. Such an analysis reflects on the field, the objective relations between participants, their position takings within the field and the rules that govern these position-taking in order for the analysis to unveil reality hidden in interaction and shaped by objective relations. The analysis further reflects on the intervention, the enactment of the intervention and design procedure. As such, a bird’s eye-view analysis works to avoid the danger of merely restating in different words what the participants have already expressed, or to express meanings that participants could themselves have identified as products of conscious intention (Bourdieu and Wacquant, 1992).

A bird’s eye-view perspective is only one part of this analysis though, and Bourdieu urges researchers not to “*stop short at the objectivist phase and the partial view of the ‘half-learned’ who ... fail to bring into their analysis the primary vision*” (Bourdieu, 2000, p. 189). Instead, as he frequently argues, the perspective of participants is an essential element of the analysis and cannot be discarded to “*defend the monopoly*” of scientific understanding

(Bourdieu, 2000, p. 189). It is therefore essential to include participants' primary vision perspectives. The primary vision is assumed to be subjective and, as very often happens, paints the participant in the best possible light as they are under pressure to reduce the risk of public humiliation in the face of failure (Bourdieu, 1990).

Taking participants' primary vision reflections at face-value and building theory around such realities, potentially restricts the validity of the research outcomes. Bourdieu however argues that it is essential to bring this primary vision into the analysis and acknowledge this "*common knowledge ... as an object to be understood*" (Bourdieu, 2000, p. 189). Therefore, the researcher-analyst needs to integrate the efforts of participants as they construct their subjective representations of themselves and their experiences in the intervention, and the analysis using the analytic bird's eye-view perspective (Bourdieu, 2000), coinciding with DBR's emphasis on collaborating with the participant albeit with their subjectivities. This is not to say that a casual 'accept-whatever-comes' approach is appropriate. Such a hippy-approach to research would have disastrous effects on the validity of the work. Instead, every effort should be made to (gently) guide participants towards a more objective view, one that is less subjective, yet careful to avoid incurring the resistance to scientific objectification that may ensue (Bourdieu, 2000).

The analytic process for DBR requires strategic and considered analysis of participants' primary vision and the bird's eye-view position of the researcher. Gravemeijer and Cobb (2006) suggest the use of retrospective and systematic analysis of the entire data set. Concurring, McKenney, Nieveen and van den Akker (2006) add that a longitudinal analysis can make claims of credibility, validity and trustworthiness if all phases of the analysis process are rigorously and thoroughly recorded and documented, including the refinement of conjectures and inferences. However, potential challenges are inherent within a retrospective analysis. Although a retrospective analysis ideally strives to account for all conjectures, implicit decisions and assumption-driven choices, given the magnitude of the data set, this may be a complex undertaking that may not adequately and comprehensively account for all changing conditions, contexts or participants' experiences throughout the course of the project. More pertinently, the volume of data to analyse may limit the

description of the evolution of design principles and the impact this has on the refinement and redesign of each iteration.

Various solutions are used to overcome challenges to the retrospective analysis. Parallel analysis offers an alternate means with which to arrive at theoretical design principles and is employed after each iteration. Using parallel analysis, each iterative cycle and formative evaluated findings are analysed to refine and elaborate DPs, and to inform the redesign of subsequent iterations. This allows the researcher to map changing contexts or participants' roles, skills and experiences, account for ways in which implementation problems were addressed, and include changing decisions regarding the design of the intervention itself. Other researchers can then theoretically follow the process from theoretical design principles, through analysis and evaluation, to the primary evidence in the form of recordings, documents or artifacts. In addition to parallel analysis, the retrospective analysis of the entire data set is improved through the use of analytic tools and an analytic frame. The data analysis package, Nvivo11, is used to strengthen the retrospective analysis of the entire digital data set. Additionally, an analytic frame is developed to refine the retrospective analysis.

The analytic frame for the study is informed by Edelson's (2002, 2006) contention that the outcome of DBR should be domain theory, design frameworks and design methodologies. Hence, the analytic frame is conceptualised as developing theory through the analysis of the research problem to understand how transforming teachers' dispositions may lead to changed practice; analysis of the ePlay MakerSpace inculcation process and enabling conditions for the transformation of teachers' dispositions; and analysis of the design methodologies for the enactment of the research process.

### **3.3.1 Problem analysis to develop teacher change theory**

Having paired the DBR approach with Bourdieu's (1986, 1990, 2000) theory of practice, his guiding principles for research inform the problem analysis. Bourdieu's research process consists of a) constructing the research object, b) analysing the field in which the object is

situated, and c) employing reflexivity towards participant objectivation (Bourdieu and Wacquant, 1992). This process integrates the primary vision of participants and the bird's eye-view/quasi-divine viewpoint of the researcher. These research principles frame the problem analysis to understand how teachers dispositions potentially changed as an outcome of the inculcation processes and enabling conditions of the ePlay MakerSpace, and how this was translated to changes enacted after the sessions. Bourdieu's research principles frame the problem analysis as follows:

- a) Analysing the position of the field vis-à-vis the field of power (Bourdieu and Wacquant, 1992), by analysing the context of the problem in relation to the greater field of power in which it is situated.
- b) Mapping the objective structures of the relations between positions within the field and the position-takings (Bourdieu and Wacquant, 1992), mapping how participants operate within the constraints and structures of the institution, and how their actions impact the structures of the institution.
- c) Analysing the individual and collective habitus of those participating in the field and their change journeys as a habitus-level analysis aimed at understanding the choices and decisions individual teachers make regarding their personal learning, regarding for instance their movement on the TCF.

The problem analysis develops theory regarding teaching change and is informed by the formative evaluation framework, participant artifacts, reflections and interviews.

### **3.3.2 Analysis of the ePlay MakerSpace**

The design of an intervention or solution, such as the ePlay MakerSpace inculcation processes and enabling conditions, integrates a range of design elements and balances trade-offs to meet the design goals and needs (Edelson, 2002, 2006). The designer-researcher makes various decisions in the course of reaching a design solution, many of these being intuitive, based on tacit knowledge or experience, and difficult to quantify or even describe. These decisions however, have to be accounted for in order to develop

warranted theory, which van den Akker (1999) terms substantive design principles and Edelson (2006; 2002) terms design frameworks. Design frameworks need to reflect essential characteristics of an intervention (van den Akker, 1999, p. 9) and describe the characteristics that subsequent designs of the solutions should have in order to address particular needs in specific contexts. In this way substantive design principles can take the form of a prescriptive design framework (Edelson, 2002, 2006) as a collection of coherent design guidelines for a particular class of design challenges.

In order to develop the design framework for the ePlay MakerSpace, Pedgley's (2007) macro- and microscopic analysis is used to provide a comprehensive understanding of design decisions within the design process. Microscopic analysis concerns the structure of the decision-making process, the reasoning and modelling that was employed, and is conducted as part of the formative evaluation after each of the ePlay MakerSpace iterations. Macroscopic analysis takes a broader view across the different phases of the project, to identify opportunities or constraints across the project. The outcome of the macroscopic analysis is a prescriptive design framework for future designs of the ePlay MakerSpace.

### **3.3.3 Analysis of the research process and methodology**

The analysis process should also develop design methodologies (Edelson, 2002, 2006) by analysing the research and design process and methodology. Analysing the design process is typically a complex undertaking, made all the more difficult when the researcher-analyst is also the designer. Edelson (2002, 2006) notes this complexity may stem from the open-endedness and reliance on creativity in the design process, making it especially challenging to characterise and explain. Similarly, Pedgley (2007) notes that the transient nature of the design activity makes it difficult to account for each decision and step, and increases the difficulty of analysis. Analysing the design process is further complicated by the designer's back-and-forth use of processes of divergence and convergence.

The analytic frame developed is employed for parallel analysis and reported in the formative evaluation of each iteration in Chapters 4 and 5, while Chapter 6 reports the retrospective analysis. The quality and validity of theories developed from the analysis processes depend on the quality of data produced. Measures to improve the quality of data and analysis are developed in the next section.

## 3.4 Quality of the Research

This study aims to iteratively develop, enact and refine the ePlay MakerSpace model to understand how the transformation of teachers' dispositions may impact their transformative integration of ETs. In conducting the research, I fulfil different roles, being insider-outsider, researcher-designer/designer-researcher, participant-observer and advocate-jury, in various degrees and often simultaneously. In light of these often contradictory roles, as design-based researcher, it is important to guard academic rigour in order to produce high quality, objective and credible theory, while balancing "*boldness and caution in a different way*" (Walker, 2006, p. 13), and navigating the many ambiguities and unknowns within natural test-bed conditions.

In order for DBR to effectively contribute to the development of policies, programmes and changed practice, it needs to produce valid, legitimate results. Maxwell (1992) argues that research should be driven by the need to gain ***understanding***, and different types of validity are derivatives of different kinds of understandings gained from inquiry (Maxwell, 1992). To this end, the "*grounds for validating the trustworthiness of observations, interpretations and generalizations*" (Maxwell, 1992, p. 280) are explicitly and deliberately foregrounded, using Maxwell's (1992) typology, to guide and structure processes and outcomes, and avoid threats that may undermine the quality and validity of findings.

### 3.4.1 Descriptive validity

A primary aspect of validity is the factual accuracy with which data is collected, reported and accounted for. Since cultural forms find articulation in and through social action, social-

science researchers report and describe social action, behaviours and verbal and non-verbal interactions (Maxwell, 1992). Such reporting and description requires standard measures or instruments with which to conduct evaluations and collect or formulate descriptions to enhance the reliability of the research findings (Design-Based Research Collective, 2003).

In this study, descriptive validity is achieved by accurately reporting data derived from interviews, questionnaires, participants created artifacts and reflections, and using standardised formative evaluation measures. To increase inter-subjective agreement, where possible, interactions and behaviours are documented in photos and/or voice recordings. Recorded interviews are transcribed using standardised transcription symbols and cross-checked to ensure accuracy. After each session, photographs are uploaded to a secure drive and renamed using participants' codes, while deleting photos containing the faces of those who did not provide permission. Teachers are also repeatedly given opportunities to refine and/or edit their created artifacts or reflections. Participants' created artifacts, especially those shared from their Google Drives, are copied to my drive (so as not to lose access should they inadvertently delete these for example) and anonymised using teachers' codes. Unless specifically indicated, no changes other than the grey text boxes with participants codes, are made to their created artifacts to ensure descriptive validity.

Descriptive validity also needs to be achieved in documenting the design process in order to provide critical evidence that may establish warrants for claims (Design-Based Research Collective, 2003). Systematic, thorough and transparent methods are chosen to document the process of design from thought-experiment to enactment and formative evaluation. Thought-experiments and ideas are thus captured and recorded in my design diary and on my phone using voice notes and my G/Drive. I also developed the habit of reading or writing difficult or challenging sections before going to bed at night, and deliberately concentrating on the particular challenge in the moments before falling asleep. Hours later I would wake and a crystallised understanding or deeply creative thought would have formed in my subconscious, which I immediately record for further interrogation.

Descriptive validity also needed to be achieved in the results obtained from the educators' self-reported data. Self-reported data is generally viewed with some suspicion, since this type of data is notoriously biased and aimed at 'painting the respondent in the best possible light'. It is frequently assumed that accepting such reports on face-value prejudices the data as being not-trustworthy or empirically flawed. In contrast, Csikszentmihalyi (1996, 1997) using Habermas (1973a, 1973b) argues that we are all prejudiced, whether as researchers or practitioners, and while this cannot be avoided, bringing scientific scepticism and reflection to the interpretation of data potentially erodes the effects of this prejudice on the reliability of findings. Moreover, Bourdieu (1984, 1991, 2000; 1992) insists in including the primary vision of the practitioner/participant and the designer-researcher to gain access to the work of objectification. However, as discussed, the epistemic break is employed to interrogate and analyse these findings, and the triangulation of multiple data sources (Design-Based Research Collective, 2003) to increase descriptive validity and develop interpretive and theoretical validity.

### 3.4.2 Interpretive validity

A researcher participating in design-based research looks at the constructed objects through socially constructed dispositions, produced and reproduced as part of their researcher habitus. Additionally, the design-based researcher fulfils simultaneous, often contradictory roles, requiring different dispositions at different times. In order to achieve interpretive validity, the researcher needs to suspend research dispositions towards searching for the meanings and understandings of those participating in the research endeavour. However, this may be more easily said than done since dispositions function below consciousness or thought, and are difficult to articulate or identify. Reflexivity (Bourdieu and Wacquant, 1992) is suggested as a tool to achieve this.

Different socially constructed dispositions construct the object of research in a certain light and predisposes the researcher to see it in certain ways and not others. Through critical reflexivity the researcher confronts their own underlying perceptions and assumptions and to bring to light their "*presuppositions tacitly engaged in the view of the world*" (Bourdieu,

2000, p. 221). This informs a critical analysis of possible dispositions that may create such perceptions, beliefs and practices. As an additional reflexive tool, the researcher systematic and deliberate charts each step during interpretation, recording the many themes, frames and codes that may emerge in the analysis phase to provide evidence of their thought processes for further reflexion.

Reflexivity and systematic charting of interpretation guides the collection, interpretation and analysis of data. Using reflexivity, I reflected on my past role as primary and high school teacher and emerging technology enthusiast, as well as lecturer of pre-service teachers and higher education lecturers, an insider in education. However, from the perspective of teachers participating in the ePlay MakerSpaces, I remain an outsider until my credibility is established and a trusting relationship developed. I also reflected on my gender – a woman working with women and men in a traditionally patriarchal context in which male-ness is often associated with power and influence, and female-ness with subservience and powerless-ness. My role as researcher from a well-known university, and when interviewing teachers, as representative of the Cape Teaching and Leadership Institute of the Western Cape Education Department, may reduce traditional patriarchal power-differentials. Also, although I speak English and Afrikaans, I am not fluent in isiXhosa, the home language of many teachers from disadvantaged schools. Hence, I reflected my own assumptions regarding language and ETs, how ETs are generally shaped by normative English discourses and how difficult it would be for isiXhosa teachers to access terms or conditions I take for granted.

During analysis, I deliberately set aside the designer-epistemology and take on the critical, socio-cultural epistemology. The different epistemology enables a bird's eye-view perspective in order to discern patterns and understand relationships from the data – towards achieving theoretical validity. Coding themes emerged from this, which were used in the data analysis programme, Nvivo11, to add another layer of analysis of the data.

Triangulation of multiple and different data sources offers a further means to achieve interpretive validity. As is frequently the case in DBR, large quantities of information rich,

salient and meaningful data is generated, and may lead to what van den Akker (1999, p. 11) terms an “*overdose of uncertainty in interpretation*”. Triangulation of methods and instruments, sources and sites offers a means with which to overcome this (van den Akker, 1999). Repeated examination and scrupulous interrogation of data (Design-Based Research Collective, 2003) further enhances interpretive validity.

### 3.4.3 Theoretical validity

A theoretical understanding of data moves beyond a concrete description and interpretation of physical and mental phenomena, and explicitly constructs theoretical abstraction as an outcome of the study (Maxwell, 1992). Theory in this sense refers either to physical events or mental constructs (Maxwell, 1992). Theoretical validity therefore moves beyond descriptive and interpretive validity, towards an *explanation* of the phenomena.

Theory, Maxwell (1992) argues, should address two components: concepts and/or categories employed by the theory, and relationships that may exist, or development among these concepts. Thus, concepts need to be valid as well as the postulated relationships between concepts. Theoretical validity relating to these concepts includes: *content validity*, the extent to which the design is based on state-of-the-art knowledge, and *construct validity*, how consistently the various design components are linked to each other (van den Akker, 1999, p. 10). Relating to relationships, content and construct validity parallels internal or causal validity (Maxwell, 1992). Theoretical validity can also be increased by considering alternative explanations and/or understandings of the phenomena under consideration and by incorporating emerging relationships between concepts (Maxwell, 1992).

Content and construct validity in this study is achieved through the deliberate and systematic development of the analytic frame in this chapter, and applying this to the retrospective analysis process of the study. Bourdieu’s (1986, 1990, 2000) thinking tools of habitus, field and capital, guides the analysis of the context and participation, while Pedgley’s (2007) Micro- and Macro-analysis and reflective frame guides the analysis of the

design and implementation. Findings are cross-referenced with the findings from previous studies as discussed in the literature review, considering various alternate theories and frameworks to the different aspects of the study. These discussions and cross-referencing elicits alternate explanations and understandings which are incorporated in the theory building. In developing the evaluation framework, specific emphasis was also placed on construct and content validity to develop internal consistency and interpretive validity, that informs the theoretical validity gained through the analysis process and limit threats to these.

Maxwell's (1992) typology identifies potential threats to the nature of theoretical, descriptive and interpretive validity in order to reduce or avoid these. This in turn increases internal consistency between the arguments put forward in this study, towards developing well-supported, warranted theory based on scrupulous readings, description and interpretation of data, and abstraction towards theory building.

### **3.5 Ethics**

The University of Cape Town granted ethical clearance to conduct this study. In all sessions educators were informed of the research outcomes and their consent was sought in writing. Consent was given to voice record and photograph sessions, and use artifacts produced during the session in the research. Codes were used throughout the study to de-identify participants' names and institutions, as well as geographic locations.

### **3.6 In summary**

This DBR study seeks to understand how the transformation of teachers' dispositions may impact their transformative integration of ETs. The ePlay MakerSpace model was conceptualised as inculcation processes and enabling conditions to transform teachers' disposition and impact the transformative integration of ETs and capacitate teachers to effect change to their teaching and learning practices. This chapter has developed the DBR Methodology that guides the research, decisions and choices for the study. Data is

generated at different points in the research process through interviews, participants' created artifacts and reflections, and formative evaluation. An analytic frame was developed to systematically analyse the data produced and the design process in order to develop valid, legitimate knowledge claims relating to the research problem and teacher change theory, the ePlay MakerSpace inculcation processes and enabling conditions, and the design methodology. The DBR methodology and research instruments developed herein are consequently used to design, enact and formatively evaluate two iterations of the ePlay MakerSpace model.

# Global design principles

## GDPs

GDP1) The ePlay MakerSpace inculcation processes and enabling conditions transform disposition by capacitating teachers to create and innovate with emerging technologies.

GDP2) The ePlay MakerSpace inculcation processes and enabling conditions transforms disposition leading to the restructuring of beliefs, practices and perceptions since the dispositions that formed these are transformed.

GDP3) The ePlay MakerSpace creates the enabling conditions to support teachers' entry into the liminal zone to transform teachers' dispositions.

GDP4) The ePlay MakerSpace creates and nurtures autonomous and autotelic ePlay.

GDP5) The ePlay MakerSpace process is inclusive. Players in the ePlay MakerSpace come from diverse contexts and range in skill, competencies and the command of different kinds of knowledge.

GDP6) The ePlay MakerSpace process models sophisticated applications and pedagogical possibilities of the transformative integration of emerging technologies that are chosen to be immediately applicable and relevant to teachers' unique needs.

GDP7) The ePlay MakerSpace process provides opportunities for reflective learning.

GDP8) The ePlay MakerSpace process provides opportunities for professional learning.

GDP9) The ePlay MakerSpace process provides opportunities for active learning.

GDP10) The ePlay MakerSpace process provides opportunities for relational learning.

GDP11) The ePlay MakerSpace process provides opportunities for transformational learning.

Figure 7 Global Design Principles (GDPs)

# Chapter 4 ePlay MakerSpace Iteration 1

This chapter reports on Iteration 1 of the ePlay MakerSpace with Intermediate Phase (IP) Language teachers. Informed by the theoretical and conceptual frames developing in Chapter 1, and the literature review in Chapter 2, the ePlay MakerSpace model was conceptualised as providing the inculcation processes and enabling conditions to transform teachers' dispositions through the transformative integration of emerging technologies (ETs). Global design principles (GDPs) for the ePlay MakerSpace were identified at the end of Chapter 2 (see **Error! Reference source not found.** for ease of reference), and inform the design of the IP Language ePlay MakerSpace.

The structure of the chapter reflects the characteristic iterative DBR cycle (Cobb *et al.*, 2003; Reeves, 2006; Herrington *et al.*, 2007). Hence, the first section reports on the problem identification and design of the ePlay MakerSpace for IP Language teachers, section two on the enactment and section three on the formative evaluation. Section 4 uses parallel analysis to formatively evaluate how the GDPs were enacted, and refine and/or elaborate the GDPs to create first-generation design principles (1gDPs) that inform the design of the Foundation Phase ePlay MakerSpace reported in Chapter 5.

Artifacts created for and in the IP Language ePlay MakerSpace, as well as the results of reflections, formative evaluations and the analysis of the session is included in the website, W2: Intermediate Phase Language.

## 4.1 Problem identification and design of ePlay MakerSpace Iteration 1

The IP Language ePlay MakerSpace was designed, developed and refined over the course of several months, and involved multiple role-players before the session took place in June 2016. This section provides an overview of the problem definition, design and development of the IP Language *course* framework, the manual and the design for the IP Language ePlay

MakerSpace. Officially the Cape Teaching and Leadership Institute (CTLI) referred to the ePlay MakerSpace sessions as *ICT Integration courses*. Whenever referring to the *ICT Integration courses*, this is acknowledged by placing the text in italics to indicate that this meaning differs from the meaning theoretically and conceptually developed in this thesis.

#### 4.1.1 Problem identification

The IP Language ePlay MakerSpace session was developed in response to the need expressed by the CTLI for an *ICT Integration course* for IP Language teachers. In order to identify and clarify the problem the *course* had to address, a reference group was formed consisting of two IP Language subject advisers, three Higher Education lecturers for IP Language method courses to preservice teaching students, the CTLI's ICT Integration manager, and the researcher. The meeting took place on the 6<sup>th</sup> April 2016.

The global problem for the *IP Language ICT integration course* was vaguely defined in a draft *course framework* that represented a global prototype solution. Prepared by the office of ICT Integration, the draft framework represented the global, ill-defined problem and possible prototype solution as the possible purpose, outcomes and content. These items were discussed at length in the first reference group meeting, which was treated in view of this study, as an unstructured interview. The unstructured interview format was used to identify the reference group's needs and requirements (Desimone, 2009, 2011, Parsons *et al.*, 2013, 2016; Twining *et al.*, 2013; Tondeur, van Braak, *et al.*, 2016) regarding the IP Language *ICT Integration Course*, to establish shared goals and to develop a shared meaning of 'integration', in order to clarify the problem the design had to address. As can be seen from the typed and hand-written textual elements in the prototype framework, some points were accepted without change, while others were removed or edited. An extract of this framework is available in Figure 8 with the revised framework available on the website: W2.1.

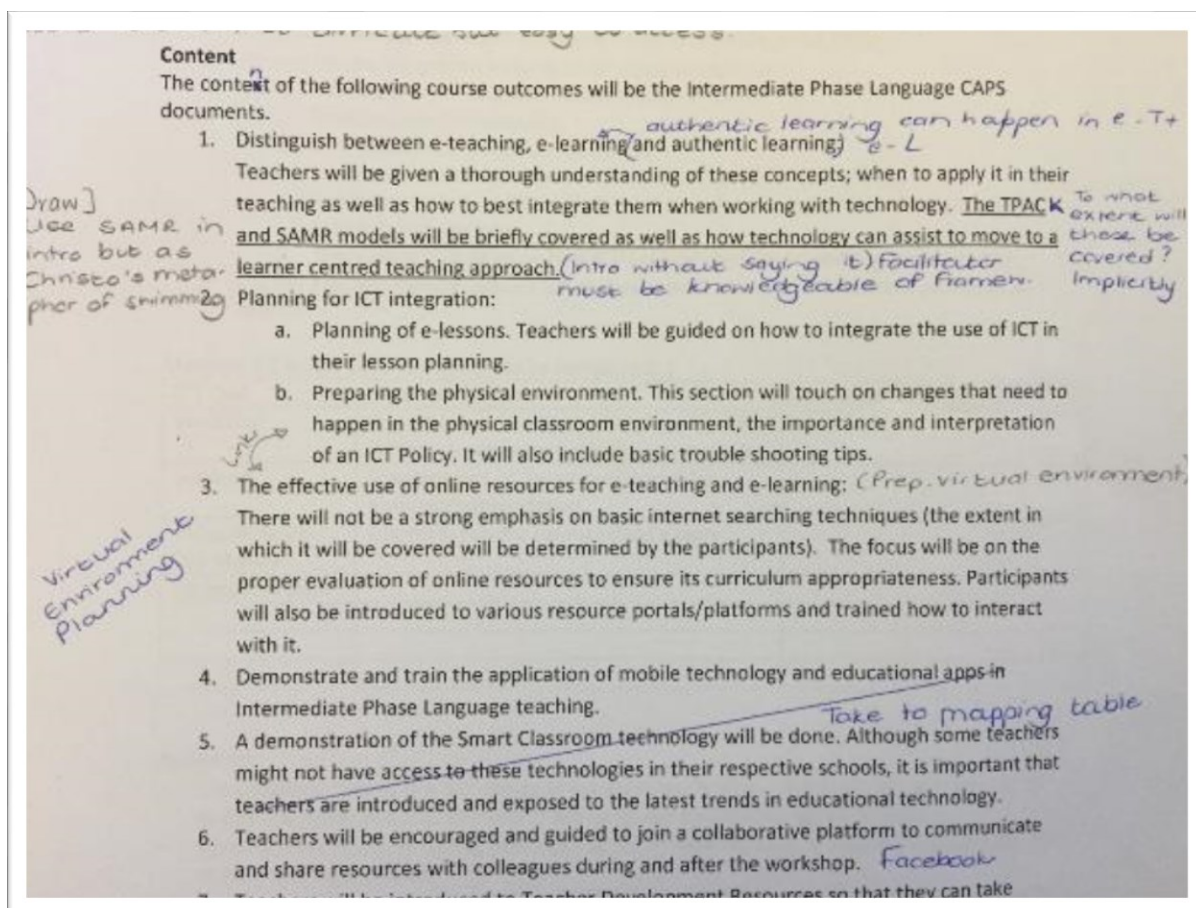


Figure 8 An extract of the draft framework for the IP Language ICT Integration course

In order to clarify the problem, the reference group needed to develop a shared meaning of ET integration to inform the goals for teacher professional development for ET integration (TPD4ETs). Creating shared meaning within a reference group increases the effectiveness of the collaborative process (Fullan, 1995; Hargreaves *et al.*, 2001). Some group members and the authors of the draft framework, associated *ICT integration* with different levels of tool use, and thus understood the prototype solution as related to competency-based TPD4ETs and technical skills training, as point 3: “*The effective use of online resources...*” illustrates. Others insisted TPD4ETs should not focus on tools but on improving learning, emphasizing the need for pedagogic knowledge informed by a knowledge-based approach to *ICT Integration*. The emphasis was consequently change in the *course framework* to capacitate teachers to effectively use online resources for eTeaching, eLearning and eAssessment of IP Language specific outcomes relating to ‘*Writing and Reading for comprehension and inference*’. This clarified the design problem.

The reference group also refined the prototype solution as different types of activities and learning to be included in the *ICT Integration Course*. The prototype solution suggested by the draft framework emphasized the need for ‘*practical and hands-on*’ experiences and as points 3, 4 and 5 demonstrate, emphasizing capacities to use tools and associated technical skills training. Instead, the reference group, informed by a knowledge-based approach to TPD4ETs, saw the *ICT Integration course* as vehicle develop teachers’ pedagogical and content knowledge relating to transactional, descriptive and narrative writing, as well as technological knowledge needed to teach these areas using ETs. Recognising the usefulness of the TPACK framework (Mishra and Koehler, 2006), and the SAMR model (Puentedura, 2012, 2013a; Glover *et al.*, 2016) it was decided that these approaches would inform the design but not be explicitly included in the professional learning sections.

The [second draft of the IP Language course framework](#) (link embedded) was subsequently prepared drawing on the points raised, and shared with the reference group. There were no further amendments and the framework was accepted, constituting the clarified problem and potential design solution.

#### 4.1.2 Developing the course manual

The second draft of the IP Language *course* framework and the GDPs (see **Error! Reference source not found.**) guided the iterative design, development and refinement of the *ICT integration course* manual. The reference group suggested that the manual be developed as a work/textbook in which teachers could take notes and complete ‘worksheet’ type activities. Additionally, the office of ICT Integration at the CTLI requested adherence to departmental guidelines to focus on eTeaching, eLearning and eAssessment for lesson plans.

The manual consists of seven modules. Modules broadly relate to GDP8) professional learning that develops knowledge relating to *ICT Integration*, and GDP9) active learning capacitating teachers to create and innovate with ET tools, supported by step-by-step instructions. GDP7) Reflective learning is encouraged throughout the manual with the

inclusion of textboxes encouraging teachers to pause and reflect on a tool's pedagogic possibilities, or pedagogical questions raised in a session. Modules 2, 4 and 6 developed technological, pedagogical and content knowledge as relates to descriptive, transactional and narrative writing. Module 3 develops teachers' capacity to create lesson plans that transformative integrates ETs and Module 5 supports active learning as teachers engage with various online assessment tools. Module 7 concerns GDP11) transformational learning to equip teachers to plan and manage change within their local contexts after the conclusion of the contact sessions.

The manual was designed and formatted to support IP Language CAPS requirements and model the transformative integration of ETs. The activities included in the manual were designed to model a genre-based approach to writing development as suggested by CAPS. Following CAPS guidelines, the genre-based approach follows a blend of descriptive and rhetorical pedagogies to teach language in context and develop a systematic framework, shared meaning of language styles and conventions, and genre types. Activities were therefore designed to model shared and individual listening and speaking, reading and viewing and recursive writing of transactional and descriptive text types as evident in Modules 2, 4 and 6. Since CAPS requires formative and summative assessment, and requests from the office of ICT Integration, eAssessment was designed to take place online for each genre type. This is included as a stand-alone module in keeping with the reference group's suggestion. However, in the ePlay MakerSpace, the eAssessment was included after both the transactional and descriptive writing activities. The completed manual is available on the website: W2.1.

### **4.1.3 Designing Iteration 2**

Informed by the problem defined by the *course* framework, and the global design principles (see Figure 17), Iteration 1 of the ePlay MakerSpace for IP Language teachers was designed. The programme for the three days of the *IP Language ICT Integration course* (included on W2.1) was designed in collaboration with the office for ICT Integration and included:

- Day 1: 21<sup>st</sup> century skills, descriptive writing development and eAssessment;
- Day 2: principles of ET integration, planning to transformatively integrate ETs, preparing the physical and virtual environments for integration and transactional writing and eAssessment; and
- Day 3: eAssessment on Day 3 using Google forms (G/Forms) and potentially including narrative writing, transformational learning and planning change.

The inculcation processes and enabling conditions to transform teachers' dispositions were designed to include the five learning processes, to inculcate dispositions of creativity and innovation, and enable risk-taking and experimentation. The design process is recorded on the website: 2.1 as handwritten notes ([Planning notes for ePlay MakerSpace IP Language session](#) – link embedded) indicating the focus areas for each session, highlight important areas, and the enactment. To avoid duplication, the design of the inculcation processes and enabling conditions is included in the 4.2) Enactment of Iteration 2.

The design process also included the evaluation and choice of tools to include in the IP Language ePlay MakerSpace. Guided by the GDPs and the need for teachers from disadvantaged schools to access tools to create and innovate, tools were chosen to be free, share-able and accessible by novice and experienced users, and also to be functionally accessible on most devices (desktops, laptops, tablet computers<sup>1</sup> or internet-enabled mobile phones). More specifically, the tools chosen needed to enable IP Language teachers to create and innovate pedagogic solutions for immediately implementation within their disadvantaged language classrooms. The tools chosen for the IP Language ePlay MakerSpace were consequently:

- ◆ Edmodo as an online platform to foster collaboration;
- ◆ YouTube videos;

---

<sup>1</sup> Tablet computers is henceforth referred to as tablets

- ◆ Google suite apps (abbreviated G/): G/Drive, G/Docs, G/Forms, G/Sheets and G/Slides;
- ◆ Mindmup.com to create mind-maps; and
- ◆ As extension: Piktochart.com and Canva.com, Kahoot! and Quizlet, and voki.com.
- ◆ Bonus feature: all these tools were saveable to teachers' G/Drives.

Having chosen the tools, and designed the IP Language ePlay MakerSpace, a G/Slide presentation was prepared: [ICT Integration IP Language](#) (link embedded and available on W2.1). Modelling transformative ET Integration, the G/Slide presentation was intentionally designed to include images and questions to encourage discussion among teachers, critical thinking and reflection (all images included were labelled for non-commercial reuse or used with permission). Teachers could respond to questions that arose in the group on Edmodo, which in turn modelled the use of back-channelling and how the online tool could be used to support critical thinking, collaboration and communication. Additionally, the video links for the descriptive writing activity and adverts for transactional writing were inserted in the slides to model how such links could be embedded.

## 4.2 Enactment of Iteration 2

The learning design for the IP Language ePlay MakerSpace was enacted at the CTLI from 27 – 29 June 2016 with 26 IP Language teachers from disadvantaged primary schools in the Western Cape province. The office of ICT Integration identified schools, based on their status in the eLearning Game Changer programme, and sent invitations to teachers at these schools to attend the *ICT Integration IP Language Pilot Course*. The schools were all disadvantaged, and were earmarked for the provision of ET tools and internet connectivity between 2016-2018. As a key feature of effective TPD, collective participation (Garet *et al.*, 2001; Penuel *et al.*, 2007; Desimone, 2009, 2011) was encouraged, and the office of ICT Integration requested that principals send groups of teachers and specifically their IP Language Head of Department to foster continued change at the school. Other teachers also heard about the *course* and requested to attend. Thus, in some instances up to five teachers

from one school attended, while individual teachers from schools with no access to devices or connectivity (except their personal devices) attended.

### 4.2.1 Challenges in the ePlay MakerSpace venue

The IP Language ePlay MakerSpace enactment took place in the Sport School adjacent to the CTLI, as the intended CTLI computer lab became unavailable at the last minute. Prior to our arrival on the Monday morning, the Sport School teachers had been working into the early hours of the night to finalize their end-of-term reports. Unfortunately, the maintenance officer only arrived at 07:50 to open the computer lab, leaving limited time to prepare the venue before starting at 08:00.

As indicated in GDPs 1-6, the intent of the ePlay MakerSpace is to create a calm, relaxed environment in which teachers can create and ePlay, and escape from everyday pressures. Contrary to this, upon entry, the venue provided numerous reminders of the pressures and stressors teachers had themselves faced as they prepared their end-of-term reports. Papers, pens, exam papers and such were scattered across the desks. In addition, not all the computers would switch on, and the presenter projector's connection to the VGA cable was so badly damaged that the live cables were exposed and required delicate 'wiggling' to get the image to appear on the screen. Moreover, when we arrived none of the computers would link to the internet or had Chrome installed, which are standard features of the computers in the CTLI Labs. Since the session was designed to make use of online tools and specifically included G/Chrome, this posed a significant challenge. To make matters worse, since the venue was changed, teachers could not initially find the computer lab and arrived throughout the first two hours, exasperated and dripping from the early morning rain.

Managing the initial challenges required many on-the-spot changes. While ICT Integration manager, Mr D, welcomed teachers, and introduced the strategic goals of the eLearning Game Changer, I went around the room attempting to restart the computers that would not initially switch on or come online. When Mr D had finished, I conducted the concept mapping session following the timed format described in Chapter 3. The concept mapping

activity was designed as a paper-based activity, which provided Mr D time to contact technicians and attend to the internet connectivity challenge. Once the concept mapping was completed, the computers were mostly all online and connected to the internet. Thereafter, we assisted teachers to download and install Chrome on their computers, which foregrounded a further challenge: when more than eight/nine teachers started downloading, the internet speed drastically reduced to a trickle leaving teachers with no internet at all. Teachers therefore took turns to download and install Chrome. During this time, I made the pedagogic decision to present the session on networking and sharing as 21<sup>st</sup> century teachers in a more eTeaching / lecture-type activity in order to provide enough time for individual teachers to download and install Chrome.

In the session after tea on day 1, although the internet intermittently dropped-out throughout the day, teachers started to engage in transformative ET integration and used online tools to create and innovate. Hence the design of inculcation processes according to GDPs 6-11 could be enacted.

Correlating to findings in literature (Bladergroen *et al.*, 2012; Spaul, 2013; Tarling and Ng'ambi, 2016), the IP Language teachers favoured teacher-centric, didactic approaches to teaching. During a whole-group discussion on Day 1, the IP Language teachers indicated that they had only experienced teacher-centric pedagogies in their own schooling, and when teaching, mostly taught using such pedagogies. This confirmed the need for the ePlay MakerSpace as means to transform teachers' dispositions (Bourdieu and Passeron, 1977; Bourdieu, 1990) from conformity and reproduction of teacher-centric pedagogies, to creativity and innovation to embody transformative ET integration and accompanying transformative pedagogies.

In adherence to the GDPs, the design and enactment of the IP Language ePlay Makerspace employed processes of inculcation and created the enabling conditions to transform teachers' dispositions. The ePlay MakerSpace environment was designed in accordance with GDPs 1 - 6, as an autotelic, authentic and autonomous, safe and nurturing space in which teachers were encouraged to take risks, experiment and discover without the fear of failure.

Laughter and humour were frequently used and heard in the sessions, while every effort was made to include all participants regardless of the barriers they experienced. The sessions modelled transformative ET integration and sophisticated applications of ETs to provide teachers with an alternative experience of teaching and learning. In accordance with the GDPs 7 - 11, different learning processes were included to inculcate through conscious awakening, pedagogic work and transmission through active practice, dispositions to create and innovate, to experiment and take risks. The enactment of the different learning process is henceforth discussed, although not in the same order as presented in the GDPs.

### 4.2.2 GDP9) Active learning

The IP Language ePlay MakerSpace created opportunities for teachers to create in a playful and active manner. Teachers created concept maps, G/Slide presentations and Mindmups, as well as G/Forms with accompanying G/Sheets where the results from the G/Forms were recorded and analysed. These tools were included following Reid and Wood's (2016) suggestion to provide teachers with a space in which to try out, try on and play with practices, beliefs, perceptions and pedagogies in a safe and nurturing environment.

Teachers engaged in active learning to create pedagogic and eAssessment tools that address CAPS requirements. The CAPS focus ensured that the learning had immediate relevance and was practically appropriate within different contexts. Following the reference group's suggestion, a descriptive writing task (see Module 2 in the manual) was modelled using the writing process of prewriting, drafting, revising, proofreading and publishing (required by CAPS). A folklore/folktale was chosen as required by CAPS across IP home or additional language teaching. The pedagogic steps such an activity would follow in real-world contexts were modelled:

- ◆ Shared prewriting for viewing and responding: watch the video, [Anansi and the Sky Kingdom](#) (link embedded), whole group discussion of the story;

- ◆ **Paired prewriting:** teachers identify a character from the story, list descriptive words for it and create a mind-map of these using mindmup.com.
- ◆ **Peer-feedback:** Mind-maps are posted to Edmodo and peers provide feedback.
- ◆ **Shared writing:** In the whole group, using a mind-map of Anansi the spider, model shared-writing of a descriptive paragraph in G/Docs.
- ◆ **Individual writing:** Teachers chose a mind-map from Edmodo and wrote a descriptive paragraph in G/Docs using the character and descriptive words in the mind-map.
- ◆ **Peer-feedback:** Teachers share their G/Docs links with the mind-map author on Edmodo and give each other feedback.
- ◆ **eAssessment:** Create a G/Form rubric to assess paragraphs.

Two points are noted with regards to the active learning in this session. Due to time-constraints, the introduction of G/Forms at the end of the session was not well scaffolded, and teachers appeared overwhelmed by this inclusion. Secondly, the strikethrough function (~~strikethrough~~) to eliminate words in the mind-maps was modelled, and teachers responded to this very positively.

A transactional writing task, concerning the analysis of adverts to prepare learners to create their own adverts, and evaluation of learners' created adverts, was modelled on Day 2, correlating to Module 4 in the manual. KFC is a well-loved brand across all populations of South Africa, and therefore a KFC Facebook banner add and YouTube video advert were chosen for this activity (both are posted in W2.1 on the website). Permission was received from KFC South Africa to use these adverts. Transactional writing and the creation of adverts is required by CAPS for all IP language teaching across grades and languages (both home and additional language teaching). The pedagogic steps of the activity were modelled:

- ◆ **Shared reading and viewing:** teachers watch the YouTube advert and discuss general qualities of adverts.
- ◆ **Paired viewing and evaluation:** teachers evaluate YouTube and Facebook banner advert using a [G/Form: Evaluating an Advert](#) (link embedded)

- ◆ **Shared reading and viewing:** Analyse the results from G/Form in whole group.
- ◆ **Shared prewriting:** Create a mind-map of the characteristics of an advert in whole group.
- ◆ **Individual prewriting:** Individuals create a mind-map using Mindmup.com of the characteristics of an advert.
- ◆ **Peer-feedback:** Advert mind-maps are shared to Edmodo for peer-feedback.
- ◆ **Individual writing and peer-feedback (Omitted due to time-constraints):** Create an advert using characteristics of an advert.
- ◆ **eAssessment:** Create a G/Form to assess learners' adverts.

Various points are noted regarding the active learning in this session. The introduction of the G/Form was more scaffolded. Following the unfavourable response on Day 1 to G/Forms, the originally designed G/Form to evaluate adverts was simplified to scaffolded teachers' exposure to its affordances. The graph-format of the results were projected and teachers could see how their responses impacted the different graphs in real-time. This created some excitement as teachers experienced the affordance of the tool without its use obstructing their experience. The G/Form was intentionally designed to inadequately evaluate an advert, creating opportunities for teachers to note how the G/Form can be improved. Thereafter teachers created their own forms in a more relaxed, systematic manner to the day before. They were highly engaged in creating the eAssessment G/Forms, used a different question-types and some even including images and videos.

The narrative writing activity (Module 6) designed for the last day, did not take place due to time-constraints.

The inclusion of play-driven active learning was designed to develop teachers' capacities to use ETs to create and innovate, and from this, inculcate dispositions of creativity and innovation. The goals of active learning align with Reid and Wood's (2016) goals for play as pedagogy in adult learning, in which teachers experienced in their bodies and incorporated in their habitus: a) basic technological knowledge and capacities, and b) expertise in

planning and implementing pedagogies that transformatively integrate ETs. Such embodied knowledge, Reid and Wood (2016) argue, enables the establishment of new routines towards improved and deeper learning. The inculcation into the habitus of new capacities and dispositions, was supported by relational, professional, reflective and transformational learning.

### 4.2.3 1gDP10) Relational learning

Relational learning was included in the ePlay MakerSpace design to provide opportunities for interaction and shared reflection (Meyer, 2010), and to support interpersonal connectedness and cooperation (Reid and Wood, 2016). The playful, safe space created in the ePlay MakerSpace, created the relational space in which teachers could develop capacities to see interconnectedness (Meyer, 2010) between organisational goals and their individual efforts. Different forms of online and face-to-face, synchronous and asynchronous interaction between teachers, the facilitator and content were designed to foster various forms of relational learning as structured by the Anderson's (2004) model. However, within this process, the language Anderson uses in his model, became problematic as teachers fulfil the role of learners and the teacher in his model is the facilitator. Although the words learner was replaced with teacher, and teacher with facilitator, this model was flagged for revision.

Different forms of interaction were fostered in the Edmodo group: teacher↔teacher, teacher↔facilitator and teacher↔content. In the first session on Day 1, teachers were introduced to Edmodo, created accounts and joined the *ICT Integration: IP Language* Edmodo group. Scaffolding their introduction to the tool, they introduced themselves and their schools (this was omitted from the transcript to protect their anonymity). Thereafter teachers used Edmodo as a reflective and collaborative learning tool. Initially questions were posed to model collaboration and shared knowledge-creation, with teachers responding to posts (transcripts are available on W2.2), and to each other's posts to foster different forms of interaction.

The initial questions on Edmodo served various purposes. It provided a real-time measure of how many teachers could access the Edmodo group. It also indicated whether, having accessed the group, teachers could post responses in a thread rather than create new posts. The content of these initial posts provided a description of the cultural capital teachers valued and inferring from this, what they wanted to gain by attending the session. This data could later be correlated to the information on the concept maps. Following the initial questions listed above, teachers started using Edmodo as part of the transactional and descriptive writing tasks, for reflection on tools and pedagogical affordances, or to post general comments.

Relational learning was further fostered in online contexts, systematically scaffolding collaboration. Using peer-feedback, teachers responded to each other's created artifacts shared in Edmodo. They also opened each other's G/Docs and G/Slides and commented on these using the comment feature, which teachers noted they done before. The descriptive writing task in G/Docs described previously was intended to be a collaborative writing task as preparation to collaboratively develop group lesson plans using G/Slides. However, while some teachers managed to collaborate in G/Docs, the majority found this strange and inaccessible, and were frustrated by the intermittent internet connection.

Relational learning was fostered in face-to-face contexts as well. Different group discussions in the session provided opportunities to question, share and build rapport with fellow teachers. Also, teachers collaborated in face-to-face contexts to create their group lesson plans. Since creativity is fostered when individuals from diverse contexts collaborate and share their varied experiences (Dorst and Cross, 2011), ICT integration manager, Mr D, pre-grouped the teachers in grade-groups that reflected diverse schooling contexts to maximise the diversity in each group, and potential for creativity in terms of originality, flexibility and fluency in lesson plans. The interaction and collaboration between teachers from diverse contexts created the context to support relational learning, new connections and conversations, which as Meyer (2010) argues, settles more effectively in the collective memory. In the interviews that followed the ePlay MakerSpace, one teacher described her experience of this activity:

◇ 50:12 IPL15: *...I was actually annoyed, I was annoyed when you said, Oh, you going to choose the groups. And I thought, shoot, I do this to my children all the time in class hey, and I get, and I now I'm getting annoyed. (FP04: Exactly) And when I was working with the two other girlies from the uhm, it was myself, IPL24, and then this two other girlies, I learnt so much and we just started speaking, and, it was actually, it was actually nice after a while, I realized ok, this is why you actually do it, you know. But initially I was like, Yesso ... if we worked together we would have done so many things.*

#### 4.2.4 1gDP8) Professional learning

Professional learning provides a knowledge and research-driven foundation to support the awakening of consciousness and move teachers beyond their edge of meaning, where they can start creating new meaning in the liminal zone. The professional included in Iteration 1 emphasized content and pedagogical knowledge (Desimone, 2009; Parsons *et al.*, 2013), as well as their technological knowledge (Mishra and Koehler, 2006; Koehler *et al.*, 2011) through the transformative integration of ETs.

Pedagogical knowledge was developed to align with Bloom's Revised Taxonomy (Krathwohl, 2002) emphasizing Higher Order Thinking Skills (HOTS) to aligns with the CAPS requirements for assessment. Also included were the 21<sup>st</sup> century skills of creativity, collaboration, communication and critical thinking (Fullan, 2013) and Anderson's (2004) model of interaction to provide a framework to foster different forms of interaction and deep and meaningful learning. Professional learning took place throughout the three days, supported by active learning and the creation of different artifacts. Teachers for instance identified the 21<sup>st</sup> century skills they valued on Edmodo, read through each other's posts and used the 'like' to indicate the characteristics listed by others teachers, that they agreed with. An analysis of the most 'liked' posts, was correlated to the 21<sup>st</sup> century skills and teachers created G/Slides to illustrate the 21<sup>st</sup> century skills they valued most.

Building on 21<sup>st</sup> century skills, HOTS and Anderson’s model of interaction, professional learning prepared teachers to design learning that transformatively integrates ETs. As requested by the reference group, a step-by-step process, the *ICT integration framework*, (available on Slide 15 of the IP Language presentation and in the manual) was designed to guide teachers’ lesson planning. The framework clearly articulated a process to structure lessons that transformatively integrate ETs. The framework was presented to teachers on Day 2, in preparation for their lessons planning. In the previous session, the descriptive writing task modelled transformative ET integration, and using this as example, teachers identified the different processes according to the *ICT Integration framework* modelled. This activity prepared teachers to plan their own lessons using the *ICT integration framework*.

The professional learning included in the IP Language ePlay MakerSpace addressed content, pedagogical and technological knowledge. This was supported by reflective learning to provide teachers with opportunities to reflect on their existing practice.

#### **4.2.5 GDP7) Reflective learning**

Reid and Wood (2016) suggest that having been in countless classes as both students and teachers, teachers developed a perception of what ‘teaching looks like’ and the role and function of a teacher. This type of observational knowledge they argue, frequently remains internalized as ‘body knowledge’ and is rarely discussed. Reflection provides a means to disrupt and challenge embodied observational knowledge and to effect change to perceptions, beliefs and practices. However, it cannot be assumed that teachers are familiar with reflective practices (O’Sullivan, 2002; Fataar and Feldman, 2016) or have the linguistic skills and confidence to engage in reflection, especially with regards to internalised and embodied dispositions that are generally difficult to articulate. Hence, using the ePlay MakerSpace process, reflection was included as light-hearted, almost informal online posts on Day 1, developing to a more formalised group reflection on Day 2 and various individual online reflections thereafter, to include reflective learning in a systematic and explicit manner.

Teachers engaged in individual reflection throughout the three days. Following Major and Ayrton's (2016) example, concept mapping on Day 1 required teachers to reflect on their existing conceptual understanding of '*ICT Integration in Education*'. Teachers redrew their concept maps in the last session on Day 3, to reflect on and document potential changes that occurred in their understanding of different concepts. Additionally, Reid and Wood (2016) suggests that teachers should reflect on 'good practice', which involved identifying 21<sup>st</sup> century skills. In listing these skills and outcomes, teachers not only reflected on the requirements for 21<sup>st</sup> century teaching and learning, but also reflected on their own practice and potentially their observed knowledge. On the last day, teachers evaluated the IP Language ePlay MakerSpace using a G/Form in which they individually reflected on their engagement in the process and what they learnt and/or valued, and whether they felt the *course* addressed their expectations (results of this *course* evaluation are discussed in the section: Evaluation and Analysis).

Shared reflective learning within the greater group took the form of informal, collegial discussions sensitive to the wide range of languages spoken in the room, and teachers' diverse socio-cultural backgrounds. On the morning of Day 1, Slide 2 in the IP Language G/Slide presentation challenged teachers with the question, '*Schools 100 years ago – how does your school compare?*' Through shared group reflection, teachers reflected on their current practice, and how this compared to teaching 100 years previously, deconstructing the image and identifying teaching and learning practices they still employ. Comments that emerged through this shared reflection, provided insight into teachers' observed knowledge and epistemologies (Major and Ayrton, 2016) and confirmed assumptions that teacher's practice reflected pedagogies aligned with teacher-centric Quadrant A and D on the TCF (Tarling and Ng'ambi, 2016). Shared reflection was also included informally after each active learning session, encouraging reflection on the learning, as well as teachers' learning process. Unfortunately, due to the size of the venue and the way in which teacher were located therein, shared reflection sessions were not audio-recorded and documented. This was flagged as a potential implementation problem to be addressed in the design of Iteration 2.

Shared reflection in the whole group was also used to support teachers in identifying their personal epistemologies and was supported by Slides 7-12 on the IP Language G/Slide presentation. Major and Ayrton (2016) argue that change to teaching hinges on identifying teachers' epistemologies first, before engaging in 'epistemic shifting' in the liminal zone to achieve dispositional transformation. The images on the slides were chosen to induce cognitive dissonance and conflict between teachers' existing assumptions, and the 21<sup>st</sup> century skills and learning outcome goals they had listed as examples of good practice in Edmodo. Through shared reflection, teachers identified their beliefs about knowledge and how they perceive their role in teaching and learning practice: either as transmitters of knowledge, facilitators of knowledge creation or co-producers of knowledge, and how this differed from the epistemic goals of 21<sup>st</sup> century teaching and learning. In this way, shared reflection supported teachers to question their observed knowledge and epistemology, and laid the foundation for their entry into the liminal zone.

Group reflection was also included in the IP Language ePlay MakerSpace in the document: [Reflection on Day 1 on morning of Day 2](#). Group reflection, as opposed to shared reflection, was formally conducted in a separate venue. The session was facilitated by the ICT Integration manager at the start of Day 2 to provide the researcher some distance from the group, to listen to their feedback and reflections on the previous days' learning, reducing the potentiality of my bias shaping teachers' responses.

During the group reflections on the morning of Day 2 teachers' comments reflected a sense of being overwhelmed with the pace and content of Day 1's work. This is reflected in the following statements:

- ◆ IPL26: *As I said yesterday, for me it was quite a good experience. I do know a little bit about technology, computers, but I am not that clued up with the computers. And yesterday for me it was a bit too much to absorb. If I must go into that lab today... I won't be able to do everything that... you have taught us yesterday, and so for me myself.... it was a bit too much.*

- ◆ IPL15: *I think, when I thought about it I actually go home to my husband, I wanted to say I really enjoyed the course or I'm really going to enjoy the course. But I think and I thought to say too, for someone who doesn't know much about computers, like IPL26 said, it's difficult to follow the course. You need to have not only being able to switch on a computer, you need to have a bit more than that of knowledge to be able to follow through with this course. Me personally I enjoyed it thoroughly and I'm quite ok with computers, and I kind of assist at our computer lab at school, so and we use it for Moodle. So I'm quite ok. But for somebody who doesn't see something like this or who doesn't have a constant contact with a computer, it can get a bit intimidating.*
- ◆ [03:28] IPL11: *For me, I don't know much about computers. But yesterday I tried to follow and even the terminology is still new. If maybe you can slow down the pace. If you go faster, then I just switch off.*

The comments by IPL26, IPL15 and IPL11 indicated that the pace at which the activities were conducted was potentially too fast for novice users and those with low technological knowledge. Venue and device related challenges potentially exacerbated such negative feelings: with the change of venue at short notice and teachers struggling to find the venue (such as IPL11), desktop-computers malfunctioning, and challenges with accessing Gmail accounts (such as IPL26), while the internet worked only intermittently, with low bandwidth, causing much frustration. The ePlay MakerSpace is designed to create the enabling conditions for teachers to cross the threshold to the liminal zone and transform dispositions. However, the environment and pace of learning on Day 1 appeared less than optimal for entry into the liminal zone, and it appears, contributed to the negative feelings teachers reported.

Despite the challenging context and pace, teachers identified various skills that they learnt on Day 1:

- ◆ *How to work with each other.*
- ◆ *Edmodo as a support device to share.*

- ◆ *Concept mapping and that's something I can take back to my children, it was really interesting. I only knew mind-mapping, but writing down those words first and then putting them up in the concept map... Teaching Afrikaans you really have to go back to basics and using concept mapping is good.*
- ◆ *How to download and install software.*
- ◆ *That you don't have to save only on a memory stick but you can save into the cloud. How to use Google Apps and so on.*
- ◆ *Creating a Gmail account for those who didn't have an account.*

Following these comments, teachers in the IP Language ePlay MakerSpace repeatedly noted the concept-mapping and mind-mapping activities as valuable and immediately implementable. They also commented on the collaboration and sharing generally and also in Edmodo. These comments suggest that the work-arounds in the session, teaching participants to download and install software, opening new Gmail accounts and staggering their access to the internet, became professional learning situations. Teachers learnt to manage challenges and problem-solve in different ways. However, it remained problematic that teachers experienced such a high level of discomfort on Day 1. The group reflections served to indicate their discomfort and the need to potentially slow the pace within the sessions.

At the end of the group reflection, I acknowledged teachers' discomfort and the challenges they experienced, giving legitimacy to their feelings, in order to create a safer and calmer enabling context for the day ahead.

#### 4.2.6 GDP11) Transformational learning

The ePlay MakerSpace is theoretically and pragmatically aimed at transforming teachers' dispositions, providing the enabling conditions for teachers to cross the threshold of their meaning-making system and enter the liminal zone. Transformational learning prepares teachers to manage their change processes and how they choose to integrate ETs in their classrooms. Meyer holds that transformative learning should shake "*core beliefs and*

*familiar ways of thinking and being and requires playspace both to hold the discomfort and realize its possibilities”* (2010, p. 23). Transformational learning took place implicitly and explicitly in the IP Language ePlay MakerSpace.

Transformational learning took place implicitly through different activities. The enabling conditions provide a context in which teachers could experiment, discover and take risks, question assumptions and challenge pedagogic beliefs. Implicit transformational learning was included in the professional, active, reflective and relational learning processes. Active and relational learning provided an embodied experience of transformative ET integration, to challenge familiar ways of thinking and being. Professional learning provided the mental tools with which teachers could reconstitute how teaching and learning for 21<sup>st</sup> century goals could be accomplished and a means to create *“fresh actions as people begin integrating their insights into their thinking, planning, decision making, and ways of being”* (Meyer, 2010, p. 23). Reflective learning activities provided teachers opportunities to identify and reflect on their pedagogic assumptions and beliefs, as well as imagine an ideal-space where such beliefs and assumptions no longer hold true or are no longer useful to prepare learners for the 21<sup>st</sup> century. Additionally, reflective learning created the space in which teachers could identify the edge of their meaning-making system or threshold to the liminal zone as their individual beliefs and assumptions about teaching and learning with or without ETs. Active, relational, professional and reflective learning provided different implicit opportunities and mechanisms with which teachers could engage in transformational learning, create new dispositions of mind and body, and start moving across their liminal zone.

Although implicit, transformational learning could be observed in teachers’ actions, comments and feedback. At the end of Day 1, most teachers had encountered the liminal zone and approached their individual thresholds. Some were able to enter, while others reported feeling overwhelmed by the discomfort at the edge of chaos. On Day 2, with the venue and internet connectivity challenges largely resolved, the discomfort seemed to dissolve as the day progressed. This could be related to more teachers having crossed the threshold and overcoming the discomfort at the edge of chaos, and entered the liminal zone

where they could challenge assumptions and beliefs, familiar ways of teaching and learning, and realize the possibilities of transformatively integrating ETs in their classroom practices.

The autonomous and autotelic nature of the ePlay MakerSpace process because particularly visible in the transformational learning during the group lessons planning. The activity was designed to require online collaboration between 3 – 4 teachers working simultaneously on the group’s lesson plan. Although I modelled and scaffolded the required process to open the same document, and collaborate in its development, only one group of teachers engaged with this. The rest of the groups remained at one desktop computer and let one teacher type while the others watched and added verbal comments. Driven by the autonomy associated with the ePlay MakerSpace, I let teachers choose how they wished to engage with the activity. Their resistance to engage in online collaboration, signified to me that teachers were at various points in their liminal zones. I realized at this point that I needed to acknowledge teachers’ choices, and not impose my bias to influence their transformational pace. Teachers were therefore left to engage with the activity as they chose. However, the intended collaboration included in the learning design for the activity was not achieved and was flagged for revision in Iteration 2.

Transformational learning was also explicitly included in the IP Language ePlay MakerSpace in the last session of Day 3. While implicit transformational learning prepares and supports teachers to cross the threshold and enter the liminal zone, explicit transformational learning is intended to capacitate teachers to current realities and plan and manage their ongoing change process through the transformative integration of ETs. Module 7 in the manual, Planning for Change, presented different strategies for change and the session, Designing Change (p. 48) was supported by a G/Slide presentation: [Roadmap to Change](#) (link embedded). Teachers made copies of the The Roadmap to Change, and individually worked on this. The document required teachers to:

1. Slide 2: reflect on the descriptors of teaching in each quadrant of the TCF and self-diagnose their position at the time, and their goal positions. A summary of the self-diagnoses and goal positions is available on the website: W2.3.

2. Slide 3: Due to time-constraints this activity was not completed.
3. Slide 4: Set low-level goals to achieve in the three weeks following the ePlay MakerSpace that are immediately implementable.
4. Slide 5: When implementing goals, teachers had to 'look for the learning' following Reid and Wood's (2016) suggestion, and collect evidence of change.
5. Slide 6 asked four questions to encourage reflection in three weekly increments after the ePlay MakerSpace session:
  - a. How did you Integrate ICTs in your teaching in the past 3 weeks?
  - b. What can you celebrate in your ICT Integration journey so far?
  - c. When and how did you include higher order thinking skills in the class? Try to be as specific as possible.
  - d. What are your goals for the next 3 weeks and how do you think you'll achieve them?
6. 3 sets of extra copies of Slide 5 and 6 encourage ongoing reflection and change.

The G/Slide: Roadmap to Change, was designed to provide a simple and easy to use tool with which teachers could plan, enact and reflect on their real-world change processes and transformative ET integration. This iterative process of planning, enactment and reflection, leading to refined planning and a repetition of the process, aligns with the goals of Action Research that is nationally supported (Department of Basic Education, 2011).

Transformational learning prepared IP Language teachers to plan and manage their change processes, and how they chose to integrate ETs in teaching and learning activities. Using the TCF, teachers identified the quadrants they wanted to teach in, and could then plan how they wanted to achieve this, setting pedagogic and integration goals to create a pathway for contextually and socially embedded progressive transformation.

Following the enactment of the ePlay MakerSpace, the design and enactment were evaluated and findings analysed to inform the refinement of the GDPs.

## 4.3 Formative evaluation and analysis of Iteration 2

The enactment of the Iteration was formatively evaluated using the research instruments developed in the methodology, section 3.2.4. The formative evaluation took place 2-3 weeks following Iteration 2 and drew on the rich data produced from the various artifacts and Edmodo posts produced by participants, as well as their individual and group reflections. In addition, semi-structured interviews were conducted with IP Language teachers 3-6 weeks after the ePlay MakerSpace. The data generated from the semi-structured interviews confirmed, elaborated or refined findings from the formative evaluations. In most cases, the semi-structured interview data confirmed the participant evaluation, but in the case of School A, data from the semi-structured interview led to the refinement of the participant evaluation.

The IP Language ePlay MakerSpace session was formatively evaluated in terms of the context of the intervention, teachers' participation, and the design and enactment of the intervention. An additional formative evaluation was conducted of the changes teachers enacted after the ePlay MakerSpace. This evaluation largely drew on the data produced through the semi-structured interviews, but also on photos and correspondence shared between teachers and the researcher after the ePlay MakerSpace had concluded. Findings from the formative evaluations served two purposes: firstly, to measure the extent to which the design and enactment of the ePlay MakerSpace met the GDPs, and secondly, to identify potential elaborations or refinements to the GDPs.

### 4.3.1 Evaluating the context of the intervention

The teachers attending the IP Language ePlay MakerSpace session were from seven (7) schools in the Western Cape; teachers from four (4) of the seven (7) schools were interviewed. The schools are disadvantaged, no-fee-paying schools with severely limited access to resources other than that provided by the state (refer to section 1.1). The general language of teaching and learning is English, although isiXhosa and Afrikaans are frequently the language spoken by teachers and learners in their homes.

The WCED and the eLearning Game Changer office, oversee the provision of device and connectivity access to schools through various initiatives. The SmartSchools project aims to provide the province's schools with connectivity and device access by 2020. This project targets Quintile 1 schools, the most disadvantaged, resource-deprived schools in the province, as first recipients (the quintile system is discussed in section 1.1). Schools participating in the initiative are graded by the WCED as model, enhanced and universal schools. The eleven (11) model schools in the province receive internet connectivity and Wi-Fi throughout the school, tablets for each learner and teacher in the school, new computer labs, laptops for teachers and interactive whiteboards (IWBs) and visualizers in each class. Enhanced schools receive similar internet connectivity, but receive 20 tablets on a charger trolley and some classes are fitted with IWBs, and where possible visualizers; teachers receive tablets or laptops. Universal schools receive broadband and their existing computer lab facilities are renovated, and where possible IWBs, visualizers and tablets on charger trolleys are provided.

The evaluation of the design context draws on teachers' comments and descriptions of their classrooms and schools during the ePlay MakerSpace contact session, as well as my observations while visiting all but one of the seven schools to conduct the interviews. In two cases the principals at the schools granted an interview as well, which greatly benefited this evaluation.

The design context is evaluated according to the framework developed in Chapter 3, and regards systemic, institutional and classroom level factors at each school. The G/Form: [Formative Evaluation of ePlay MakerSpace Context, Participants, Design and Enactment](#) (link embedded) was designed to capture results.

#### 4.3.1.1 Systemic level factors

While many systemic factors can be identified as impacting the teaching and learning in the seven schools, the focus falls on those most pertinent to enable transformative integration

of ETs and teachers' ongoing dispositional transformation. These factors broadly related to device and internet access, and curriculum coverage.

Device and internet access is generally problematic in disadvantaged schools, a challenge that the SmartSchools initiative is addressing throughout the province. The project has been publicized in the media and internal WCED systemic communication, therefore one would assume some teachers and principals would know about it, and possibly know their school's status as either a model, enhanced or universal school. To the contrary, only School F's principal and teachers knew the school's status (being a model school). The principals and teachers from the other schools had heard that the WCED would be providing internet and device access, but could not provide information beyond that, and did not know of the three classifications for schools. Three of the schools were waiting for internet to be installed, as provided by the SmartSchools project - coincidentally technicians were installing broadband access at School K during the interviews. In model schools, such as School F, the broadband LAN access is converted to create a WAN, but in most cases, the WCED defers the responsibility to provide Wi-Fi access from the office to classrooms, to the school. With limited access to resources, Wi-Fi access is not generally a priority. The other three schools used modems or dongles to provide the connectivity to administrators, mainly to receive and send emails. Teachers are not generally provided internet access outside the administration building.

All the schools are by law required to follow the CAPS document. The Integrated Quality Management System (IQMS) is used as a performativity measure, while curriculum advisors visit schools throughout the year to increase pressure on teachers to comply with CAPS requirements and ensure coverage of the curriculum content. The teachers attending the ePlay MakerSpace sessions prioritised coverage and adherence to CAPS and its goals, and felt under pressure to '*... get through it all...*' (IPL11).

#### 4.3.1.2 Institutional and classroom level factors

Institutional and classroom level factors impacting the teachers participating in the ePlay MakerSpace were evaluated. A comparison of institutional and classroom level factors foregrounded the interlinked-nature of these factors, which revealed similar and contrasting themes across the sites. These themes relate to existing conditions *before* teachers and HODs participated in the ePlay process.

A deciding factor for ET integration is access to devices and to a lesser extent, internet connectivity. The leadership at each of the four schools, support the general goals of ET integration in terms of improved teaching and learning outcomes. I introduced myself to the principals at each school, and interviewed the principals at School K and A. All four principals supported the narrative that ET integration is crucial to the future of education. However, in practice this was not always evident.

Device access varied between the four schools. During 2012, two charger trolleys with twenty tablets on each, and four IWBs were delivered to School Z. At the time of my visit however, the teachers noted that the tablets and IWBs were still unused and in their original packaging in the school's strong room. This is in addition to the fully equipped computer lab with 40 computers at the school which was mostly used by teachers for administrative purposes.

At School K, the computer lab had been converted into a classroom and computers pushed to the side. The computer lab was installed in approximately 2005/2006 by the Khanya project, however no maintenance support was provided thereafter. Thus, when computers malfunctioned, the school could not access resources to service, update or repair devices. Subsequently, most computers became redundant, informing the decision to repurpose the lab into a classroom. At the end of 2015/beginning 2016, a sponsor donated 20 tablets to the school. Unfortunately, on the first day of their use early in 2016, a learner dropped one of the tablets causing some damage to the screen. The school had to pay in excess of R1000 to have it fixed, which in an already resource-scarce school, added financial pressure to the

school's budget. Following this incident, the principal concluded that unless funds could be found to build a dedicated room where devices could be safely used, he was not willing to incur further costs and the tablets remained locked away in the strong room.

School A had a functioning computer lab with a full-time facilitator supporting learners and teachers. Internet connectivity is available to teachers in the computer lab. However, there were no other devices such as tablets, data projectors or IWBs in the school. Teachers therefore relied on paper-based pedagogic tools and only had green chalkboards in the classrooms. Learners accessed the computer lab in dedicated timeslots as described by teachers below:

- ◇ IPL06: *We also have a set timetable. So, you can't just tell the maybe the Grade 4 teacher who hasn't been on, great but my learners need that, I need to log the space, the period, so can we cut into your time, so I don't think it's going to work.*
- ◇ IPL22: *The periods are also about, how, it's 40 minutes for the ones, half, and then 40 for the other. So, they split the classroom.*
- ◇ IPL06: *First the boys then the girls so they can't take the whole class at once.*
- ◇ IPL06: *What happened now he [the facilitator] came to see me to say uhm he's gonna approach us and we keep them busy with stuff (IPL21 speaking over her)*
- ◇ IPL21: *Yes, like the Cami programme*
- ◇ IPL06: *Yes, and he's gonna talk to the Grade heads and ask like for Maths what are you doing this week, or whatever, what can you do and so forth to help the learners, but specifically geared towards Maths now.*
- ◇ IPL21: *So this is now the first time that he has approached us and asked ok so now what are you doing now in Maths. Ok, so I told him so we did transformations, but from the beginning of the year until now, I don't know what they did in the computer lab.*

◆ IPL23: *I think they were typing in Word. I told the principal, when he had a meeting with us, I told him that we are supposed to know what they are doing. Like for Maths. So he said ok, they are going to install CAMI Maths, so now only I know what my kids are doing.*

The meeting IPL23 refers to, took place after teachers participated in the ePlay MakerSpace. Their request to align the work done in the computer lab with their Mathematics curriculum requirements indicates that change to the way in which the computer lab time was utilised, was potentially taking place. However, prior to that, the work learners did in the computer lab with the facilitator was unconnected to the curricular topics they were covering in class, and it appears, learning mostly focused on teaching stand-alone technical skills such as typing or completing unrelated Mathematics activities in Cami Maths or HeyMaths.

School F, a model school, was built in 2013/2014 and is situated in a low-income area in Cape Town. The principal at the school is an ET enthusiast and has enrolled for a Masters' degree in ICTs in Teaching and Learning at a Cape Town university. He has nurtured a similar enthusiasm among the staff for ETs and subsequently, IPL15 enrolled for the same Masters' programme. He also ensured that both incoming and outgoing IP Language HODs join the ePlay MakerSpace session. There are IWBs in a few classes (three in total) and while broadband had been provided to the school, at the time of interview, Wi-Fi was not yet available in all the classrooms. Two charger trolleys with twenty tablets on each, are available and teachers book slots to use these. This is in addition to learners going to the computer lab twice a week during their regular Mathematics lessons to work on an online Mathematics programme. At the time of the interview, the school had initiated the process of developing a responsible use policy, inviting leaders, teachers and stakeholders to participate.

Devices are appropriated differently at the four schools. Contradictions were evident between Schools A, K and Z's leaders' and teachers' verbalised beliefs and support for the use of ETs for teaching and learning, and the actual use of devices available at the schools. This correlates findings from similar South African studies (Chigona *et al.*, 2011; Bladergroen

*et al.*, 2012), where teachers' beliefs and perceptions did not align with practice. These differences can be seen in the way that device-appropriation is timetabled, how this appropriation is linked to the curriculum, and the school's policies to support and legitimise different pedagogies.

Timetabling of subjects, activities or the use of devices or the computer lab, provides a regulated and routinized rhythm, and importantly, legitimacy to these activities in the school. In Schools A and F, access to the computer lab and tablets in School F, is timetabled. However, the way in which time is used in the computer lab differed significantly. In School F, learners spent two periods (approximately an hour in total) on the computers engaging with an online Mathematics programme while teacher supply ongoing pedagogical support. In this way, the computer lab and tablets are used to address immediate curriculum outcomes correlating to the curriculum content covered in the classroom. In contrast, while time in the computer lab at School A is also timetabled for each class, and is supervised by a dedicated facilitator, the learning taking place appears unconnected to the curriculum covered in classes. The learning instead appears to be an add-on or additional activity, to keep learners busy and occupy their time, as IPL06 notes: [the ICT Lab technician] *'came to see me to say uhm he's gonna approach us and we keep them [learners] busy with stuff'*. Prior to this, learning in School A's computer lab was unconnected from the curriculum and aimed at developing stand-alone technical skills such as typing in MS Word, or completing unrelated curriculum content in the CAMI Maths programme.

Furthermore, at Schools Z and K, the available devices and computer lab remained unused prior to teachers' engagement with the IP Language ePlay MakerSpace. Thus, while teachers and principals verbally supported the integration of ETs into teaching and learning, at school Z and K this was not supported on the timetable, lending no institutionalized legitimacy to this appropriation other than verbal support. At School A the lack of linkage between the teaching and learning taking place as part of curriculum coverage in classrooms, and learning taking place in the computer lab, structures the learning in the computer lab as stand-alone and an additional extra. In contrast, at School F, the learning in the class was directly linked to the learning on devices, structuring learning in both spaces as integrated

and legitimised. Whereas learning integrated with device usage was legitimized differently in terms of timetabled use and curriculum linkage, institutional policies had not yet changed to support such integration.

Institutional policies at all seven schools, did not support or legitimize the use of learners' mobile devices. During the ePlay MakerSpace, teachers indicated that responsible use policies to support learners' responsible use of devices and the internet, were not available at any of the seven schools represented in the group. To the contrary, not only were learners banned from bringing mobile devices and particularly their mobile phones, but teachers at all the schools except School F, were also banned from using mobile phones during school hours. Two justifications were repeatedly raised for the ongoing banning of mobile phones/devices. Schools hoped to limit the sharing on social media of online videos of children being bullied, or inappropriate photos of teachers and learners, and hoped to avoid learners getting targeted by criminals and the increased risk of theft associated with them carrying expensive devices/phones.

The lack of responsible use policies to prepare and equip learners to use devices and the internet responsibly, coupled with the banning of mobile phone/devices, can be interpreted in different ways. While it may appear to protect learners' interests, one could argue that learners would use the devices outside of school, and could be targeted by criminals in these situations. Additionally, learners could indiscriminately access inappropriate content from the internet, having not been equipped to be responsible in their choices. However, such institutional policies or the lack of responsible use policies, may rather signify a lack of value or worth associated with learning and mobile devices/phones, with school leaders associating these devices with gaming and not potential learning tools. What is more, innovative pedagogies such as Bring-Your-Own-Device (BYOD), would potentially be viewed in a negative light since such approaches are device-dependent, and since devices are banned, learners could conclude that their use for learning may also be banned. Another inference could be that the culture within the schools as evidenced by these policies, may be viewed as legitimizing traditional pedagogic approaches and pedagogic tools as holding higher cultural capital than those associated with mobile phones/devices.

Institutional and systemic policies create the conditions that either support or constrain transformative ET integration. Whereas timetabling of device appropriation is important, device appropriation is rendered legitimate when it correlates the learning taking place in terms of curriculum coverage. Similarly, policies lend legitimacy to the appropriation of devices for learning, and banning learners' and teachers' mobile phones/devices excludes these as legitimate supporting tools for learning. At School F, the enabling conditions within the institutional structures and processes appear to support transformative ET integration more readily than those at School A; however, the enabling conditions at both Schools K and Z do not appear to support this. Although transformative ET integration may not be impossible, teachers at these schools would need to work much harder to achieve this in the absence of enabling conditions.

This section formatively evaluated the systemic, institutional and classroom level factors that legitimize or de-legitimize transformative ET Integration, and which enable or impede teachers' ongoing transformation of dispositions. In the next section, teachers' participation in the IP Language ePlay MakerSpace is formatively evaluated to ascertain how this potentially enables or impedes the transformation of dispositions.

### **4.3.2 Evaluation of teachers' participation**

The manner in which participants engage in the ePlay MakerSpace potentially impacts their movement across the liminal zone, and potentially the transformation of dispositions. To test this theory, the manner in which teachers participated was formatively evaluated.

The formative evaluation of teachers' participation was initially conducted two days after the IP Language ePlay MakerSpace. Results from the individual formative participant evaluations were then aggregated to provide a general score of participation in the IP Language ePlay MakerSpace. The formative evaluation process drew on data produced through participants' individual *course* reflections in which they reflected on their progress and their experience of the session. In addition, the formative evaluation of each participant reflects teacher's engagement in the ePlay MakerSpace process as informed by the

researchers' observations, their engagement in the Edmodo group, as well as their created artifacts, including mind-maps and concept maps. These three data sources were triangulated to inform the formative evaluation of each participant according to the rubric below (recorded using the G/Form format discussed previously). Twenty-six evaluations were then repeated a week later after evaluating the Foundation Phase teachers' participation. The results were compared to the original evaluations to identify potential discrepancies, and address these, towards increasing interpretive validity. Following the school-based interviews three to six weeks after the IP Language ePlay MakerSpace, the twelve teachers' interview data was compared to their individual participant evaluations. In all cases the interview data either confirmed the formative evaluation, or raised additional information that increased the rating of the teacher.

Following the formative evaluation of individual teachers' participation in the ePlay MakerSpace, an aggregation of this data was developed. For each measurement on the rubric, an average was established by adding all the measurements for the 26 teachers, and dividing this by 26. The results are displayed on the G/Sheet: [PhD Evaluating ePlay MakerSpace participants after interviews \(Responses\)](#) (link embedded). The average scores were then visually represented (see Figure 9).

The formative evaluation of IP Language teachers indicated strengths and weaknesses, and areas for improvement for future iterations of the ePlay MakerSpace. Creativity on average scored the highest average results (2.46/3), followed by engagement (2.27/3) and participants' perceived satisfaction (2.23/3) with the learning that occurred in the ePlay MakerSpace. Creativity is discussed below in terms of change. However, it is possible to correlate the high measure of engagement with the relative satisfaction with which participants rated the *course*. Reflection on the other hand, scored only 1.96/3, the lowest score on the participant formal evaluation. It signifies teachers' lower engagement in

### Formative evaluation of IP Language teachers' participation

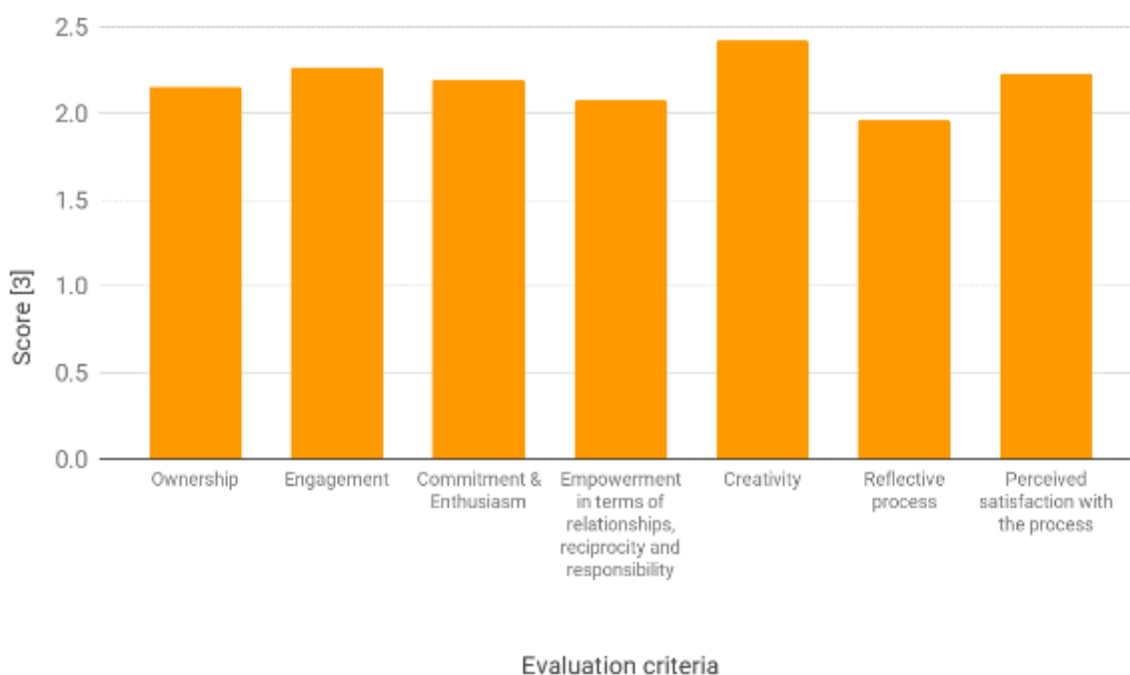


Figure 9 Formative evaluation results of IP Language teachers' participation

reflective learning. Reflective learning was also flagged when discussing the enactment of the ePlay MakerSpace, as needing refinement, which this result confirms. These results correlate to Fataar and Feldman (2016) and O'Sullivan's (2002) who observed similar challenges to reflection among teachers.

An analysis of the individual formative evaluation of IP Language teachers' participation indicated that eleven (11) teachers scored an average of 3, the highest possible score. Those with an average score of 3 can be classified as taking ownership of and being highly engaged in the ePlay MakerSpace process, and being highly committed and enthusiastic about the process, the learning taking place therein and their change processes. When the different artifacts these eleven teachers created were evaluated for creativity, based on the measures of fluency, flexibility and originality, these teachers repeatedly displayed high levels of creativity. They generated novel or unusual mind-maps or concept maps, and used different ETs tools in non-habitual ways, beyond that used by their peers or modelled in class. The eleven teachers also engaged actively in the individual, shared or group reflections. At the conclusion of the ePlay MakerSpace, their rating of the *course* indicated

that the *course exceeded* their expectations and they appeared extremely satisfied with the learning that had occurred during the contact session.

Seven teachers scored an average of two (2), while four (4) teachers scored only one (1) on the formative evaluation for participation. Those scoring one, appeared to lack ownership and it appeared as if they refrained from actively engaging in the different learning activities. They did not often appear enthusiastic or committed, and did not seem open to collaborate with colleagues or other participants, either online or in groups. Very often these four teachers did not share artifacts they had produced, and would remain unresponsive during the group learning design session. One teacher, IPL22 (Average score of 3) noted of one of the four teachers who scored low in most instances for participation, that she would not even participate with IPL22 in a small group situation. IPL22 describes this:

- ◆ IPL22: [text omitted] *So that one, really, she put me under a lot of pressure, because I had to do.. everything. And when it came to the presentation, she also didn't want to say anything. So for me it was like (gestures with fists together as if to say that it was very hard work.) And I had to learn a lot because I was always asking uhm.. uhm IPL23 here, what must I do now, and now? So it was, but I learnt also a lot in the process. Ja, I learnt a lot. And now I can apply it in my classroom.*
- ◆ IT: *And do you think it sped up your learning?*
- ◆ IPL22: *YES definitely, definitely.*

IPL22 expressed her frustration that her partner had displayed limited reciprocity, responsibility or collaboration during their planning and presentation of the group learning design, and left IPL22 to do everything. She conceded that this *definitely* sped up her learning. Additionally, both teachers spoke isiXhosa as home language, and when I joined them during the session, I assumed their conversation in isiXhosa was mediating the learning. However, IPL22 later indicated that it was about the other teacher not wanting to engage in the activity.

An analysis followed to correlate the four teachers who scored the lowest average (one (1)) on the formative evaluation for participation, in terms of the institutional constraints and their interview data. Two teachers, IPL09 and IPL18, were from School Z. During the interview, both teachers appeared reticent to share and frequently pointed to or waited for IPL10 to answer questions. School Z is in a predominantly isiXhosa speaking township and most learners and teachers speak isiXhosa at home. One could thus deduce that IPL09 and IPL18 potentially faced language barriers, and did not want to participate in the interview as a result of this. Also, IPL18, although a Grade 3 teacher, attended the IP Language course, which I only discovered during the interview. I repeatedly assured her that she was not in trouble for doing so, but throughout the interview her face displayed a worried, anxious look and her body posture remained bent over, her hands wringing a tissue into tiny fragments. It appeared that the interview situation was causing her some distress, and I did not place further pressure on her to engage therein.

Institutionally, School Z, as described above, had available at least 40 tablets and a fully equipped computer lab, but this remained largely unused. The teachers shared during the interview that they had taken their learners to the computer lab the day before the interview, and taught them how to log into the system using the general access key. This had been the first time that year that they had taken their learners to the computer lab (the interview was in late August 2016). In the absence of institutional support in terms of timetabled and regulated time in the computer lab or on devices, as noted above, teachers would have needed to work much harder to transformatively integrate ETs. Although participation evaluation scores were low, when asked if the *course* met their expectations, IPL09 noted: *Yes, in a way that I learned a lot and would love to learn more again*. This self-evaluating statement indicates that IPL09 felt that she had learnt a lot, despite the researchers' observations to the contrary.

The other two teachers who scored lowest for participation, were IPL11 and IPL16. During the ePlay MakerSpace, IPL11 was a quiet and reserved participant, who did not readily engage with teachers who were not from her school. She also preferred to speak isiXhosa during these sessions, suggesting that she potentially found it challenging to communicate

or collaborate online in English. IPL16 was equally quiet in both the ePlay MakerSpace session and during the interviews. Even when directly asking her questions, she refrained from answering in both instances. However, she noted of the *course*:

◆ IPL16: [text omitted] *now I can able to plan, present and teach using computer.*

While she noted this in her *course* reflection, the reality however was that she appeared unable to even log into her account. After the interview at her school, I asked her to share some of her work from the ePlay MakerSpace with me, for which sharing settings were incorrectly set. However, when we arrived at the computer lab, she could not log into her Gmail account despite the lab facilitator and myself trying for approximately half an hour to reset her password. I offered to return to the school as soon as she located the manual in which she wrote her password to help her, and that I would wait on her phone call or text message to arrange this, but this never materialized. While the other teachers at School A, all scored three (3) on the participation evaluation, IPL16's score of one (1) was confirmed by the interview data. One could thus infer that although the potential conditions at the school was supportive of transformational ET integration, participants' ownership, engagement, commitment and enthusiasm, their empowerment, the development of their creativity and their participation in reflective learning, significantly impact the potential for their transformation of dispositions

This section evaluated the participation of IP Language teachers in the ePlay MakerSpace. In the next, the design and enactment of the intervention is formatively evaluated.

### **4.3.3 Evaluating the design and enactment of the intervention**

The formative evaluation of the design and enactment of the IP Language ePlay MakerSpace occurred in the week following the contact session. The evaluation was repeated after the Foundation Phase ePlay MakerSpace was evaluated, and results compared to ensure internal reliability of the measurement tool. The evaluation is informed by teachers'

Edmodo notes, group and *course* reflections, the researchers' observations and reflections, and the interview data.

The enactment of the IP Language ePlay MakerSpace was fraught with challenges. The many unexpected challenges required on-the-spot work-arounds or generating alternative solutions to compensate for equipment malfunction, online access failure or similar challenges. Two teachers could not access their Gmail accounts and repeated attempts over the three days to open new accounts did not yield results. On Day 2, computers that had worked the day before were not working, limiting the available computers and leaving three teachers without devices for hours. These challenges coupled with the intermittent internet access in the computer lab, caused much frustration.

When conducting the formative evaluation of the design and enactment of the IP Language ePlay MakerSpace, I was cognisant that the challenges I experienced in the venue, would bias the evaluation. To avoid bias, I repeated the evaluation three times over three months, and in each case closely followed the descriptors and criteria developed in section 3.2.4, drawing on the collective data produced from Iteration 1. Subsequently the formative evaluation was strictly conducted according to the criteria developed for the design and enactment's formative evaluation as reported herein.

#### 4.3.3.1 Formative evaluation of the solution design

##### 4.3.3.1.1 Criteria: Practicality

Teachers responded positively to the design and enactment of the session, and the practical applicability of their learning in the ePlay MakerSpace session. Eleven teachers indicated that the *course* exceeded their expectations, and noted that they could immediately implement what they had learnt. They were particularly appreciative of the opportunity to learn how to create learning tools online, work in the cloud and use G/Apps.

The lesson presentation on Day 3 created some anxiety, with one teacher noting that it was the most challenging part of the course. Two pertinent comments are included:

- IPL8: *It was challenging to compile a presentation about integrating ICT into the curriculum.*
- Explaining a possible reason for this, IPL15 notes: *So much teaching experience in one room.*

However, in their interviews, both teachers rated this as one of the most useful and positive points of the course.

Furthermore, the choice of tools included in the session proved practically applicable and were received positively. During Day 2's group reflection, teachers noted that they could immediately implement concept mapping and mind-mapping using Mindmup.com in their classes. Additionally, teachers repeatedly celebrated in their *course* reflections that they had mastered different G/Apps for use in the class, and were excited about saving all their documents to their G/Drives. One of the teachers who displayed very low technological skills, noted of this:

*IPL23: Temost challenging part of the course was google form when I was introduced to it on day 1. On the last day which is today, I can confidently say that I have mastered it. [sic]*

It suggests that inculcation through the transmission and active practice of capacities leading to mastery occurred, suggesting that the transformation of dispositions likely occurred as well.

Edmodo was introduced in a scaffolded manner, and initially teachers seemed to engage and post responses to questions in an appropriate manner. However, when they were required to use the tool for a pedagogic reason, that is, to post descriptive words for a character, they did not respond to the initial thread, but created their own posts. This created confusion when teachers had to respond to each other's posts and could not find these, or had to scroll through multiple posts to find the right one. A more nuanced and strategic process should be developed to scaffold the introduction of tools and make explicit the un-thought-of practices experienced users take for granted in the use of social media tools.

The use of G/Forms during the three days modelled multiple pedagogic and learning goals. In general, teachers experienced the use of G/Apps positively, with one teacher noting in her interview:

◆ IPL15: *...I always thought it was just Microsoft, it's just Microsoft Word, it's just Microsoft, that's the only space I can type on that actually makes sense, you know. I know there are other like in Notepad or whatever, but this is where you can change and add pictures. And then I got to learn about Google and for me the drive is the most amazing thing ever!*

Although IPL15's reflection after the ePlay MakerSpace, was very positive, the initial use of the tool was not as successful. The tool was included to model the development of rubrics for eAssessment of descriptive paragraphs on Day 1. The timing of this introduction was however problematic. With only approximately 10 minutes remaining in the session, I modelled the use of G/Forms to create a rubric. More experienced users were able to follow, however the introduction was rushed and tended to overwhelm novice or inexperienced users. The next day, the use of G/Forms was more carefully scaffolded, and the design of the form was simplified. This introduced the tool without the use thereof impeding the potential learning. In addition, teachers were asked to first evaluate adverts in pairs (requiring Higher Order Thinking Skills) before completing the G/Form evaluation. This supported and scaffolded their learning experience, and when asked to evaluate the adverts individually using the G/Form, teachers therefore had spoken and thought about this evaluation already and did not have to use a tool for the first time and simultaneously formulate their first responses as well. Additionally, the use of the G/Form modelled the use of data in lesson plans in real-time. Collecting and displaying the real-time data collection as teachers produced this, modelled for teachers a learning-centric pedagogic approach that invites students to collaborate in knowledge development.

#### 4.3.3.1.2 Criteria: Relevance

Teachers' course reflections and interview data indicate that they experienced the learning included in the IP Language ePlay MakerSpace as highly relevant to their immediate pedagogic needs. The relevance of the content and tools emphasized by teachers' inclusion thereof in their IQMS evaluations (data from interviews):

- ◆ IPL04: *We're definitely going to do it because we're busy with IQMS and classroom inspection in the next few weeks.*
- ◆ IPL23: *We use the projector for our IQMS, and for the CAs its used, and then they can see our objectives, and our videos. (CAs: Curriculum Advisors)*

The relevance of the IP Language ePlay MakerSpace content and process and particularly the lesson planning, was emphasized in one teacher's description:

- ◆ IPL21: *For my IQMS ja, that was a separate thingy. For my IQMS lesson I used the PowerPoint. Actually I wasn't going to use ANY of that, and I just happened to have did the PowerPoint cause I had to cause it was what they asked we had to, five of us we had to. I don't know why, but I just happened to I couldn't sleep that night, so I had to. So I was sitting and just happened to, and I thought why didn't, and I opened the Google Slides, and I wondered why didn't I use my PowerPoint, and as I was just playing around again, I got the Google Forms, and because I had an assessment, cause in the textbook there's an activity, that I won't use that assessment at the end of the lesson, I'm going to have my own questions. So I typed it out on Google Forms, and I used like multiple choice questions, short answer, paragraph answer, and I just projected that and then at the end of the lesson, there's the questions that you must do that. That and I also used, the camcorder on the tablet, to take a picture of the textbook, so now you don't have to the textbook and say this picture over here, and it's this and that. So that's a bit easier. And also when we mark, when we when we do a discussion, we discuss the answer and so forth, now we're gonna go to the board. So instead of one person writing it out you can just take a picture and there.*

IPL21 initially had not planned to include a PowerPoint presentation in her lesson, but decided to use the G/Slides (she refers to these as PowerPoint slides) her group had collaboratively developed. Remembering the work, she had done with her group, and possibly the collective memory of achieving success in developing these pedagogic tools, she felt motivated to use the tool in her class. What is more, she creative a solution to capture pages from the textbook for projection, using the tablet. Additionally, although she did not have devices for learners to complete the G/Forms and since learners' mobile devices are banned in the school, she further displayed creativity and innovation in projecting the G/Form she had created and letting learners answer the questions on paper. The learning from the ePlay MakerSpace was not only relevant to her immediate needs, but she shared this with her colleagues, adding relevance to their ongoing experiences as well.

One area that was noted by teachers as in need of improvement, was learning how to use the IWB and visualizer. However, due to equipment malfunction the office of ICT Integration cancelled this session. The relevance of the *course* could potentially be increased should this be added.

#### 4.3.3.1.3 Criteria: Sustainability

Two aims of the ePlay MakerSpace is to capacitate educators to create and innovate through playful engagement with ET tools, and to equip them to manage their own change processes. During the contact sessions, teachers engaged in the playful, active learning, creating and innovating in the ePlay MakerSpace. In this way, the playful engagement provided a space in which teachers could 'try out, try on and play with' (Reid and Wood, 2016) unexplored practices and thoughts within a safe space. This led to teachers discovering skills they may not have been aware of, as this teacher notes:

- ◆ IPL01: *The course was an eye opener. I have come to realize that I do have technology skills but it was dormant in the schooling environment. I would really like to attend a more advanced course.*

Additionally, in their interviews, the teachers at School F, K and A reported that they continued to engage in playful, active learning following the contact session. Empowering teachers to recognise and appreciate skills they did not realize they had, and to continue engaging with the playful learning from the ePlay MakerSpace, adds to the sustainability of the process.

Furthermore, teachers were frequently observed laughing, giggling and generally having fun while engaging in the different activities. As IPL21's example (discussed in terms of relevance) indicates, relational and active learning were shown to increase teachers' potential movement across the liminal zone, adding to the potential long-term sustainability of dispositional transformation process.

The evidence from teachers' interviews and continued contact, as discussed in the next section, indicates that teachers continued to change and move across the liminal zone. This further increases the sustainability of their learning and change.

In 2017, the *IP Language ICT Integration course* was presented to 60+ teachers at the CTLI, with a further 200+ teachers targeted for the 2018 intake. For the 2018 training, the CTLI commissioned me to develop a training programme to equip trainers (from the 2016 and 2017 teachers) to facilitate the ePlay MakerSpace decentralized at district level. In addition, the *IP Language ICT Integration course* has been accredited as a registered short course for nation-wide delivery in 2018, supported by the national Department of Basic Education. Thus, systemically the sustainability of the design is also increased.

#### **4.3.3.1.4**    Criteria: Effectiveness

The design met the global design principles, discussed more fully in the last sections of this chapter.

#### **4.3.3.1.5**    Criteria: Validity

The learning design for the IP Language ePlay MakerSpace drew on play theory and state-of-the-art knowledge.

Literature regarding play theory, play pedagogy and TPD with regards to transformative ET integration, is scarce. Although play theory is discussed, play pedagogy with regards and especially play to change teaching and learning practices with regards to ET integration is a relatively new field. Thus, while some peer-reviewed articles could be accessed regarding the principles of ePlay, much of the literature was newly published in peer-reviewed and non-peer reviewed sources. As a result, I had to make the decision to draw on play theory and MakerSpace literature from both peer reviewed and non-peer reviewed sources as was pertinent to develop and conceptualise the ePlay MakerSpace conceptually. Such a conceptual development, especially with regards to teacher professional development, which forms part of a socio-cultural design-based research study, has not to my knowledge been published, which increases the novelty value to the project.

Furthermore, setting ePlay in a MakerSpace adds to the state-of-the-art design. MakerSpaces are identified in recent NMC Horizon reports (Johnson *et al.*, 2015a, 2016; Freeman *et al.*, 2017), as both immediate and future trends in learning sciences. Peer-reviewed literature on the use of MakerSpace has only recently started appearing in journals (2014) and is mostly concentrated in the Library Sciences. Thus, the inclusion of MakerSpaces as part of the ePlay design to transform teachers' dispositions, is state-of-the-art.

#### **4.3.4 Formative evaluation of the enactment and implementation procedure**

##### **4.3.4.1 Criteria: Procedural strengths**

The design of the programmed schedule was intentionally semi-structured, and the flexibility of this proved highly beneficial in managing the many malfunctions, challenges and frustrations that arose during the contact session.

Teachers derived obvious pleasure from playing with the different online and cloud-based tools, and commented repeatedly in the feedback on this. One teacher who displayed a

particularly low skill-level, noted of this in her *course* reflection when stating whether the course met her expectations:

- ◆ IPL12: *Yes, as ii always hered people talking about ICT integration now i have more chances to be involved in this matter (sic).*

Teachers' enjoyment of the ePlay MakerSpace process seemed to invigorate and energize them, and on the last day, many commented that they were excited to spend the rest of their holiday playing and practicing with the online tools. Various teachers noted how much they enjoyed the ePlay MakerSpace in their course reflection:

- ◆ IPL02: *It was a very nice course. I thoroughly enjoyed it! But I have so much to learn still. Well done team ICT!*
- ◆ IPL24: *It was a very good course. I wish all our courses were this helpful.*
- ◆ IPL15: *It was an immensely enjoyable course, that made me realize how important a teacher's attitude and approach is towards learning and teaching. Funny enough, it was my intention to, in next term, continue with my lessons electronically, as i needed to get my children to better understand the Afrikaans Language (FAL). The tools on the internet as well technology, will definitely enhance and hopefully better their experience as well as my own.*
- ◆ IPL13: *Thank you Issabel and [Mr D] for an absolutely interesting, enlightning and empowering course. Was well worth giving up a few days in my holiday, while fasting, to be inspired. God Bless!!!*

These teachers' comments indicate that the transformative pedagogies modelled through the ePlay MakerSpace process can be identified a strength. Similarly, while the focus on empowering and capacitating teachers was not explicitly stated, as IPL13 notes, teachers experienced the process as such. Therefore, this approach could be identified as a strength as well. In addition, although the sessions were conducted in English, teachers could appropriate the learning and tools to the learning in Afrikaans, English or isiXhosa, either for

Home Language or First Additional Language teaching as IPL15's comment indicates. This wide-curricular relevance is a further strength of the implementation.

#### 4.3.4.2 Criteria: Procedural weaknesses

The repeated equipment failure and intermittent internet access was cause for major frustration. In particular, teachers were frustrating at not being able to learn how to use the IWBs and visualizers.

Learning support during the contact session was another weakness. The larger group of 26 teachers meant that more teachers needed assistance than I could provide at the same time. The large differential between experienced and novice users contributed to this, as novice users required more assistance leaving little time to extend the learning of experienced users. While teachers could help each other, this was not always what teachers wanted, as one teacher noted:

- IPL6: *I'm not technologically savvy so some of the activities we had to do required asking for assistance which can be frustrating if you are not helped straight away because there are others too who needed assistance.*

This frustration should be avoided to the transformation of dispositions and uphold the ePlay MakerSpace's nurturing environment, either by facilitating with assistants to support teachers, or reducing the group size.

Lastly, three teachers noted in their *course* reflections that the three-day contact session was too short, and that they felt this should be extended.

#### 4.3.4.3 Criteria: Procedural opportunities

Collective participation and the inclusion of the HODs and a group of teachers from each school, rather than individuals, should be exploited in future iterations. Where groups of teachers and HODs from Schools F, K and A attended, they returned to their schools and were collectively able to create opportunities for the rest of the staff to learn from their experience and start changing the culture in the school. At School F, the HODs initiated a 20-

minute Cyber Quickie session in which teachers meet each Thursday to share one thing they had learnt in terms of ET Integration and/or tools. At School A, the teachers petitioned the principal to create a greater linkage between the curriculum content covered in class and the learning in the computer lab. School Ks teachers appropriated the tablets for use in the classrooms. Additionally, following the IP Language ePlay MakerSpace, an IP Mathematics ePlay MakerSpace was held at the CTLI which one of the teachers from School K attended, bringing two of their colleagues with her. These examples indicate that the collaborative relational learning that started in the ePlay MakerSpace was continued at school-level among colleagues.

Where possible teachers could be invited to bring their own devices to compensate for equipment malfunction.

Where possible a Wi-Fi hotspot independent of the venue / facility should be included in the implementation to compensate for intermittent internet connectivity.

#### 4.3.4.4 Criteria: Procedural threats

On Day 3 two curriculum advisors joined the presentation session. The carefully nurtured and upheld safe ePlay MakerSpace context was somewhat disturbed by their presence. While some teachers appreciated their feedback after their group presentations, for others it appeared the presence of the curriculum advisors caused unnecessary anxiety. This was evident in the way teachers' heads bowed and their shoulders slumped forward, while the 'buzz' of excitement that had filled the room prior to their entry, went quiet.

It would be advisable to limit such incidences in future ePlay MakerSpace sessions as this impacts the relational learning taking place. Alternatively, any person joining the group for whatever reason should be thoroughly prepared to follow the group's guidelines and uphold the ground-rules and preserve the safe and secure context.

This section formatively evaluated the design and enactment of the IP Language ePlay MakerSpace. Evidence presented suggests that teachers continued learning, having taken charge of their change journeys. This is further discussed in the following section.

### 4.3.5 Evaluating change

The purpose of the ePlay MakerSpace is to create the enabling conditions through transformative ET integration to transform teachers' dispositions. This section provides evidence of the manner in which teachers were able to transformatively integrate ETs into pedagogic realities and effect changes following the IP Language ePlay MakerSpace.

#### 4.3.5.1 Changes measured during the IP Language ePlay MakerSpace

The ePlay MakerSpace inculcation processes and enabling conditions are designed to transform teachers' dispositions to impact how they transformatively integrate ETs. As the evidence from teachers' self-diagnosis on the TCF confirmed, the majority of teachers describe their pedagogic approach as teacher-centric, regulated and restricted, positioned variously in Quadrant A or D. Viewed through the theoretical frame, such a pedagogic approach is reproduced by collective and individual pedagogic habitus that are structured to reproduce rather than create and innovate. The ePlay MakerSpace emphasizes the development of teachers' capacities to create and innovate as a means to potentially transform dispositions, that would, theoretically, restructure pedagogic beliefs, practices and perceptions towards more learning-centric, egalitarian and transformative pedagogies. This section provides evidence of changes measured during teachers' engagement in the ePlay MakerSpace to support this theory.

IP Language teachers created various artifacts in the ePlay MakerSpace. This included a concept map as means to reflect on their conceptual understanding of '*ICT Integration in Education*' in the first session of Day 1, and again in the last session on Day 3. The concept mapping protocol was strictly followed as developed in Chapter 3, to increase comparability (Benney and Hughes, 1956), and descriptive validity. In addition, teachers created mind-maps of the characteristics of a character, and wrote a descriptive paragraph in G/Docs

using these, and mind-maps of the characteristics of an advert and created a G/Forms for evaluating an advert. These artifacts were anonymised and included in the G/Slide presentation on the website: W2.2.

Teachers' created artifacts were evaluated to measure creativity in terms of fluency, flexibility and originality (Torrance, 1972b). A rubric for measuring fluency, flexibility and originality for each artifact was developed and each artifact measured according to this, see G/Sheet: [ePlay MakerSpace: Measuring creativity in artifacts](#). To increase interpretive validity, the rubric was iteratively developed, trailed and refined with the help of colleagues, over the course of a year. Using the rubric, each artifact was evaluated on at least three occasions over the course of July 2016 – October 2017, and results compared to the Foundation Phase teachers' artifacts. This process further refined the measurement tool and increased interpretive validity. The rubric was designed to measure creativity scores, ranging between one and four. Results from the creativity measured in teachers' artifacts over the course of the three days of the IP Language ePlay MakerSpace are presented in Figure 10.

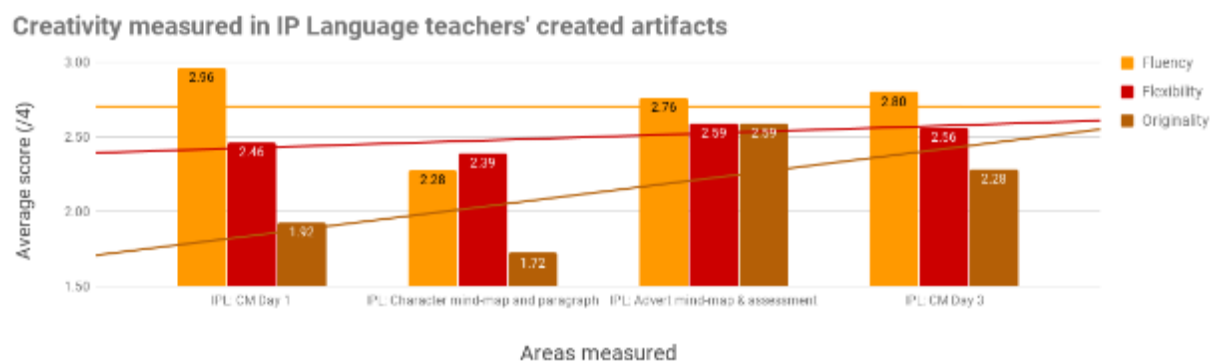


Figure 10 Creativity measured in IP Language teachers' artifacts

As can be seen in the chart: Creativity measured in IP Language teachers created artifacts, the trend lines indicate that some aspects of creativity remained more or less unchanged, while others showed a significant increase.

Fluency refers to the ability to generate any number of different ideas. As can be seen from the chart, the fluency measure peaked on the first day in the CM activity, dropped to an

average of 2.28 for the character mind-map and then increased to 2.8 on the last day. The drop could be related to the tool, as teachers used Mindmup.com for the first time to create the character mind-map, which could explain the decline in fluency. Similarly, the last session on Day 3 was somewhat rushed with teachers wanting to leave, and while the full time was available for them to complete their concept maps, not everyone used the time allocated - which could also explain the lack of fluency.

Flexibility refers to the ability or capacity to switch between approaches and is related to the capacity to adapt to different environments or challenges. Flexibility was measured in the way teachers for example switched between working in Mindmup.com to create a mind-map and then working in G/Docs or G/Forms to create an artifact using the information on the mind-map. Similarly, in the concept maps, flexibility was measured by assessing teachers' capacity to switch between ideas or categories of ideas. As can be seen on the chart, the trendline for flexibility shows an increase between the CM on Day 1 and that on Day 3, peaking with the advert mind-map and assessment activity at 2.56.

Originality refers to the capacity to generate novel or unusual ideas, and is indicative of an individual's dependence or lack of reliance on routine or habitual ways of thinking. The most significant increase was measured in teachers' capacity to generate novel or unusual ideas in their created artifacts. The Day 1 CMs indicated that teachers generally relied on habitual and routine ways of thinking when reflecting on the topic: *'Integrating ICTs in Education'*, with eighteen (18) teachers scoring 2 on the rubric, three scoring 3 and five scoring 1. Hence the majority of teachers included routine and habitual concepts with one or two less-obvious or unexpected concepts or relations. Originality measured in the descriptive writing activity was an average of 1.72, and may potentially be influenced by the new tool being used (mindmup.com and G/Docs) and also the frustration of intermittent internet connectivity in the venue. The advert mind-maps and G/Forms created on Day 2 showed a marked improvement in originality with the average score being 2.59. This indicates that more teachers were starting to generate novel or unusual ideas, and were relying less on habitual ways of thinking. Originality for the CMs on Day 3 drops again to 2.28, which as

discussed above, may have been impacted by teachers rushing the activity and wanting to leave.

Overall, an increase can be observed in the creativity measured in IP Language teachers' artifacts over the course of the three days of the ePlay MakerSpace. Despite the introduction of new tools and the challenges on the last day to get teachers to complete their CMs, the trendlines indicate that over the course of the three days, a positive change occurred. Bateson and Martin (2013) in their discussion on creativity, note that it is possible for an individual to display creativity in terms of originality and not necessarily in fluency. This may be the case if one views the average creativity measured in Day 1's CMs. There is a significant difference between teachers' average fluency (2.96) and originality (1.92) scores. However, over the course of the three days, the gap between fluency and originality decreases steadily. This further supports the claim that teachers' creativity measure increased during the ePlay MakerSpace session.

The next section answers two questions: whether teachers effected changes to their teaching, and whether the increased creativity, measured in terms of flexibility, fluency and originality during the ePlay MakerSpace, can be linked to these changes.

#### 4.3.5.2 Changes reported after the IP Language ePlay MakerSpace

A pressing goal of the ePlay MakerSpace concept is to prepare and equip teachers to manage their own change processes. At the conclusion of the three day session, teachers used the G/Slide: [Roadmap to change](#), to diagnose their current position on the TCF (Tarling and Ng'ambi, 2016), and identify a goal position they wish to achieve by the end of 2016. They also set goals to achieve in their schools and classes in the three weeks after the ePlay MakerSpace, while the G/Slide created the opportunity for ongoing reflection.

Evidence indicates that some of the IP Language teachers effected different changes at classroom and institutional level. These changes were observed during the researchers' school visits and from the interview data. In addition, a few teachers shared photos and

updates on their progress via WhatsApp or posted images to the Edmodo group, and IPL15 updated her Roadmap to Change, providing further evidence of change.

#### 4.3.5.2.1 School F

School F was represented by five teachers, three of whom were Post Level 1, IPL04, IPL15 and IPL24, and two were Heads of Department: IPL13 and IPL26, while an additional three teachers attended the Foundation Phase ePlay MakerSpace. The school is a model school, and the principal actively supports and encourages teachers to transformatively integrate ETs, creating the enabling environment for this.

Teachers' dispositional transformation started in the IP Language ePlay MakerSpace. Bar IPL26, all the teachers scored 3/3 in the formative evaluation for participation. IPL26 experienced continued challenges to log into her Gmail account throughout the three days, leaving her disappointed and in tears on the last day, having not been able to participate more actively. However, while it may appear that her score is unfairly assigned, she also left early on Day 2 and 3 to attend to her daughter's wedding arrangements, which decreased her score.

Using the TCF (Tarling and Ng'ambi, 2016) teachers self-diagnosed their current positions, and set goals for themselves. IPL13 and IPL15 self-diagnosed their positions on the TCF as teaching mostly in D, while IPL4 and IPL24 self-diagnosed their teaching at the time as aligned with Quadrant A-type teaching. IPL4, IPL13 and IPL15 set goals to teach using Quadrant C-type pedagogies, while IPL24 set the goal of teaching in Quadrant D.

The creativity measured in School F teachers' created artifacts, indicate a significant change between Day 1-3 of the IP Language ePlay MakerSpace. The scores for fluency, flexibility and originality for individual artifacts were averaged to generate a creativity measure for each artifact. Teachers from School F's creativity scores were then visually represented in a graph (see Figure 11). Compared to the creativity scores of other teachers, such as teachers from School A (see Figure 13) and School K (see Figure 14), teachers from School F scored

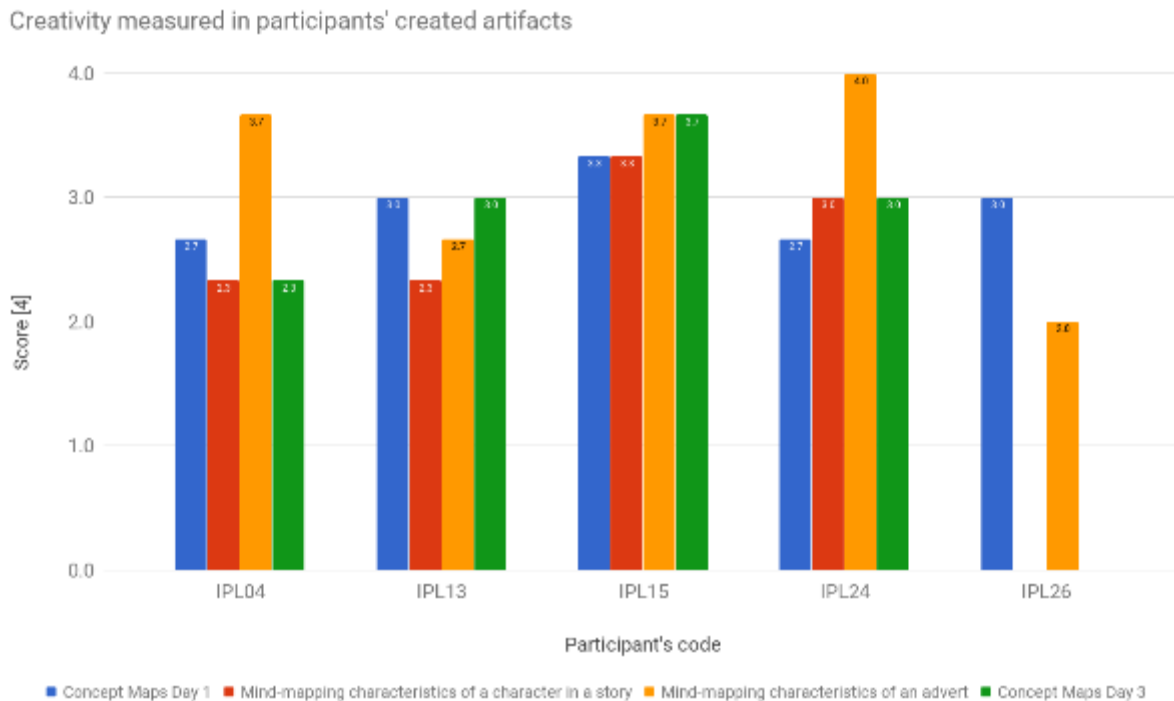


Figure 11 Creativity measured for School F's teachers' created artifacts

significantly higher. IPL13, IPL15 and IPL24's creativity scores further indicate a consistent increase between Days 1 and 3, whereas IPL04's scores range between 2.3 and 3.7.

The IP Language teachers at School F effected individual changes at their schools and in their classrooms. While IPL04, IPL13, IPL24 and IPL26 had not implemented different teaching and learning strategies from the ePlay MakerSpace sessions, at the time of the interview, IPL15 had done so and continued reporting on her change over the course of the next year.

IPL15 is a Grade 7 language teacher at School F, where she is also responsible for managing the computer lab and supporting colleagues who wish to integrate ETs. She used her Roadmap to Change document to capture her change journey, and as reflective tool. In addition, she sent me photos, links and messages via WhatsApp and email of the progress she was making. IPL15 had indicated in her reflections that she had learnt a lot during the ePlay MakerSpace, and set goals to implement what she had learnt in the months following this. During the interview, she commented as follows:

◇ 57:04 IPL15: *I think the last, my last comment, I don't know if you read it, it was to you and [Mr D], and I really, I thanked you from the bottom of my heart, because I really learnt something. I'm not, I'm not, I didn't go to formal computer courses, or nothing like that. Everything I know, I'm self-taught. Uhm, but it's just because I play around a lot, and I'm not scared to try, I literally go in because I know I can always go back. So uhm for me, this was really cool to have some formal training and to actually sit back and follow steps, and follow procedure that you people set out, and in that way learning. Because everything that I've learnt so far, it's uhm... by feeling myself, feeling my way around. But this was, you gave us thing to structure, there was structure, and I could follow structure, and I could learn from the structure, you know. And I just thought it was very exciting, uhm, being able to chat to people... uhh.. other educators, and sharing for me was most important. I love sharing, I love, and I love I love if other people share with me as well. I'm not a selfish educator, so uhm, that's just from my perspective. And I just thought that was, uhm like I told you, Google Drive, sho, uhm.*

As she had planned during the ePlay MakerSpace, she returned to school and implemented her goals. During the period after the ePlay MakerSpace, she could not access the computer lab as all available time was booked for Mathematics. Therefore, she modelled the use of Mindmups as pre-writing activity, followed by an individual writing activity for Afrikaans using a projector and the school's laptop. This included what she called 'the cutting out', - that is, the strike-through function, with her learners. When time became available, she took learners to the computer lab where they completed a spelling test on the computers. After the Afrikaans lesson, she reflected as follows, in her [Roadmap to Change](#) (link embedded):

◇ IPL15: *Even though I wasn't able to bring learners into computer lab, and learners do not have their own devices as yet, I would like for them to be more formally introduced to lessons on the computer. Our learners may seem like they know how to use cell phones, but they don't know how to use it as a learning tool/device.*

In the last session on Day 3, IPL15 self-diagnosed her pedagogic approach as being in Quadrant D, and she set herself the goal of teaching in Quadrant C. Subsequently she designed a learning task that matched the descriptors of Quadrant C and reported on this in her Roadmap to Change document.

Wanting to create more learning-centric opportunities, she asked learners to create presentations for Life Orientation detailing their potential career choices (a CAPS requirement for this grade). She did not restrict them to a particular presentation type or tools to use, or regulate their interaction as she said she wanted to function in Quadrant C on the TCF and focus on the learning. While many students used Google Slides or PowerPoint, others used different tools. One student for example, who wanted to become a cartoonist / animator used an app on his phone to create a cartoon (see Figure 12 – click on the screenshot to view, or visit the website, W2.3).



Figure 12 A Gr 7 Learners' cartoon ([click to follow the link](#))

Her learning design engaged learners, either to create with presentation tools, or to use mobile phones and apps they use daily. The learning design incorporated active and relational learning elements, as learners actively engaged in making and creating their

presentations, leading to a highly engaged learning experience. The learning also focused on Higher Order Thinking Skills (Bloom *et al.*, 1956; Krathwohl, 2002), and very appropriately employed the ICT Integration Principles included in the professional learning session of the ePlay MakerSpace. She also implemented the transformational learning from the ePlay MakerSpace, as she managed her change journey, using the TCF to plan and structure the pedagogy she wanted to employ and subsequent ET Integration strategy to follow. This enabled her to move from her existing, self-diagnosed position in Quadrant D, to her goal position in Quadrant C on the TCF.

In her deliberate and purposeful movement on the TCF, from Quadrant D to Quadrant C, IPL15 deliberately and purposefully managed her movement across the liminal zone. Using the TCF, her movement can be described as from a regulated, restricted pedagogic orientation to a non-regulated and unrestricted approach. This self-directed, self-perpetuating movement indicates that durable dispositions of creativity and innovation were reproducing transformative ET integration.

IPL15 continues to share evidence of her transformative ET integration, and changes taking place at the school. During the June 2017 exam-season, her Grade 7 Afrikaans and Natural Science learners completed their exams in the computer lab using the online exam papers she designed in G/Forms (examples are available on W2.3). During 2017, the learners received tablets to work on and for the November 2017 exams, all the Grade 7 learners wrote their exams online using G/Forms. The school has implemented a 'Cyber Quickie' system where individual teachers share, in only 20-30 minutes, any useful ET tools or pedagogies with their colleagues. The idea for this emerged during the interview in August 2016, which the HODs, IPL13 and IPL26 subsequently implemented. During 2017, the principle sent the rest of the staff to attend the *ICT Integration courses* while teachers from the 2016 and 2017 groups were identified as potential trainers to design, facilitate and formatively evaluate ePlay MakerSpaces during 2018.

#### 4.3.5.2.2 Change at School A

Five teachers from School A attended the IP Language ePlay MakerSpace. Whereas a computer lab is available at the school and its use is timetabled, teachers did not appropriate the computer lab for curricular activities prior to attending the ePlay MakerSpace. Instead, a facilitator managed learning in the computer lab that was unconnected to the curriculum learning taking place in teachers' classrooms. Following the ePlay MakerSpace, teachers met with the principal and asked that a more direct link be created between the work the computer lab facilitator did with learners and the curriculum covered in classrooms, with a particular emphasis on Mathematics. During the interview, IPL23 said that the principal agreed and that the computer lab facilitator would meet with the Maths and Grade heads, and teachers, to manage this and create greater integration between the work learners did during their computer lab timeslots, and what they did in their classrooms.

School A, at the time, did not have any ET tools available for teachers to use. During the ePlay MakerSpace at the CTLI, one of the teachers mentioned this, upon which the office of ICT integration donated a second-hand projector for the teachers to use at the school! However, at the time, there was no Wi-Fi or IWBs, and only one ordinary wall-mountable whiteboard, the large, heavy type that takes two people to carry. Following the ePlay MakerSpace, IPL06, IPL21, IPL22 and IPL23 started using the projector daily. Since they had one projector and one large standard whiteboard, they created a schedule to share the projector and whiteboard. Astonishingly, they carried the whiteboard up and down two flights of stairs to their classrooms whenever they want to use it. One teacher jokingly added that they knew where the projector was by the sound of the whiteboard falling off the chalkboard's rails (which it balances on).

This change has been ongoing, at an institutional and classroom level. During 2017, two more IP Language teachers and one FP teacher attended the *ICT Integration course* at the CTLI from School A. They reported that thirteen IWBs were installed, especially in IPL06, IPL21, IPL22 and IPL23's classes. Twenty tablets had been donated to the school and while

Wi-Fi was installed and made available to teachers, there remained problems with bandwidth. They could not comment on the curricular link between the computer lab facilitator and the classroom learning. However, they stated that they felt inspired to attend the 2017 courses as the four teachers from the 2016 courses had inspired them to also '*get on the bandwagon*'. In this way, the change that started as one projector and one standard whiteboard carried between classrooms by the four teachers from the 2016 group, grew to impact the rest of the IP Language teachers.

Teachers from School A who had participated in the ePlay MakerSpace, experienced individual changes differently in the ePlay MakerSpace. Four of the five teachers, IPL06, IPL21, IPL22 and IPL23 diagnosed their position on the TCF at the time as being in Quadrant A, describing their pedagogic approach as teacher-centric, regulated and restricted, with none of them appropriating ETs for teaching purposes in their class. All four teachers set their goal as wanting to achieve Quadrant C-type teaching by the end of 2016, involving more learning-centric pedagogies and transformatively integrating ETs into curricular activities in which learners create, evaluate and analyse using ETs (IPL16 did not submit the link to her Roadmap to Change hence her results cannot be included). The formative evaluation of the teachers indicated that they had experienced change during the ePlay MakerSpace. Whereas the four teachers, IPL06, IPL21, IPL22 and IPL23, scored 3/3 for participation in the ePlay MakerSpace, IPL16 scored 1/3. The creativity measures of the artifacts the five teachers created, showed an increase over the three days, most notably in terms of fluency, and less in terms of originality and flexibility. The measurement for fluency, flexibility and originality of each artifact was aggregated to provide a score of creativity for each artifact created, and these scores were visually represented in a graph, see Figure 13.

As can be seen in this graph, IPL06, IPL16, IPL20 and IPL23 experienced an average increase in creativity during the ePlay MakerSpace, while IPL21 and IPL22 experienced a decrease. In this regard, IPL21's creativity measure contradicted the data produced during the interview. Following the interview, I made the following note:

*IT notes: IPL21 appeared to remain on the periphery during the ePlay MakerSpace session, seemingly too shy to engage in the small groups. She did not readily interact with group members and let others make all the decision or conduct all the activities. On the last day, she did not participate in presenting the group learning design. However, during the interview, she displayed far greater ownership and commitment, empowerment and creativity. She created various pedagogic tools to use with the projector and shared this with her colleagues, who said they asked her for help or ideas. However, during the interview she appeared to be an introverted person, sharing only the bare essentials, followed by her colleagues' explanations of her achievements.*

Creativity measured in participants' created artifacts

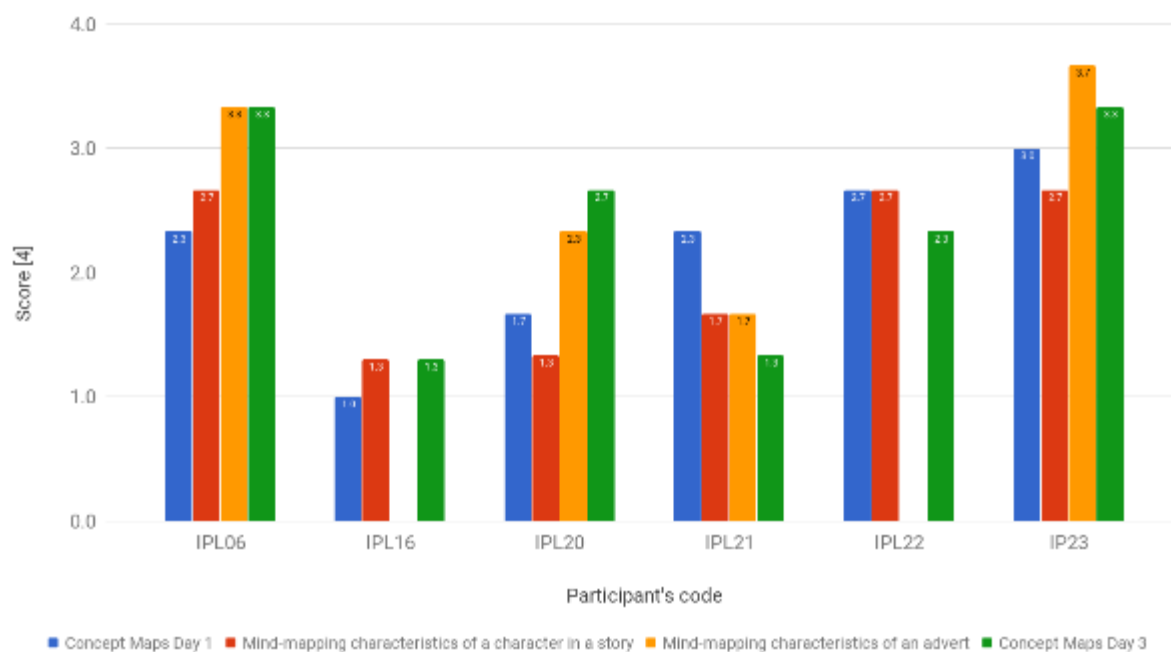


Figure 13 Creativity measures for School A's teachers' created artifacts

The artifacts IPL21 created in the ePlay MakerSpace, and the creativity measured in these – leading to rather low scores, contradicts the creative solutions and her colleagues’ praise of her achievements during the interview. She also did not engage with me via WhatsApp or responded to the emails I sent asking for feedback. As a result, I initially formatively evaluated her participation as extremely low, and she achieved mostly 1s and 2s. However, the interview data and her colleagues’ reports of her activities, directly contradicted this initial evaluation. Consequently, her participation was rescored to match the evidence rather than my observations. However, based on the rubric and standardised scoring, the creativity measure remained unchanged.

The changes that took place at School A appear to be influenced and/or initiated by the four teachers, IPL06, IPL21, IPL22 and IPL23, with IPL16 role’s remaining undefined during the school visit and interview. The formative evaluation of the first four teachers’ participation in the ePlay MakerSpace, indicated that they displayed high degrees of ownership, engagement, commitment and enthusiasm, as well as empowerment in terms of reciprocity, responsibility and relationship / collaboration, and engaged in the reflective learning process.

Four of the teachers at School A changed the way in which they taught and integrated ET tools, both individually and supporting other staff members to do the same. Their high participation and three teachers’ improved creativity scores, appear to correlate with the changes they effected following their engagement with the ePlay MakerSpace. More so, correlating to Bateson and Martin’s (2013) distinction between creativity and innovation, it appears these teachers displayed higher levels of innovation than creativity. Bateson and Martin (2013) describe innovation as the capacity to generate a novel form of behaviour or idea that has practical benefits and which can be adopted by others. These teachers innovated practical means to start integrating ETs and online tools into their classroom practice, overcoming institutional challenges and exploiting opportunities, such as the provision of the one data projector and whiteboard. Their enthusiasm motivated others to change their behaviour and ideas, and *‘get on the bandwagon’*, indicating their high capacity for innovation. While this innovation may potentially be correlated to their engagement in

the ePlay MakerSpace, it should be noted that it was only after their engagement that they approached the principal to link the computer lab learning with curriculum content, and that they started using ET tools.

The evidence suggest that these teachers engaged transformational ET integration. Based on their innovative behaviour and ideas, and the way this impacted change at their school, they can be said to have experienced disposition-level transformation. IPL06, IPL20, IPL21 and IPL22 reported changes to their teaching and integration of ETs in their classes and within the school, indicating that they transformatively integrated ETs. The institutional context and leadership provided the enabling environment to support their change, with the principal agreeing to their requests. In the following year, the school received greater access to devices and connectivity, indicating not only institutional but also systemic support, as well as support from sponsors in the community who donated tablets. The dispositional transformation IPL06, IPL20, IPL21 and IPL22 experienced, thus influenced greater institutional change as well.

#### 4.3.5.2.3 Change at School K

Three teachers from School K attended the IP Language ePlay MakerSpace: IPL05, IPL07 and IPL17, and were subsequently interviewed. IPL05 and IPL07 self-diagnosed their pedagogic approach at the time as aligned with Quadrant A on the TCF, while IPL17 self-diagnosed her position as in Quadrant D. All three set the goal to teach using Quadrant C-type transformative pedagogies. The formative evaluation of these three teachers' participation, indicated that both IPL07 and IPL17 scored 2/3, while IPL05 scored 3/3. The different aspects of creativity measured in the artifacts they shared, were averaged to indicate the average creativity measured in each artifacts' creation. The results of this are displayed in the accompanying graph (see Figure 14). Whereas IPL05 indicates more or less consistent scores, both IPL07 and IPL17's creativity measures increased between Days 1 and 3 of the ePlay MakerSpace, with IPL17 showing the most significant increase.

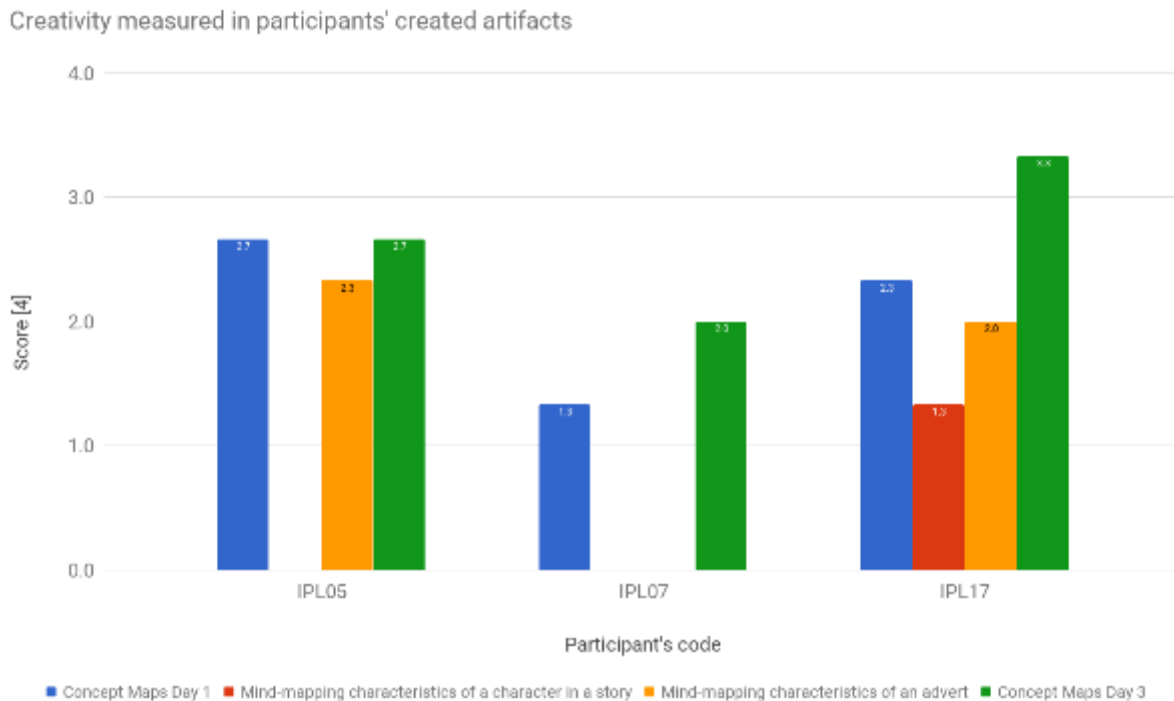


Figure 14 Creativity measured in School K's teachers' created artifacts

The teachers at School K, in particular IPL05 and IPL17, effected change in different ways following the ePlay MakerSpace (IPL07 did not contribute during the interview). IPL05 found the tablets in the strong-room, and started using these in her class. She reportedly tried using the tablets with learners, wanting them to look up word meanings using an online tool, Word Me. However, the Wi-Fi would not support the number of devices due to bandwidth constraints, and so planned to swap time with the principal and let her learners look up words in the computer lab. She also showed learners how to use the app using her projector and laptop, which they then tried at home. In conversation with learners, she came to realize that despite her assumptions, many had access to mobile devices such as tablets, as indicated in her comments:

- ◆ IPL05: *And when I asked them, I was also surprised for when they had the tablet. So so there was no internet connection, I said, Fine pack up, um, they must take out their dictionaries the old way? Like we did the old way like you, mam? You can say we must bring our tablets! (excited voice) When I asked who had tablets, out of the*

*39 learners there was about 12 (IPL17: yes) that put their hands up, that said but they do have tablets.*

♦ IT: *Ja, Ja*

♦ IPL05: *It's now not 39 but it's 12 out of the 39 who has access or who knows or they use their parent's tablet at home and I asked those 12 learners will your parents let you bring it to school. They said no but we can ask but 6 of the 12 say it's their own tablets.*

IPL05 consequently wanted to invite learners in the weeks after the interview, to bring their devices to school as part of a Bring-Your-Own-Device (BYOD) initiative.

IPL17 also reported using the school's tablets. However, during the interview, she did not know what to call these and initially referred to the tablets as small computers, which I took to be notebooks but which it was established, were tablets. She used the Futurekids content to let learners find pictures of earthquakes and paste these into a MS Word document.

Both IPL05 and IPL17 noted the frustration they experienced when trying to get learners to access the G/Drive or to use Edmodo, as learners required email addresses to access these. The learners at the school generally do not have email accounts, and since learners are not old enough to open their own Gmail accounts, they need to ask parents to open accounts for them. However, the literacy level and technological knowledge among parents, they noted, results in parents being unable to support them in this task. (This correlated with the teachers' comments from School Z as well.)

IPL05 and IPL07 tentatively started using devices and in the process, experienced different challenges to this. IPL05 generated a novel solution to the challenge of device and internet access by inviting learners to bring their devices from home initiating a BYOD initiative.

IPL07 implement novel pedagogic practices by letting learners work on the tablets to support curriculum delivery, which had not occurred in the school since the start of the year. Her actions can potentially be more closely aligned with innovation than creativity if applying Bateson and Martin's (2013) definition. She innovated novel forms of behaviour

and ideas to obtain a practical benefit in the form of improved learning, which was then adopted by other teachers (following the IP Mathematics ePlay MakerSpace in October 2016). In both instances, tentative change had been affected in both creative and innovative ways, increasing their use of devices but without significantly changing their pedagogic orientation. Despite the lack of evidence for pedagogic change, the changes teachers implemented are changes they feel comfortable with and at the pace they feel they can manage.

The different examples of change described at School F, K and A, indicate that teachers planned and managed transformative ET integration and subsequent changes processes in an autonomous, self-directed manner. At School F, IPL15 planned and managed transformative ET integration by designing learning to specifically target Quadrant C-type transformative pedagogies. School A's teachers collaboratively created greater curriculum-based learning linkages between the work they did in class and what learners did in the computer lab, and also innovated systems to move to Quadrant D from Quadrant A in their pedagogic approaches. Teachers at School K chose to start substituting paper-based activities with tablet-based activities, moving higher in Quadrant A and towards Quadrant D. They also inspired other teachers at their schools to attend the *ICT Integration courses*, and adopt similar pedagogic approaches. These examples indicate that teachers planned and managed transformative ET integration according to the local needs and priorities, and effected change to their teaching and learning practices, as indicated by their movement on the TCF. The results indicate that teachers' dispositions were transformed in varying ways, and their continued feedback, indicates that this change has been sustained.

#### **4.4 Elaborating and refining the design principles**

The last formative evaluation of the IP Language ePlay MakerSpace, evaluated the design, enactment and process of the ePlay MakerSpace according to the global design principles developed in Chapter 2. The intention of this final formative evaluation, is to refine and elaborate the global design principles with to inform the design of Iteration 2 for Foundation Phase educators.

GDP1) The ePlay MakerSpace inculcation processes and enabling conditions transforms disposition by capacitating teachers to create and innovate with emerging technologies.

The ePlay MakerSpace process developed teachers' dispositions to create and innovate, as was indicated by the increased creativity measured for the IP Language teachers.

Particularly teachers' originality scores increased more than their fluency and flexibility scores. This was correlated to the way in which teachers at School K for example, generated novel solutions to address challenges within their context and transformative integrated ETs at classroom and whole-school level. However, not all teachers' creativity measures increased significantly during the ePlay MakerSpace, and some even decreased, such as IPL21. However, as was argued, the evidence from teachers such as IPL17 and IPL21's examples, suggest that transformation of dispositions occurred as evident in these teachers' increased capacity to innovate practical solutions. This emphasis is included in the refining of the GDP as:

**Refined 1gDP1) The ePlay MakerSpace processes and enabling conditions develop teachers' capacity to create and/or innovate with emerging technologies to transform dispositions.**

GDP2) The ePlay MakerSpace inculcation processes and enabling conditions transforms disposition leading to the restructuring of beliefs, practices and perceptions since the dispositions that formed these are transformed.

In the last session of Day 3 of the ePlay MakerSpace, the majority of teachers self-diagnosed their pedagogic orientation, and identified their goal position on the TCF. Interview data and informal feedback was used to ascertain whether teachers' pedagogic beliefs, practices or perceptions had changed.

While many teachers identified Quadrant C as their goal position on the TCF, only IPL15 deliberately set goals and managed her change process to achieve this. Other teachers implemented change at their class and schools. Analysing their interview data, it appears that their change journeys were more implicit and less directed, with teachers moving from Quadrant A to D (IPL06, IPL221, IPL22 and IPL23), or from a low position in Quadrant A to a

slightly higher position (IPL05 and IPL17). Regardless of their movement on the TCF, whether intentional or not, change occurred. IPL15's case most significantly indicates epistemological evolution, while the teachers at School A effected change with the school system, which impacted learners across the Intermediate Phase. In both cases, change was affected to practices, beliefs and/or perceptions, whether in the individual or in the school's culture or collective habitus, leading to the refinement of the GDP as:

**Refined 1gDP2) The ePlay MakerSpace process and enabling conditions can restructure individual and collective beliefs, practices and/or perceptions by transforming dispositions that formed these.**

GDP3) The ePlay MakerSpace creates the enabling conditions to support teachers' entry into the liminal zone to transform teachers' dispositions.

The morning of Day 2 of the ePlay MakerSpace, started with a group reflection session in which many teachers commented on the discomfort they experienced during Day 1. At lunchtime on Day 2, these negative feelings had dissipated and teachers increasingly became energized, to such an extent that on Day 3, many commented that they would spend the rest of their holiday playing with the new tools. As much as possible as facilitator, I worked to carry the weight of change for teachers, but as this was the first time that I had facilitated teachers' entry into the liminal zone, I was also not fully prepared for the depth and heavy weight this would incur. While I expected some negative feelings, and prepared to manage this, my own frustration at the challenges posed by the venue, computers and internet connectivity, added to the mixture of teachers' emotions, contributing the weight of change in the space. Despite this, the evidence presented described teachers' crossing of the threshold into the liminal zone where the transformation of dispositions could take place. Once back at school, teachers transformatively integrated ETs and effected different forms change. Thus, rather than as the GDP states, that teachers enter the liminal zone to transform dispositions, the GDP is rephrased:

**Refined 1gDP3) The ePlay MakerSpace creates the enabling conditions and carries the weight of change to support teachers' entry into the liminal zone where the transformation of dispositions can occur.**

GDP4) The ePlay MakerSpace creates and nurtures autonomous and autotelic ePlay.

GDP5) The ePlay MakerSpace process is inclusive. Players in the ePlay MakerSpace come from diverse contexts and range in skill, competencies and the command of different kinds of knowledge.

The evidence presented indicates that teachers engaged in the ePlay MakerSpace and enacted transformative ET integration in an autonomously and self-directed manner, validating this GDP. The autotelic nature of the transformative ET integration is however ill-defined, and evidenced from the data, 'self-directly' is a more appropriate term.

Three teachers noted that the pace during the ePlay MakerSpace was too fast, and suggested either extending the number of days or slowing the pace. The pace of their entry and crossing of the liminal zone, did not align with the learning pace of the ePlay MakerSpace. Although the DP remains unchanged, these teachers' comments however emphasize the need for greater sensitivity and support all participants, potentially providing additional facilitators or keeping group sizes smaller. Moreover, the analysis of GDP4 and GDP5 indicated that these two DPs could be amalgamated and refined as:

**Refined 1gDP4) The ePlay MakerSpace assumes teachers are autonomous and self-directed, and is sensitive to and inclusive of the needs of all participants.**

GDP6) The ePlay MakerSpace process models sophisticated applications and pedagogical possibilities of the transformative integration of emerging technologies that are chosen to be immediately applicable and relevant to teachers' unique needs.

Evidence presented indicated that teachers found the course highly practical, relevant and that they could immediately implement what they had learnt. The high relevance of ETs, learning and the modelling of transformative ET integration, was evident in teachers' inclusion of the modelled practices and tools in their IQMS evaluations, validating these

tools are representing legitimate cultural capital. In view of this, GDP6 is confirmed and validated, and left unchanged, although it is renumbered as 1gDP5.

**GDP7) The ePlay MakerSpace process provides opportunities for reflective learning.**

The group and individual reflective sessions successfully supported teachers to articulate their learning and change, how they engaged in the process and experienced other's learning. Many of the IP Language ePlay MakerSpace reflective sessions were however not recorded in Edmodo, but were included as informal shared whole-group reflective sessions. The lack of evidence to indicate the reflective journey, placed emphasis on key reflective moments such as the *course* reflections, and not losing reflection *in* the journey. In future iterations, such reflections should ideally be recorded in the online space, before this is shared in the whole-group, to document the reflective journey. In addition, based on the formative evaluation results for participation, most teachers scored lower for engagement in reflection. Following O'Sullivan's (2002) findings, GDP7 is thus refined to include the emphasis on scaffolding to support participants in learning to reflect at the same time as reflecting on learning.

**Refined 1gDP6) The ePlay MakerSpace process systematically scaffolds and provides opportunities for reflective learning.**

**GDP8) The ePlay MakerSpace process provides opportunities for professional learning.**

The professional learning included in the IP Language ePlay MakerSpace was well received. However, the use of Anderson's Model for Interaction appeared to cause some challenges when teachers were required to apply it in their lesson plans. Similarly, while teachers could verbalize pedagogical rationale for including HOTS and 21<sup>st</sup> century skills in their lesson plans, in the presentation of their lesson plans, many continued drawing on lower order thinking skills of remembering, understanding and applying. This suggests that rather than a wide overview, professional learning should be more directed and encourage deep and meaningful learning (Anderson, 2004b), and should be more carefully scaffolded. GDP8 is thus rephrased:

**Refined 1gDP7) The ePlay MakerSpace process systematically scaffolds and provides directed opportunities for professional learning.**

GDP9) The ePlay MakerSpace process provides opportunities for active learning.

Teachers' course reflections on Day 3, reflect the success with which the active learning was implementing in the ePlay MakerSpace. Teachers listed the parts of the *course* that they enjoyed most as: G/Drive and Edmodo, G/Forms and Mindmapping, collocated to the verbs: use, download and creating, enjoyed, using and able. These words choices suggest that within the active learning, teachers appreciated and enjoyed the dynamic, emergent process of gaining capacities through the transmission of active practice towards mastery.

The formative evaluation of teachers' created artifacts indicated their inconsistent posting in Edmodo and their unfavourable first experience of G/Forms. A more carefully structured and scaffolded process is suggested to support teachers, especially those with low technical knowledge, when new tools are introduced. Therefore, a three-step Tool Introductory Process (TIP) was designed to introducing new tools in the ePlay MakerSpace (illustrated in Figure 15):

1. **Playful Exposure:** Educators complete a playful, light-hearted activity using the tool for the first time.
2. **Task-Driven Use:** Teachers use the tool in a structured, meaning-driven task related to their professional context. They explore and discover the affordances of the tool while the task is foregrounded and the tool made 'invisible'. Teachers share links to their created artifacts in the online platform, where the facilitator encourages peer-feedback and reflection on the different ways in which teachers appropriated the affordances, potentially leading to teaching moments where teachers may elaborate or explain their learning journey, how they completed or inserted a certain aspect, or managed another.
3. **Direct Application:** Participants then use the tool to design an authentic application thereof that would be immediately useful in their classroom contexts. Ideally, direct application occurs soon after task-driven use and is followed by a presentation of their



*Figure 15 Introducing new tools in the ePlay MakerSpace*

work to the whole group where shared reflection can take place, limiting the time between first introduction and application in real-world contexts.

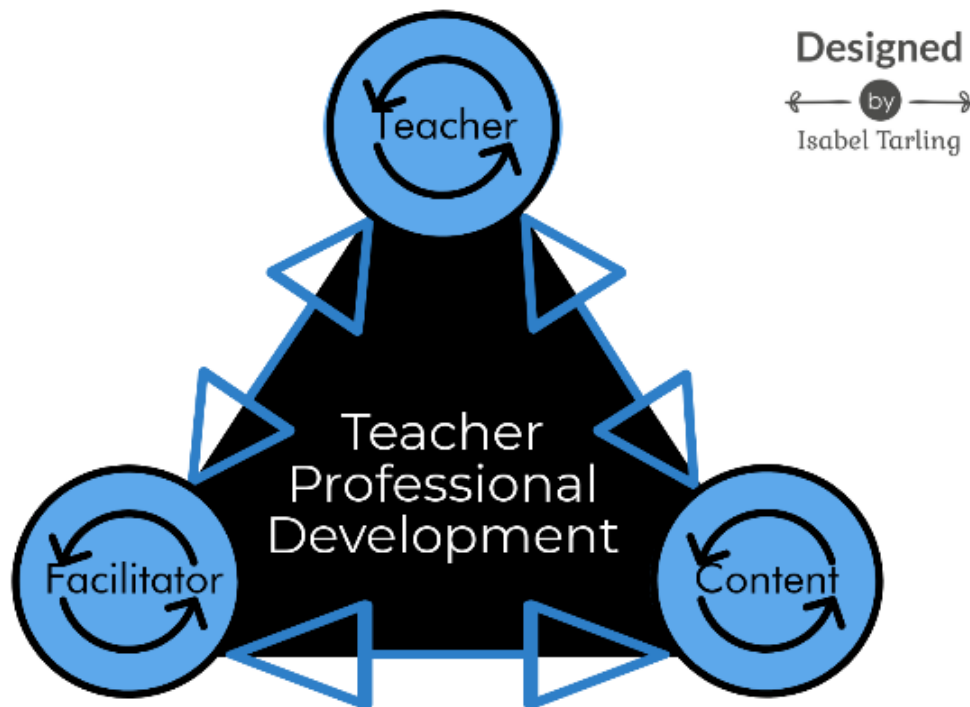
The three-step TIP structures and scaffolds the learning process to maximise teachers' positive engagement with the tool through active learning from the first moment that they encounter it. GDP9 is rephrased as:

**Refined 1gDP8) The ePlay MakerSpace process supports dynamic, emergent and active learning and introduces new tools using the tool introductory process.**

GDP10) The ePlay MakerSpace process provides opportunities for relational learning.

Relational learning was designed to foster different forms of interaction as structured by Anderson’s (2004) model. Additionally, the interactions were designed to be open, non-regulated or restricted as far as possible, to model Quadrant C-type pedagogies. When teachers worked on their group lesson plans, although online collaboration was modelled, only one group collaborated online, while the other groups continued working alongside each other with one teacher typing and the others sitting providing verbal comment. The relational learning and particularly the scaffolding of collaboration generally as well as online, needs more systematic scaffolding in future iterations.

## Interaction Model for TPD



*Figure 16 The Interaction model for Teacher Professional Development*

Also, the language of Anderson’s model was problematic to describe the design of interaction, and thus the model was redesigned (see Figure 16). The GDP10 is rephrased:

**Refined 1gDP9) The ePlay MakerSpace process systematically and explicitly introduces collaboration and provides opportunities for different forms of relational learning.**

**GDP11) The ePlay MakerSpace process provides opportunities for transformational learning.**

The inclusion of transformational learning prepared teachers to manage their own change journeys when they returned to school. The examples from School F, K and A, indicate that teachers in varying degrees, managed how they wanted to change in their classrooms or within their schools. However, on the last day, when teachers needed to self-diagnose their position on the TCF, teachers appeared confused and I got the impression they had forgotten about the quadrants although it was introduced on Day 1. Therefore, the use of the TCF needs to be more systematically and explicitly scaffolded over the course of the three days.

Additionally, a design-epistemology requires a future-orientation to think the un-thought and un-experienced beyond current ways of thinking. During the session on Day 1, this epistemological move had to be included as teachers largely functioned in a problem-oriented space.

Furthermore, the schedule on Day 3 limited the time spent to develop the Roadmap for Change. This meant that the Postcard from 2026 activity was not conducted, and teachers were encouraged to complete it at home, which only IPL15 did. The postcard-activity forms a bridge to support teachers' changed focus, from their current challenges and problems, to a solution-focused, future-orientation needed for innovation. Therefore, more time should be provided for the postcard-activity.

Lastly, when setting goals, teachers set vaguely articulated and poorly defined goals. In future iterations, the goal-setting activity should be more carefully scaffolded to support teachers in setting low-level, immediately achievable and contextually relevant goals. The GDP11 is rephrased:

**Refined 1gDP10) The ePlay MakerSpace systematically and explicitly scaffolds transformational learning.**

The elaborations and refinements of the global design principles resulted in ten first-generation design principles (1gDPs) included in Figure 17. The 1gDPs guided the design of Iteration 2 for Foundation Phase teachers as reported in Chapter 5.

## 4.5 Concluding comments

This chapter has reported on the design, enactment and formative evaluation of the IP Language ePlay MakerSpace that took place from 27 – 29 June 2016 with teachers from disadvantaged primary schools in the Western Cape. Data developed through the problem identification and design, enactment and formative evaluation of Iteration 1 of the ePlay MakerSpace, informed the refinement and elaboration of the 1gDPs to transform teachers dispositions through the transformative integration of ETs.

The refined 1gDPs were subsequently employed to design Iteration 2 of the ePlay MakerSpace for Foundation Phase (FP) teachers, as reported in the next chapter. Findings from the IP Language and FP ePlay MakerSpaces, are collated and analysed in the final chapter as part of the discussion of this work.

# First-generation design principles

## 1gDPs

1gDP1) The ePlay MakerSpace processes and enabling conditions develop teachers' capacity to create and/or innovate with emerging technologies to transform dispositions.

1gDP2) The ePlay MakerSpace process and enabling conditions can restructure individual and collective beliefs, practices and/or perceptions by transforming dispositions that formed these.

1gDP3) The ePlay MakerSpace creates the enabling conditions and carries the weight of change to support teachers' entry into the liminal zone where the transformation of dispositions can occur.

1gDP4) The ePlay MakerSpace assumes teachers are autonomous and self-directed, and is sensitive to and inclusive of the needs of all participants.

1gDP5) The ePlay MakerSpace process models sophisticated applications and pedagogical possibilities of the transformative integration of emerging technologies that are chosen to be immediately applicable and relevant to teachers' unique needs.

1gDP6) The ePlay MakerSpace process systematically scaffolds and provides opportunities for reflective learning.

1gDP7) The ePlay MakerSpace process systematically scaffolds and provides directed opportunities for professional learning.

1gDP8) The ePlay MakerSpace process supports dynamic, emergent and active learning and introduces new tools using the tool introductory process.

1gDP9) The ePlay MakerSpace process systematically and explicitly introduces collaboration and provides opportunities for different forms of relational learning.

1gDP10) The ePlay MakerSpace systematically and explicitly scaffolds transformational learning.

Figure 17 First-generation design principles (1gDPs)

# Chapter 5 ePlay MakerSpace Iteration 2

This chapter reports on the second iteration of the ePlay MakerSpace with Foundation Phase (FP) teachers from disadvantaged schools in the Western Cape. Following the Design-Based Research (DBR) Methodology, the ePlay MakerSpace model was iteratively tested for the first time with IP Language teachers as documented in Chapter 4. Iteration 1 refined and elaborated the global design principles (GDPs) for the ePlay MakerSpace developing ten first-generation design principles (1gDPs) for effecting the transformation of dispositions through the ePlay MakerSpace model. This chapter draws on the ten 1gDPs (see Figure 17 for ease of reference) to design and enact the second iteration of the ePlay MakerSpace process with FP teachers.

Chapter 5 is structured according to the DBR cycle to discuss the problem identification and design, enactment and formative evaluation of the FP ePlay MakerSpace aimed at refining the 1gDPs. The chapter is augmented by the website: W3, containing artifacts produced during the design of the FP ePlay MakerSpace, as well as artifacts created by the FP teachers, their reflections and the formative evaluation of the session.

## 5.1 Problem identification and design of the FP ePlay MakerSpace

The FP ePlay MakerSpace was conducted at the CTLI from 4 – 6 July 2016 with 16 FP teachers from disadvantaged schools in the Western Cape. The problem identification and design for the *FP ICT Integration course*<sup>2</sup> / FP ePlay MakerSpace and design is reported in this section.

---

<sup>2</sup> As in Chapter 4, the official title (or part thereof) used by the CTLI for the ePlay MakerSpaces is acknowledged by placing the word in Italics, for example: *ICT Integration courses* or *courses*.

### 5.1.1 Problem identification

A reference group was formed to identify and clarify the problem and requirements that Iteration 2 of the ePlay MakerSpace had to address. The office of ICT Integration at the CTLI convened the reference group comprising two FP Curriculum Advisors (CAs), two lecturers from Higher Education Institutions who lecture FP pre-service teachers, and two experienced FP teachers, the ICT Integration manager, Mr D and the researcher. The two reference group meetings were treated as unstructured interviews.

The vaguely defined prototype problem was identified by Mr D in a draft *course* framework, identifying the potential purpose, outcomes and processes to inform the prototype solution. A competency-based approach to teacher professional development regarding emerging technologies (TPD4ETs) informed the prototype problem, stating as the outcome of the *course* (at the time referred to as a workshop): '*At the end of this workshop Foundation Phase teachers will be: Knowledgeable about select ICT's, its features and how to link it to the curriculum*'. The prototype solution was identified as requiring competency-based technological training and technological knowledge to prepare teachers to use devices to present lessons. Subsequently, the reference group collaboratively reviewed and refined the *FP ICT Integration Course* framework. Both the prototype (version 1) and refined frameworks are available on the website: W3.1.

A knowledge-based approach to TDP4ETs emerged during the review of the prototype framework. Debating the items on the prototype framework, the reference group noted that the competency-based approach was limiting. Instead, the group decided that the *course* should prepare teachers and support teachers to integrate existing practices and CAPS demands, with transformative pedagogies. The group also indicated that the *course* needed to equip teachers with the basic principles that underpin ICT Integration, and the TPACK framework (Mishra and Koehler, 2006) was suggested. The TPACK framework provided a language through which a shared understanding of ICT Integration was developed in the reference group. It was also included in the *course* framework.

A second reference group meeting in February 2016, finalized the FP *course* framework and fully elaborate the problem that the FP ePlay MakerSpace needed to address. Although the emphasis in the framework was adjusted to reflect the changed understanding of *ICT Integration* in terms of Mishra and Koehler's (2006) framing, a competency-based approach continued to dominate, framing the solution in terms of technological training. Additionally, FP teachers are generalists in their teaching, and typically teach Mathematics, Language and Life Skills, therefore the reference group decided against a specific curricular focus, and instead chose to adopt a more generalist approach in the *course*. The number of ETs was also reduced and the focus was placed on developing teachers' capacity to use graphics, sound and video, and online resources that support eTeaching, eLearning and eAssessment.

The revised version of the *FP ICT Integration Course Framework* was accepted in the second reference group meeting on the 15 February 2016. This constituted the problem statement for Iteration 2, and informed the development of the *course* manual and design of the FP ePlay MakerSpace.

## 5.1.2 Developing the course manual

Following the design-based research methodology of the thesis, the manual for the FP *course* was iteratively developed between December 2015 and June 2016. Working closely with the office of ICT Integration, seven iterations of the manual were produced. Prominent areas of refinement related to the professional learning sections, and the layout and presentation of the technological knowledge development to support active learning.

The professional learning sections were iteratively refined through repeated cycles of problem clarification, design, development and evaluation. Within the vast array of transformative pedagogies literature, the challenge was to find the most suitable professional learning content that constitute *the basic integration principles*, that would be suitable for teachers from disadvantaged schools with varying degrees of skills, linguistic abilities and pedagogic beliefs, perceptions and practices, among other. Moreover, even when peer-reviewed and well-proven theories were transposed to a more accessible

register, the office of ICT Integration repeatedly noted that the register would be inaccessible to teachers. After several iterations it was decided to focus on Bloom's revised taxonomy (Krathwohl, 2002) and Higher Order Thinking Skills (HOTS) as this is included in the CAPS, 21<sup>st</sup> century learning, and Anderson's (2004) model of interaction.

A further challenge arose in the design and format of the active learning sections in the manual. Initially the *course* was designed for teachers, who it was assumed, would have some existing technological knowledge. Hence the active learning sections were not supported by additional 'how-to-guides' in the manual, and instead short bullet-pointed lists were included, assuming that the introduction and exploration of tools would be managed in the ePlay MakerSpace. However, after several iterations, it was decided that the design should address the needs of novice teachers with limited prior knowledge or technical skills, and should support their active learning during the session, but also thereafter.

The iterative refinement of the FP *ICT Integration Course* framework and manual, clearly defined the problem that the FP ePlay MakerSpace had to address.

### 5.1.3 Designing Iteration 2

Guided by the 1gDPs (see Figure 17), the course framework and manual, Iteration 2 of the ePlay MakerSpace for FP teachers was designed. The ten 1gDPs structured the design of inculcation processes and development of the enabling conditions to support the transformation of dispositions in the FP ePlay MakerSpace.

A programme for the three-day session was developed. Professional learning sessions were scheduled in the morning before lunch, and active and relational learning sessions thereafter to limit the time between professional and active learning. Following the formative evaluation of the IP Language session, and noting the challenges with regards to the venue and schedule, the programme format broadly referred to sessions without clearly articulating each process to build flexibility into the design, and allow more room for work-arounds and on-the-spot changes. To avoid duplication, the elements included in each

session are discussed as part of the enactment in the next section, while the choice of tools is discussed here.

Tools were chosen to address the framework requirements for ETs that support the use of video, sound and graphics in the FP class. The chosen tools had to be accessible on most devices preferably online and offline, free, shareable and functionally suitable to novice and experienced users. The tools chosen for inclusion were:

- ◆ Edmodo as an online platform to foster collaboration;
- ◆ YouTube videos;
- ◆ Google suite apps (Google abbreviated to G/): G/Drive, G/Slides; G/Forms and G/Sheets;
- ◆ Befunky.com to create collages with graphics;
- ◆ Initially the session was going to include tablets as well as desktops, therefore DIPTIC as a cartoon-creating tool was included.
- ◆ Voki.com to use sound; and
- ◆ For extension: Piktochart.com and Canva.com, Kahoot! and Quizlet; Creating WhatsApp groups; recording voice notes.
- ◆ Bonus feature: these tools are all saveable to teachers' G/Drives.

In keeping with 1gDP8, the introduction of tools was designed according to the three-step Tool Introductory Process (TIP) included in:

- Step 1. **Playful exposure** in a light-hearted, playful and fun-filled manner
- Step 2. **Task-driven use** – using the tool to create - for example a pedagogic artifact that could be used in teachers' classroom, with or without modification
- Step 3. **Direct application** – the tool is used in an activity to create CAPS-aligned or need-driven pedagogic tools

The FP ePlay MakerSpace was designed to model transformative pedagogies. A G/Slide presentation: [ICT Integration FP ePlay MakerSpace](#) (link embedded and available on W3.1) was designed to accompany the enactment and learning in the FP ePlay MakerSpace. The G/Slide presentation mostly contains images rather than volumes of words to model the use of graphics to stimulate and encourage critical thinking and communication, and to foster different forms of interaction. (Images included were labelled for non-commercial reuse or used with permission.)

## 5.2 Enactment of Iteration 2

Iteration 2 of the ePlay MakerSpace enactment took place from 4 – 6 July 2016. Aligned with the generalist teaching in the FP class, the design for Iteration 2 was not intended to develop specific CAPS-aligned pedagogic and content knowledge, but was more generalist in nature.

### 5.2.1 Participants and venue

FP teachers from disadvantaged schools were invited to attend the FP ePlay MakerSpace. The office of ICT integration sent invitations to FP teachers generally and also targeted schools that would receive devices and/or internet connectivity from the eLearning Game Changer programme during 2016-2018. Informed by the benefits of collective participation (Desimone, 2009, 2011; Parsons *et al.*, 2016), two-three teachers from a school were encouraged to participate, as well as FP Heads of Department (HODs). However, teachers generally heard about the *course* and registered to attend, whether they had access to ETs or not. In total, 21 teachers registered to attend the *course* from 4 – 6 July 2016, with 16 teachers completing all three days.

The FP ePlay MakerSpace took place in one of the well-equipped and fully functioning CTLI computer labs. The computer lab is spacious and devoid of clutter, posters and other reminders of end-of-term stresses that was so prominent in the IP Language ePlay MakerSpace venue. During the three-day session, the LAN connection remained stable

throughout, and supported high speed, simultaneous internet access to all users. Since the tablets were not yet ready, the course only used the desktop computers. The SmartClassroom devices were however set up in an adjacent classroom and teachers could engage with and learn how to use the IWBs and visualizers on Day 2. Hence, the venue, and uninterrupted device and internet access created the enabling environment to support the enactment of the FP ePlay MakerSpace.

The design of Iteration 2 followed the 1gDPs, provided inculcation processes and enabling conditions to support the transformation of teachers' dispositions. This included, drawing on 1gDPs 1-5, opportunities to create and innovate with ETs, and modelling sophisticated application and pedagogic possibilities, and the creation of a safe, nurturing environment, to provide teachers with an embodied experience of transformative ET integration.

Additionally, following drawing on 1gDPs 6-10, Iteration 2 was designed to scaffold and systematically introduce the five learning processes, although not in presented in the same order as that of the 1gDPs.

## 5.2.2 1gDP8) Active learning

Active learning was designed and enacted in keeping with 1gDP8, although other 1gDPs also came into play. The FP ePlay MakerSpace provided teachers with various opportunities to create and innovate with ETs in a playful and fun-filled manner. Teachers created concept maps, G/Slide presentations, collages with Befunky.com and G/Forms for eAssessment, with accompanying G/Sheets. Rather than a competency-based technology-training approach, teachers were encouraged to explore and discover, to try out and try on (Reid and Wood, 2016) different pedagogic practices, beliefs and tools within the safe and nurturing space. The fun-filled, safe learning space and dynamic, emergent active learning was intended to build confidence, competence and consciousness (Meyer, 2010) to support teachers' weight of change as they approached the threshold of their meaning-systems. FP teachers' created artifacts are available in the G/Slide presentation: [FP teachers' created artifacts](#) (link embedded and available on W3.2).

The active learning in the FP ePlay MakerSpace required teachers to create:

- ◆ Day 1: Concept maps following the protocol developed in the methodology.
- ◆ Day 1: G/Slides of the 21<sup>st</sup> century skills: collaboration, communication, critical thinking and creativity. This was for most teachers, their first experience with G/Apps, and for many, it was also their first experience using a slide presentation tool.
- ◆ Day 2: Befunky.com collages to address various of the CAPS themes.
- ◆ Day 2: Avatars in Voki.com, that produce recorded sound messages.
- ◆ Day 2: G/Slides of their lesson plans – each group member created a different slide on the group’s lesson plan, collaborating synchronously to create this.
- ◆ Day 3: G/Forms that learners could complete and rubrics that teacher could use for assessment of capturing of marks.

The introduction of each tool was scaffolded using the TIP. To avoid overwhelming teachers, especially first-time users of the tools, I modelled the basic steps to create with the tools and then encouraged discover and exploration. Having noted the challenges with G/Forms in Iteration 1, the G/Form was particularly carefully introduced using the TIP:

Step 1. **Playful exposure:** Teachers completed a G/Form reflecting on their experienced of Day 2: [Reflecting on Day 2 of the Foundation Phase ICT Integration Course](#) (link embedded). As they submitted the form, their responses were projected in graph format and they could see in real-time how their responses impacted the graphs. This modelled not only the use of the G/Form, but also the use of learner generated data, visually representing data in real-time and collaborative knowledge production among other.

Step 2. **Task-driven use:** Teachers created G/Forms of their own, setting a silly test for each other to complete. I modelled ways to insert graphics and video into the forms, but at the time, there was no way to insert sound which teachers found frustrating.

Step 3. **Direct application:** Teachers created a G/Form for use in their classrooms. In keeping with the autotelic nature of the ePlay MakerSpace, there was no restriction on the type of form or purpose it has to serve. The links to their G/Forms were posted to Edmodo and teachers commented on each other's G/forms.

While teachers were sharing feedback on each other's G/forms in Edmodo, several teachers asked FP09 to show them how she had created her form in the whole group. The sessions dynamically shifted to a shared reflection mode as teachers started reflecting on FP09's learning process, and then reflected on their own learning as well.

The active learning taking place within the ePlay MakerSpace aligned with the goals of play as pedagogy in adult learning (Reid and Wood, 2016). As such it served to embody and incorporate in teachers' habitus basic technological knowledge and capacities, as well as equip teachers to plan and implement pedagogies to transformatively integrate ETs in their classrooms. The playful, fun-filled context in which the active learning took place, also increased the reflective and relational learning taking place.

### 5.2.3 1gDP9) Relational learning

The relational learning was designed to address 1gDP9, and fostered different forms of interaction using the Interaction model for Teacher Professional Development developed after Iteration 1 (see Figure 16). As with Iteration 1, interactions were designed to model different pedagogic approaches and support relational learning.

Relational learning was fostered in face-to-face contexts. On the first morning, teachers introduced themselves in the face-to-face session. One of the findings from Iteration 1, was the need to overtly create and maintain the parameters to enable teachers to safely create and take risks in the ePlay MakerSpace. Therefore, during this face-to-face interaction, concept of the ePlay MakerSpace was introduced, as a safe, nurturing space in which teachers try out new experiences, practices, tools or thoughts to encourage experimentation. It was also framed as a play-filled space in which risk is embraced and failure framed as one step in many towards learning and change. Teachers were asked to list

rules to secure the space and as a group agree to uphold these rules. The rules teachers suggested were written on large sheet (see Figure 18) and displayed. This activity set the parameters for interaction and relational learning in the space, and set the emotional

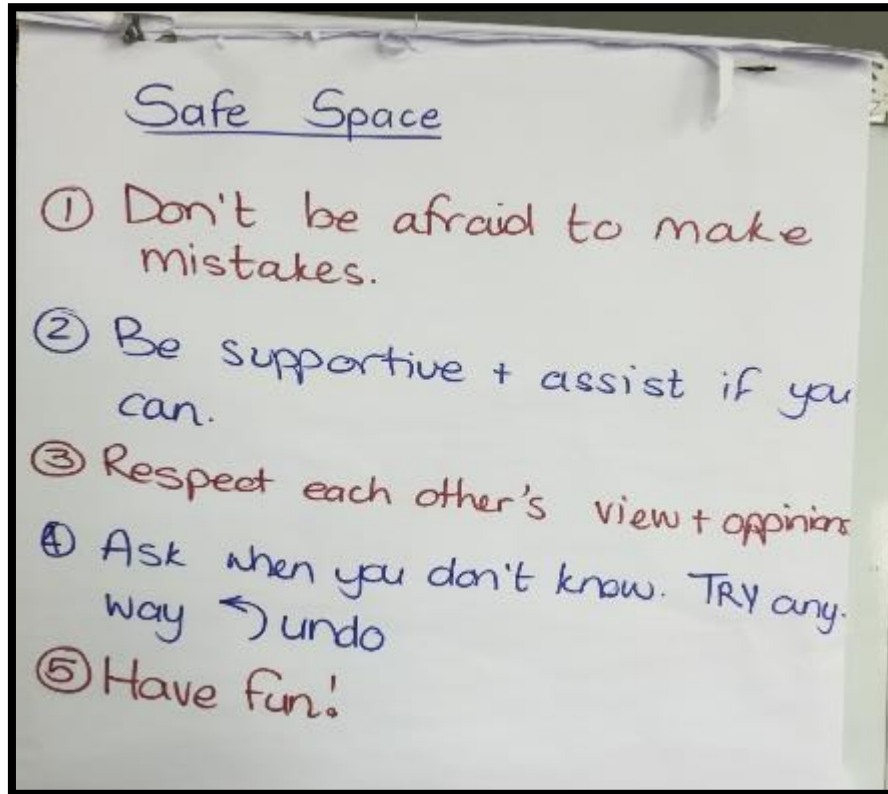


Figure 18 FP teachers' rules to create a safe space for the ePlay MakerSpace

context in which teachers could “experience and express empathy; deepen ... relationships; and develop trust, friendships, and intimacy with others” (Meyer, 2010, p. 45).

Edmodo was used to foster teacher↔teacher and teacher↔content interaction in an online platform. Following findings from Iteration 1, Edmodo was introduced using the TIP.

In view of the challenges to achieve online collaboration in Iteration 1, 1gDP9 states: ‘*The ePlay MakerSpace process systematically and explicitly introduces collaboration...*’ With reference to construct of ETs as tools, concepts, innovations and advancements (Veletsianos, 2010) with the potential to transform, collaboration was framed as an emerging technology concept and tool, an innovation and advancement that can be utilized

in diverse educational settings, to achieve different educational purposes. As a tool, online collaboration mediates activity to produce (pedagogic) understandings and practices (Somekh, 2007). Critically, framing online collaboration as a tool, impacts its introduction and inclusion in the design and enactment of the ePlay MakerSpace.

The framing of online collaboration as an ET tool, meant its introduction was structured using the three-step TIP of the ePlay MakerSpace. The introduction of online collaboration therefore proceeded as follow:

- Step 1. **Playful exposure:** After teachers had their G/Slides of 21<sup>st</sup> century skills, they shared the links to their G/Slide presentation to Edmodo. They opened each other's presentations from Edmodo, and using the comment feature in G/Slides, provided feedback to their colleagues. Thus, teachers' first exposure to online collaboration, was playful, light-hearted and non-threatening. During this activity, teachers were often heard laughing or giggling at each other's comments, filling the room with excitement and a playful, jovial atmosphere.
- Step 2. **Task-driven use:** The next day, teachers shared the links to their Befunky collages in Edmodo. The activity was designed for teachers to collaboratively create a collage, but due to the autotelic nature of the ePlay MakerSpace, when I asked teacher to finish their individual collages in order to move to collaborative creation, they requested more time to create and play with the tool, saying that they were enjoying the experience. Respecting their wishes, I therefore did not force the issue and left teachers to create their own collages.
- Step 3. **Direct application:** When teachers started engaging in their group lesson plans, they did so face-to-face. Once they had created the outline of their lessons, one teacher in the group created a G/Slide, and shared the link to the other teachers in the group. The owner of the G/Slide physically passed their keyboard to the other group members to type in their email addresses when sharing, to create an embodied experience of sharing the document. Teachers then moved to their computers where they opened the document from their shared folder.

Once at their computers, the FP teachers started collaborating in creating their group lesson plans. Lost in this simple sentence, is the experience and almost palpable electric atmosphere that filled the room when this happened. Having experienced the confusion and disorientation in Iteration 1, I anticipated that the weight of change would potentially be very large once teachers first experienced online collaboration in the G/Slide. Therefore, once teachers had all opened the same document, and saw their collaborators' labels pop onto their screens, I asked them to stop and listen to a story. Stories are a frequent inclusion in FP classrooms, and provide a means to create an emotional connection to a memory. I told the following story:

*After a busy week, I arrived late at a family birthday celebration. I hastily ordered a salad, and even though this was ordered long after everyone else's orders, the salad was ready at the same time as the rest of the family's meals, arriving on the table with their food. It turned out to be an enormous salad, and the family assumed it was a table salad. To my dismay, the birthday person started helping herself to the salad, followed by the rest of the family. Not wanting to spoil the evening, I did not say anything and watched as all the avocado, feta and crispy roast chicken disappeared from the bowl.*

The room was filled with laughter and teachers nodded knowingly, as they related to this story. This emotional connection was created to provide a bridge between an everyday experience that they are familiar with, and the un-experienced and un-thought-of practice of online collaboration. At this point, having introduced the emotional connection, I explained that they would be working in the same document at the same time, and would be able to see each other working. However, I warned, they would also be able to mess in each other's salads and steal the avo and feta. This comment evoked much laughter indicating the emotional bridge was in place. Teachers turned to their computers, and they watched as the owner of each document inserted five or more slides. Next, they opened the chat feature on the side of the G/Slide screen in order to chat to each other. Lastly, I showed them where they were working on the document, how they could see their group members'

icons pop up on the slide index on the left, and how this flagged where different teachers' salad bowls were – which they were not to mess in.

The FP teachers then started collaborating in creating their group lesson plans. As they experienced, tried on and tried out the new and highly unfamiliar way of working, their movement across the liminal zone was almost visible. A buzz filled the room. At first teachers were apprehensive and cautiously typed on a slide. Someone else would insert an image and they could see the images appearing on the left slide index, although they were typing on their slide. This caused some feelings of disorientation and puzzlement for many, evident in their facial expressions, hunched postures, their eyes close to the screen, and deep frowns of concentration on their faces as they crossed a new threshold. As more content started appearing on the other slides, and they added content to their slides, teachers started to relax in the process, and some of the disorientation seemed to dissipate, indicating that teachers had crossed the edge of chaos and entered the liminal zone. The next challenge arose when one of the group members changed the theme of the presentation, or re-ordered the slides. This disorientated teachers with low technological knowledge, and I had to move quickly around the room to reassure them that all was fine and orientate them to find their slides again. I repeatedly reminded the whole group that changing key aspects of slides, such as the order or theme, required consensus in the group, and that they should use the chat feature on the right side of their screens. The chat feature provided some support for teachers' while crossing the liminal zone. I also played calming music in the room as an additional support.

At the end of this session, all the teachers in the room had participated in the activity and collaborated in the group lesson plans. This is significant, since the teachers in Iteration 1 had been reluctant to do so and only one group engaged in this. It provides evidence that the changed approach, framing online collaboration as an ET and introducing it using the three-step TIP, yielded positive results. In addition, this aligns with Meyer's (2010, p. 17) findings that "*whenever people engage in creative collaboration [and] significant learning*" as demonstrated here, deep-seated change occurs.

## 5.2.4 1gDP7) Professional learning

The professional learning was designed from 1gDP7. Based on findings from Iteration 1, in Iteration 2 the professional learning was adjusted from wide-learning to deep-learning. Fewer concepts were introduced to the professional learning sessions, but treated in a more deliberate and systematic way.

The professional learning in Iteration 2 included three main focus areas: Blooms' revised taxonomy (Krathwohl, 2002), Anderson's (2004) model of interaction, and 21st century skills (Fullan 2013). CAPS assessment requirements are framed in terms of Bloom's revised taxonomy and teachers of all grades and subject specialisations must adhere to this. Hence, it's inclusion serves to contextualise professional learning in the ePlay MakerSpace within teachers lived-experiences. Bloom's revised taxonomy was aligned with Fullan's (2013) work to focus the professional learning on developing 21<sup>st</sup> century skills of creating, collaborating, communicating and critical thinking. Anderson's (2004) model was not well applied in Iteration 1. Therefore, in Iteration 2, it was introduced loosely following the TIP.

### Step 1. **Playful exposure:**

Anderson's model (2004a) was displayed on the presenter screen (slide 25), and teachers asked to interpret what it represented. In Edmodo, the six forms of interaction had been posted as for example teacher↔teacher, teacher↔learner and learner↔content. Applying the newly learnt knowledge, teachers voted on Edmodo to indicate which form of interaction they mostly experienced in their classrooms, and teacher↔learner interaction was identified.

### Step 2. **Task-driven use:**

Teachers had watched the video: [Singapore's 21st century learning strategies](#) (link embedded), the previous day. The link to the video was shared to the Edmodo group and individually, using headphones, teachers watched it again, with the instruction to identify examples of the different forms of interaction according to Anderson's model. The different

forms of interaction were posted in Edmodo and teachers could list the examples they identified as responses to each of the posts. An example is included below (using the same original format to indicate how the post appeared to teachers).

IT: How did they achieve learner <---> learner interaction?

Like (1) 8 Replies Jul 5, 2016

FP18: They worked in groups.

FP05: Peer groups; peer teaching

[Teacher's post removed - no permission]

FP14: Learners communicate to foster collaboration and encourage critical thinking.

FP03: Were learners work in pairs. They interact with each other and they are fully engage in what they should do.

FP21: They discussed the topic amongst each other: shared ideas, etc

FP16: They could ask their peers to explain things to them that they did not understand. They learned from each other because the one knew more and in that way they were able to help each other.

Following the Edmodo activity, teachers turned to page 28 in the manual to reflect on their practice and identified possible areas where they could foster different forms of interaction in their classrooms.

Step 3. **Direct application:** Teachers then applied Anderson's model to design learning that fosters different forms of interaction in their group lesson plans.

The use of TIP to introduce Anderson's model appeared to produce more positive engagement with the tool during teachers' group lesson plans. Most groups appropriated the tool effectively to design different forms of interaction.

In addition to the above professional learning, the Teaching Change Frame (TCF) (Tarling and Ng'ambi, 2016) was also introduced on Day 2. The conceptual understanding developed as part of the professional learning and especially with regards to Bloom's revised taxonomy and Anderson's model, prepared teachers to conceptually access the structure of the framework. Teachers were introduced to the four quadrants, and then diagnosed their position on the TCF. The inclusion of the TCF provided teachers with a theoretical tool to make informed decisions, 'based on principles of ICT integration' as required by the FP framework, and to design learning in their group sessions that is situated in the different quadrants.

Although the professional learning in Iteration 1 and 2 of the ePlay MakerSpace drew on similar content, the manner in which the learning occurred was altered. Anderson's model was introduced using TIP, leading to higher engagement with the tool, and teachers related the different forms of interaction to their lived-experiences. The TCF was presented on Day 2 rather than Day 3, and teachers could therefore engage with the quadrants, diagnose their positions on the TCF, and structure their group lesson plans to situate these in particular quadrants. In this way both professional learning was supported by reflective learning and provided teachers opportunities to reflect on their practice in order to change this.

### **5.2.5 1gDP6) Reflective learning**

Reflective learning forms a supportive bridge within the ePlay MakerSpace and is designed for Iteration 2 following 1gDP6. Reflection acts as a mirror with which teachers can examine their known and experienced practices, beliefs and perceptions, step back from this, and explore unknown, un-articulated and un-thought-of practices, beliefs and perceptions. Critical reflection and examination of existing beliefs, perceptions and practices, increases the possibility of forming more complex and elastic understandings (Baily, Stribling and McGowan, 2014). However, as O'Sullivan (2002) cautioned, and as was evident in the formative evaluations of the IP Language group, teachers may not be familiar with the practice of reflective learning, and may require time and support to develop this. Particularly, teachers in Iteration 1 tended to reflect at a mechanical level of recognition, relating events and listing skills for example, rarely reflect on the act of cognition. The design in Iteration 2 addressed these challenges through individual, shared and group reflection.

Individual reflection was conducted throughout the FP ePlay MakerSpace. Concept mapping was used on Day 1 and 3 as a reflective tool following the protocol developed in the methodology. Edmodo was used throughout the three days, encouraging teachers to reflect on their existing practice, but also to reflect on their learning taking place. For example, when working with Anderson's model, teachers reflected on their practice to identify the types of interaction they most often experienced in their classrooms; identified different

forms of interaction evident in a video; and reflected on potential ways to foster different forms of interaction in their classrooms. In this way, reflection was used as a tool to move beyond listing skills, to exploring unfamiliar or un-thought-of practices, beliefs and perceptions.

Additionally, Teachers also completed two online individual reflections using G/Forms. As a means to introduce the affordances of G/Forms, the FP teachers completed the G/Form: Reflection on Day 2 of the Foundation Phase Course, at the start of Day 3. In addition, at the end of Day 3 and using the same G/Form as for Iteration 1, teachers reflected individually on their experiences and learning in the course, and set themselves goals to achieve following the ePlay MakerSpace. Lastly, the structure of the last day was changed to provide more time for teachers to reflect on their learning, to create their CMs and Roadmaps to Change, and complete the individual *course* reflections.

Teachers also engaged in shared informal reflection to reflect informally on tools introduced in the ePlay MakerSpace and professional learning taking place. After teachers had created artifacts, for instance, these were shared in Edmodo and displayed on the presenter computer. This often resulted in shared informal reflection, as when FP09's shared her Befunky collage, and teachers spontaneously started asking her how she had added different features or used different template formats. More importantly, novice users in the room asked her '*how*' she '*figured out*' that she could apply the different functions as she had done. This became a shared reflective learning experience: initially FP09 reflected on her cognitive process in exploring and discovering the affordances of the tool, followed by two other teachers who also shared their processes with novice users. This shared reflective learning was supported by the relational learning and safe, nurturing space created by the rules established on the first day. In addition, shared informal reflection was used during the professional learning sessions as supported by the different slides in the presentation.

Group reflection took place in a classroom adjacent to the computer lab and was conducted by the ICT Integration manager as a formal, group reflection session. During this session, the group reflected on their experiences and learning from Day 1. Teachers generally

experienced Day 1's learning as positive and exciting. FP10 and FP12 were novice users, with almost no technological knowledge to such an extent that they had trouble controlling the mouse to open drop down menus on the screen. However, in contrast to teachers in Iteration 1, their comments did not reflect feelings of being overwhelmed:

- ◇ FP10: *For me it was totally a new experiences because I'm not used to it. Sometimes I got lost and didn't know how to go there. It is only the typing that I did, and to retrieve my email. So it was a total new experience and I enjoy it, and sometimes I feel ashamed because I have to touch FP09 next to me... But I enjoyed really I do, I enjoyed it and if there is another chance, I want to learn more. [sic]*
- ◇ FP12: *... So this Edmodo is more than this flash drive, it was really a wonderful experience, and I just thought I must bring my laptop, because I think it is the moment. My phone is updated and I brought my laptop to try and connect, and I will try and connect, and see if it works. (She was referring to G/Drive and not Edmodo.)*

FP10's comment raised the issue of shame, and her experience of feeling unable to perform particular tasks causing her to feel ashamed. Crossing the threshold and entering the liminal zone, as discussed, can be associated with such negative feelings. However, FP09 sitting next to FP10 supported her in the learning process – an example of relational learning carrying the weight of change, leading FP10 to note that she 'really enjoyed' the learning experience. Moreover, the safe, nurturing space created by the rules for the FP ePlay MakerSpace, set the tone in which FP10 could raise her feelings of shame, without fear of being judged harshly or ridiculed for this. This powerfully demonstrates the need to collaboratively create and share in upholding the safe, nurturing context within the ePlay MakerSpace.

The individual, shared and group reflective learning in the FP ePlay MakerSpace differed from that in the IP Language session. The teachers in the IP Language session tended to list skills, challenges or focus on practices. While the FP teachers also listed these, they moved beyond this to explore cognition in terms of their practical and pedagogical knowledge, and to confer meaning and potentially embrace changes to their existing ways of teaching,

thinking and believing. The rules to protect the safe and nurturing context contributed to novice teachers exposing their inadequacies, and sharing for example, the shame they felt at not being skilled at appropriating different tools. Similarly, opening the shared reflection space for teachers to demonstrate their learning as FP09's example illustrates, created deeper reflection on cognition and the learning process among teachers. These two aspects are subsequently flagged for inclusion in future enactments.

### 5.2.6 1gDP10) Transformational learning

Transformation learning in Iteration 2 draws on 1gDP10. The design of Iteration 2 thus included implicit and explicit transformational learning. Implicit transformational learning occurred as teachers engaged in the various learning activities, to try out, try on and explore pedagogic beliefs, practices and perceptions. Active and relational learning provided an embodied experience of learning-centric transformative ET integration, that emphasizes creativity and innovation. Professional learning equipped teachers with mental tools to craft new perceptions, beliefs and assumptions (Major and Ayrton, 2016) and reflective learning foregrounded the cognitive dissonance between such new capacities and previous pedagogies of the habitus. More so than in Iteration 1, teachers used reflective learning to reflect on their own learning processes. In this shared reflective process, teachers articulated the edge of their liminal zones and specifically their movement within it, how they formed new dispositions of the mind and body, and engaged in transformational learning.

FP teacher's crossing of the threshold to the liminal zone differed to that in iteration 1. Throughout the three days of the ePlay MakerSpace, teachers appeared relaxed, comfortable and at ease. Although most were unfamiliar with newly introduced tools or skills, the teachers did not appear to be distressed, anxious or overwhelmed. In the group reflections on the morning of Day 2 and repeated in the online reflections on the morning of Day 3, 88% of FP teachers reported that they enjoyed the sessions, 10 rating it 5/5 and 4 rating it 4/5. This contrasted the feedback from teachers in Iteration 1 on the morning of Day 2, in which teachers reported feeling overwhelmed by the learning and pace on Day 1.

Lastly, the most notable indicator of the transformation of dispositions, was the manner in which all the FP teachers collaborated online to create the group lesson plans. At the end of Day 3, teachers presented the slides they had made and each teacher in the different groups presented, correlating my observations during the session that teachers had all engaged in the activity. Teachers' individual and collective actions while engaged in the online collaboration, and their comments during the activity, provided evidence that they were moving within the liminal zone. Through their collaborative creation, it was evident that significant learning was taking place which increased the potential for what Meyer (2010) refers to as 'deep change', correlating dispositional transformation.

Explicit transformational learning was also included in Iteration 2. The TCF was introduced earlier, on Day 2, as part of the professional learning session, and teachers reflected on and diagnosed their position on the TCF. On Day 3, using the [Roadmap to Change](#) (link embedded), teachers plan their change journey. They identify their current and goals positions on the TCF. Employing a future-orientation, to write a postcard to themselves from their future '2026' selves, in which they imagine an ideal situation in which all constraints are removed, and articulate how their teaching changes within this ideal situation. Teachers also set goals that are highly measurable and achievable in their classroom or schooling contexts and are encouraged to continue using the Roadmap to Change document as an ongoing change management tool. The Roadmap to Change provides a tool with which teachers can systematically and explicitly plan and manage their change processes.

The combination of implicit and explicit transformational learning in the FP ePlay MakerSpace served to capacitate teachers to manage their change journeys. The implicit transformational learning supported their crossing of the threshold into the liminal zone where the transformation of dispositions could occur. Additionally, the explicit transformational learning capacitated teacher to manage and sustain their ongoing change after their engagement with the Play MakerSpace had ended.

After the FP ePlay MakerSpace had concluded, the design and enactment were evaluated and findings analysed to inform the refinement of the 1gDPs and indicate potential improvements or elaborations to future ePlay MakerSpaces.

## **5.3 Evaluation and analysis of FP ePlay MakerSpace**

Iteration 2 of the FP ePlay MakerSpace was formative evaluated and analysed using the instruments developed in 3.2.4. The formative evaluation took place in the two weeks following the FP ePlay MakerSpace, and was informed by the rich data produced during Iteration 2 including: participants' created artifacts, reflections and Edmodo comments, and the researcher's observations. Three-six weeks after the ePlay MakerSpace, some teachers were interviewed, as well as the principal at School O. Data produced through the semi-structured interviews and site visits augmented the formative evaluations, serving to triangulate findings.

The formative evaluation of Iteration 2 relates to the context of the intervention and teachers' participation therein, the design and enactment of the FP ePlay MakerSpace, and the changes teachers enacted thereafter. The chapter concludes with an evaluation and refinement of the 1gDPs.

### **5.3.1 Evaluating the context of the intervention**

The sixteen teachers attending Iteration 2 represented nine (9) different schools: School B (1), C (1), D (1), E (2), F (4), H (1), N (1), O (4) and Y (1). The formative evaluation of the context of the intervention was informed by teachers' comments on Edmodo, their group reflection on Day 2, and the interview and site data collected. Interviews and site visits were conducted with teachers who had agreed to be interviewed, and at schools where principals gave permission for the interviews and site visits. Additionally, not all teachers' schedules allowed for interviews to take place, and in one case, FP21 (from School N) joined FP19 and 20 at School E for the interview. The lack of data for schools where site visits did not occur is therefore reflected in the formative evaluation.

The formative evaluation of the context addressed systemic, institutional and classroom level factors, to identify possible challenges, opportunities, constraints and trade-offs at each level.

### 5.3.2 Systemic level factors

The systemic factors listed in Iteration 1's formative evaluation is the same as for Iteration 2, since schools operate in the same system and are impacted by similar systemic factors. The evaluation is therefore not repeated. However, teachers attending Iteration 2 repeatedly commented on the pressure they experienced for their learners to achieve in the systemic provincial Literacy and Numeracy assessments. Therefore, this systemic factor is formatively evaluated in this section. Although it is also valid for the IP Language systemic evaluation, the language teachers did not comment on the assessments, from which one could infer that they experienced other more pressing systemic challenges as discussed in 4.3.1.1.

The field of education in the Western Cape and nationally in South Africa, strongly emphasizes teaching and learning of Languages and Mathematics. Annual systemic assessments are conducted in all Western Cape schools in September / October to measure learners' literacy and numeracy achievement. All Grade 3 and 6 learners in the province are required to complete the standardized systemic assessments. Initially the systemic tests were conducted as annual national assessments (ANAs), but in the past two years, only the provincial Literature and Numeracy assessments (LitNums) were conducted in the Western Cape. Consequently, both national and provincial education departments prioritise the improvement of literacy and numeracy results. Teacher professional development and resource provision in the province focuses on improving teachers' pedagogies regarding Language and Mathematics teaching throughout the school, and place particular emphasis on this in the FP where the foundations for conceptual knowledge development are formed.

### 5.3.3 Institutional and classroom level factors

The institutional and classroom level factors impacting teachers participating in Iteration 2, were formatively evaluated using the evaluation framework and captured in the G/Form developed for this. Following each site visit and semi-structured interviews, the formative evaluation results from each school was analysed. This section reports the findings from this formative evaluation.

Schools represented by teachers in Iteration 2, are classified by the national DBE as either quintile 1 or 2, and as indicated in Chapter 1, referred to as disadvantaged, lacking access to resources. Although the eLearning Game Changer initiative aims to provide all schools in the province with device and internet access by 2020, bar one principal, none of the teachers or principals knew the status of the school in the eLearning Game Changer, or when or whether they would receive device or internet access. The conditions of the field at each of Schools O, Y, H and E, are formatively evaluated to illustrate the impact of institutional and classroom level factors on transformative ET integration. Contextual challenges and opportunities at School F were formatively evaluated and analysed in Iteration 1, and is not repeated herein.

School O is a low-fee paying school where FP11 taught Gr 2, FP14 taught Grade 1 and FP15 taught Grade 3 and was also the HOD of the Foundation Phase. FP05 taught at School O three morning as week, and at another school the other two morning as she is a special needs teacher, provides learning support at both sites. The school building is rented by the WCED from a local religious organisation, therefore the WCED and the eLearning Game Changer are unwilling to install permanent fixtures in a building they do not own. This impacts for example the installation of an alarm system and security bars on the windows or security gates on the doors, and the installation of a computer lab or even a Wi-Fi router. Without security features, devices cannot be installed in classrooms, and where the school has purchased devices, these need to be carried to the office at the end of each day for safe-keeping. During the interview, FP11 related her frustration with the situation. To summarise:

FP11 had raised money through cake sales at the end of 2015 to buy a flat screen television set for her class. The school has a large old and very heavy television set, that teachers need to carry to and from the office whenever they want to use it. Since the office and classrooms are not connected by an under-cover pathway, when it rains, teachers cannot collect and/or return the television until it stops raining. Even though FP11 had raised the money for her class' flat screen television, the governing body did not sanction purchase of this until they had installed an alarm and security features in her class. At the time of the interview, it had been almost nine months since she had raised the money, and FP11 expressed her frustration with not being allowed to purchase the television.

FP14 has an IWB in her class, which the school purchased and supplied a security system to ensure its safety. During the interview, FP14 offered to swap classes with FP11 whenever she wanted to use the IWB. Additionally, FP15 suggested that the three teachers approached the principal together to address the situation. During a follow-up site visit in November 2016, FP11 had been allowed to purchase her flat screen television and was using it in her class, albeit having to carry it to the office each day until the school could install a security alarm and gate in her class.

School Y is a no-fee paying, learning and special education needs school, and is situated in one of the Cape Town's townships. FP12 is one of the Grade 1 teachers. The school serves learners with mental and physical disabilities from the surrounding township, and is therefore equipped with wheelchair access points and handrails for visually or physically impaired learners. Eleven IWBs and two visualizers, as well as teacher laptops are available at the school. However, internet connectivity is a challenge. While broadband access is available in the office area, the school does not have the resources to install Wi-Fi routers. Additionally, the dongle that connects the IWB to the projector, creates a Wi-Fi network, making it impossible with the current Wi-Fi enabled technology available in the class, for teachers to use the projector and access the internet simultaneously on the IWBs. Hence, all resources and tools must work in an offline environment.

FP12's classroom is equipped with an IWB and projector, which in the high crime area where the school is situated, needs particularly stringent security measures. Hence, the ceiling to her class is reinforced with rebar, the projector is encased in a rebar cage with a thick padlock, and to get into the class, one enters through three doors: a wooden exterior door (vandals broke the handle months before so it can only be opened with a screwdriver), a thick, solid metal door and then a rebar security gate. The windows are covered with thick rebar security bars. Similar security features are visible throughout the school, and even the playground equipment is surrounded by high metal fencing and padlocked to protect the swings and jungle gym. FP12 reported being a victim of crime many times, and on her way to a follow-up session at the CTLI in October, was mugged and her phone stolen. She arrived shaken and her arm bruised, but was determined to attend the session. The violence and crime experienced by learners and teachers at the school, does not however appear to deter the teachers from creating a welcoming learning environment in their classrooms. FP12's class walls were covered in bright posters and vocabulary displayed in English and isiXhosa, learners' home language. The windows were painted in bright primary colours. Upon questioning, FP12 explained that once she started using the IWB, the sun shone directly on it making it impossible to see the images or words displayed on the screen. Since she could not buy curtains for her class, she instead painted the windows with a mixture of powder paint and wood glue.

FP19 and FP20 teach at School E, a primary school on the outskirts of Cape Town. Due to some leadership instability at the school, an acting principal temporarily managing the school until a permanent placement could be made. He needed a classroom and therefore converted the outdated Khanya lab into a class. At the time of the interview, technicians were busy installing Wi-Fi routers near the office in which we were meeting, their noisy drilling degrading the sound quality of the recording at times. Although Wi-Fi was accessible in the office, the teachers were not given access to this, and FP19 and FP20 noted that the network administrator refused to divulge the Wi-Fi password. Thus, both teachers had limited opportunity to apply what they had learnt in the ePlay MakerSpace in their classrooms.

School H was at the time of the interview, temporarily located in prefabricated classrooms. While the school was being built, the learners and teachers attended school at the temporary premises and would move into their school building once completed. FP18 taught at school H. Unfortunately, due to the temporary nature of the school, no devices or connectivity were available in classrooms, and the office used as dongle to connect to the internet and answer emails. When visiting the school, a representative the CTLI's ICT Integration manager accompanied me. Upon hearing that there were no devices, he arranged for FP18 to collect a second-hand projector from the CTLI. Attempts to contact FP18 thereafter were unsuccessful, hence it is unclear whether she started using the projector as she had planned.

### **5.3.4 Evaluation participation**

The formative evaluation of FP teachers' participation in the FP ePlay MakerSpace, was conducted in the days following the session. Data produced from teachers' interviews augmented the formative evaluation of participation, and where necessary, the scores were altered to reflect a deeper understanding developed from the interview data. An average score was created by adding all the scores for each criterion relating to participation, and dividing this by 16. The average scores were then visually represented using a column chart, as can be seen in Figure 19.

The participation of FP teachers in the ePlay MakerSpace differed significantly from the IP Language teachers' participation. The FP teachers varied substantially with regards to technological skill, and while some teachers could be classified as expert users (FP05 and FP09), others had extremely limited technological skills (FP10 and FP12). In addition, whereas English was the common language spoken in the session, many teachers spoke Afrikaans or isiXhosa as home languages, and English as an additional language, or as in

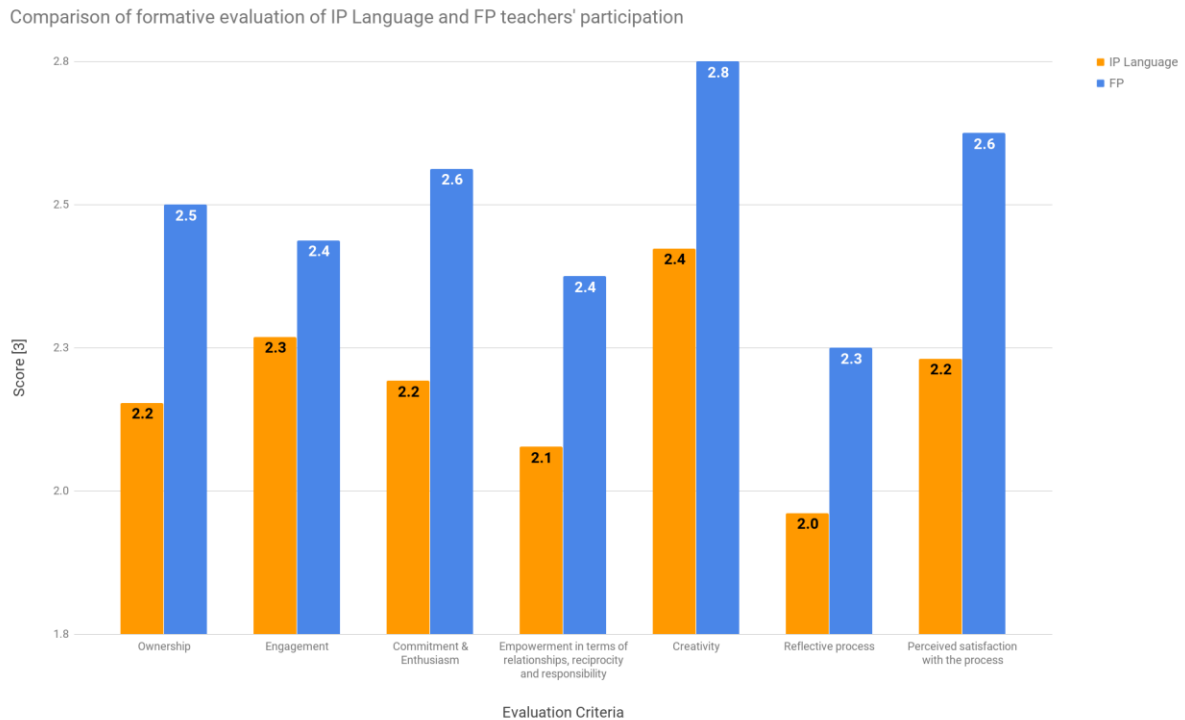


Figure 19 Formative evaluation indicating IP Language (orange) and FP (blue) teachers' participation

FP12's case, it was her third language. The teaching contexts within which teachers operated differed substantially as well: whereas 12 teachers taught in traditional Grade 1 – 3 classrooms, FP03, FP05, FP09 and FP12 were special needs educators and taught in non-traditional classrooms and schools. Despite such vast differences in technological knowledge and skill, pedagogical contexts and access, teachers' participation, as formatively evaluated using the same criteria and G/Form as for Iteration 1, showed a consistent improvement in all aspects.

Most significant changes in the participation measured in the FP teachers occurred in terms of Ownership, Commitment and Enthusiasm, Empowerment, Creativity, Reflective process and Perceived satisfaction with the process. In general, teachers in the FP group enthusiastically committed and took ownership of their learning and engagement in the ePlay MakerSpace process, and the changes they wanted to affect. Their participation reflected an openness to collaborate and engage in dialogue with all participants, and a general commitment to support egalitarian role division. As noted previously, teachers spontaneously supported one another and engaged in the collective shared reflections that

took place. The creativity score, triangulated with the creativity measured in teachers' artifacts, indicating an overall higher creativity score on Day 1 and a consistent increase over the three days of the FP ePlay MakerSpace. The FP teachers were more open to participate in the different reflective sessions as well, whether in informal shared or formal group reflective session. As discussed above, while teachers reflected on basic skills and techniques, they also moved beyond this to reflect cognitively on their learning and the learning of their students. Lastly, the FP teachers noted and were perceived to be markedly more satisfied with the learning process in the ePlay MakerSpace.

While teachers from both iterations faced similar contextual challenges, and individual differences, their participation in the ePlay MakerSpace differed significantly. As has been argued, *how* teachers participate in the ePlay MakerSpace, potentially impacts the transformation of dispositions. In the next section, the design and enactment of Iteration 2 is formatively evaluated.

### **5.3.5 Evaluating the design of the intervention**

The formative evaluation of the design and enactment of the FP ePlay MakerSpace took place in the week following the contact session. A second evaluation was repeated after the IP Language design and enactment was formatively evaluated a second time. Following the semi-structured interviews, the formative evaluation of the design and enactment were revisited a third time to refine and/or elaborate on the evaluation. The repeated formative evaluations were done to ensure internal validity of findings and decrease researcher bias.

The formative evaluation of the design of Iteration 2, concerns practicality, relevance and sustainability, effectiveness and validity. The enactment and implementation of the design was formatively evaluated in terms of procedural strengths, weaknesses, opportunities and threats.

### 5.3.5.1 Formative evaluation of the solution design

The formative evaluation of the design of the ePlay MakerSpace is reported in this section. This relates to the design and tools chosen for Iteration 2. Additionally, the formative evaluation assesses the design's sustainability and how effectively this design aligns the 1gDPs. Lastly the validity of the design is formatively evaluated.

#### 5.3.5.1.1 Criteria: Practicality

The formative evaluation criteria of practicality refer to the extent to which users and external experts may find the intervention appealing and useable in naturally occurring testbed context.

Learning in the FP ePlay MakerSpace and subsequent tool choices, were designed to address the problem defined by the *FP ICT Integration Course Framework* developed by the FP reference group. The group's considerable practical experienced in the FP informed the design and subsequent appeal and usability of the design. Guided by their suggestions, the refined *course* framework and 1gDPs, Iteration 2 was designed to support the generalist teaching in the FP classroom, choosing tools relating to video, sound and graphics that can be applied to all subject areas in the FP. When designing their group lesson plans, the generalist application of the tools and learning was evident in the range of topics. Framed by the autotelic and autonomous nature of the ePlay MakerSpace process, teachers could choose any CAPS topics from any subject. The different groups chose home language teaching, life skills and Grade R reading development. Teachers then developed different pedagogical learning and assessment tools applying the ET tools introduced in the ePlay MakerSpace, video, sound and graphics in diverse ways. This illustrates the high practical appeal and usability of the tools and learning included in the design of Iteration 2.

Teachers also noted that tools and learning was practically usable and implementable, and discussed in 5.3.6, employed these in their classrooms. FP16's comment provides a general summary of teachers' responses:

- ◆ FP16: *For me it was exciting. I've heard a lot about Google space and clouds and stuff like that, so it was exciting for me to be trained in it, [text omitted] also the video uploading and especially the PowerPoint and also learning about EDMODO and the slide share was great.*

Therefore, teachers' comments and subsequent action in their classrooms, provide evidence that the design and choice of tools for Iteration 2 was both practical and usable within teachers' everyday life and teaching contexts.

#### 5.3.5.1.2 Criteria: Relevance

The formative evaluation of the relevance of a design questions whether the design meets the goals, need and/or wants of participants as well as institutional goals and requirements. Evidence collected through participants' reflections during Iteration 2, and the interview data following the contact session, suggests that a high degree of relevance was achieved.

Evidence produced in teachers' reflections during the FP ePlay MakerSpace suggest the learning design addressed teachers' wants, needs and agendas. Teachers repeatedly commented positively regarding the professional and active learning. In the Reflection on Day 2, FP04 for instance commented on the professional learning as follows:

- ◆ FP04: *Blended learning I like. The implications and the overarching theme.*
- ◆ MrD: *What about blended learning did you like?*
- ◆ FP04: *The way that it's... the two come together, the traditional and the new come together and not throwing the old away but bringing the two together, that I like. [text omitted] Oh yes, and the 4C's, of course, I will never forget the 4C's, thank you Isabel, I really... I will never forget the 4C's. And I will go and I will put it in my classroom - the 4 C's. I'll put it up. It was good.*

FP04's comment indicates that the professional learning was highly relevant to her classroom context, so much so that she wanted to display it in her class. Other teachers' comments and subsequent actions parallel FP04's, confirming the high relevance of the

design. FP14 and FP15 for instance, implemented a Bring-Your-Own-Device pedagogy at their schools, while FP16 used a WhatsApp group with her learners' parents to move learning beyond the four walls of her class. In both instances, these teachers used devices learners accessed outside of school to create learning environments that embrace and integrate ETs in learners' lives. In the process, they also created greater learner↔content interaction.

Furthermore, the relevance of the design was evident in teachers' individual *course* reflections on the last day. When asked if the course met their expectations, all but one teacher noted that they felt the *course* met or exceeded their expectations. Some teacher commented:

- ◆ FP20: *Yes. I learnt new things which I very much wanted to learn. Working on an Interactive-Whiteboard. Working in G/drive. Creating collages. Uploading videos.*
- ◆ FP16: *Yes, it was beyond my expectations. It's a whole new world out there where technology in concern and there are endless ideas of how to implement and use the different tools in the classroom.*
- ◆ FP19: *Yes, and much more. I know now how to use the technology in my class. I know how to work on the Interactive-Whiteboard.*
- ◆ FP09: *Definitely. I needed to gain more knowledge and understanding regarding the true meaning and application of ICT Integration in my classroom and a new door has opened for me through this course. My existing skills set has been broadened, I could connect with other teachers and share ideas and resources through an online platform and I think bigger than two days ago :-)*

These teachers' comments indicate that they experienced the learning as highly relevant to their classroom needs and requirements. In addition, teachers' learning impacted their schooling environments and addressed institutional goals as well.

The interview data and site visits with teachers indicate that the learning in the ePlay MakerSpace had a positive impact on teachers' institutions as well. Although discussed in

greater depth in 5.3.6, two examples of this are included here. At school O, FP15 and FP14 initiated a BYOD programme, which was later implemented in the Year 6 class as well. FP15 as HOD of the FP, also moved all the FP planning and administration to G/Drive to foster greater sharing and collaboration, and to reduce the risk of losing data due to malfunctions of memory sticks (as she experienced in the term before the ePlay MakerSpace session). This was welcomed by the principal and in the months following her participation in the ePlay MakerSpace, the Gr 4 – 7 teachers also moved onto the G/Drive. School K's teacher, FP12, returned to the school and found the visualiser that had been donated to the school years before. She taught herself to use it and then taught the school driver, a therapist and other teachers, who started using it regularly. Both FP15 and FP12 displayed relatively low technological skill in the session, and yet their learning from the ePlay MakerSpace impacted the learning and administration at their school as a whole. This evidence indicates that the design was not only relevant to teachers, but also to their institutions.

#### 5.3.5.1.3 Criteria: Sustainability

The measure of sustainability reflects how the iteration's design aligns with the problem, and how a balance was maintained between resources, time and effort expended towards achieving these goals.

The FP ePlay MakerSpace design process involved the collaborative work of the reference group, the office of ICT Integration and the researcher in creating the *FP ICT Integration Course Framework*. The time and effort involved in creating this framework was critical to the success of FP ePlay MakerSpace, increasing its relevance and practical benefit as indicated above. Future iterations would not need to create the framework from the start, but could refine and elaborate on version 2 of the framework. This makes the design highly sustainable for future iterations.

The manual development for iteration 2 took almost eight months to complete and involved seven different iterations. As noted previously, at least seven iterations of the manual were enacted, from problem identification, design, development and evaluation, before it was finalised. This process was extremely time-consuming and required tremendous effort.

However, once the design of the FP manual was finalized, the IP Language manual could be developed based on this design. Whereas the design and development of the FP manual took eight months to finalize, the IP Language manual development took 6 – 8 weeks to finalize. Subsequent manuals have been developed, for example for IP Mathematics, and high school Language and Mathematics. The time and effort required for the design and development of these subsequent manuals have been significantly reduced by the iterative design of the FP manual, and the time and effort involved in this. This contributes to the sustainability of the design.

Skills transfer has also occurred to increase the sustainability of the design. In 2017 the FP ePlay MakerSpace was presented to approximately 100 FP teachers at the CTLI. A further 250 teachers will participate in the FP ePlay MakerSpace in 2018 decentralised in the eight districts of the Western Cape Education Department, rather than at the CTLI. This will require at least 18 FP ePlay MakerSpace facilitators to be trained. The CTLI have thus commissioned me to prepare a training course to train ePlay MakerSpace facilitators for 2018. During 2017, FP05 was trained and mentored as a teacher assistant in the FP course; FP09 and FP05 have both been invited to join the 2018 FP ePlay MakerSpace training. The skills transfer associated with the FP ePlay MakerSpace design is systemically supported and enabled, and therefore adds significantly to the sustainability of the design.

#### 5.3.5.1.4 Criteria: Effectiveness

The design met the ten 1gDPs as discussed in the last section of this chapter. In addition, the investment of time and effort expended in the design of the FP ePlay MakerSpace has been rewarded in repeated investment by the CTLI in developing capacity to present the FP ePlay MakerSpace to more teachers for 2017 and 2018. The FP ePlay MakerSpace is also in the process of receiving accreditation for delivery in 2018 / 2019 to teachers across South Africa in a blended format. In view of these subsequent results, the time and effort to develop the FP ePlay MakerSpace is justified.

#### 5.3.5.1.5 Criteria: Validity

As with Iteration 1, the design for the FP ePlay MakerSpace combined critical, socio-cultural and design epistemologies in novel and unusual ways to create and innovate a uniquely practical, relevant, sustainable and effective intervention. The design drew variously on well-established theories: for example Bourdieu's theory of practice (1990a, 1999, 2000), Fullan's (2013) skills for the 21<sup>st</sup> century, Bloom's Revised Taxonomy (Krathwohl, 2002) and Anderson's (2004) model of interaction among other. However, in conceptualising the ePlay MakerSpace process, while drawing on established play theorists (Huizinga, 1949; Sutton-Smith, 2001; Meyer, 2010; Sicart, 2014; Brabazon, 2016), peer-reviewed research in the use of MakerSpaces for teacher professional development is scarce and mostly situated in library sciences. In keeping with the theoretical foundation of this DBR study, these theoretical tenets significantly shaped the design of the process and linked the various design elements together. The combination of these theoretical elements to create a model that uses play and combines this with MakerSpaces to develop teachers' capacities to create and innovate, and effect change, is however largely unexplored. Much of the conceptual work to combine these established and relatively new research areas can thus be said to be state-of-the-art, novel and innovative.

In addition, the design of the ePlay MakerSpace in both Iteration 1 and 2, address the immediate needs and wants of teachers in poorly resourced schools, and discussed in 5.3.4, resulted in the transformative integration of ETs and changes to their teaching. The success with which the process is changing teaching and achieving transformative integration of ETs in classrooms, has led to its large-scale adoption. In the absence of a similar programme that effects transformative ET integration in South Africa's disadvantaged schools, the process can be said to be state-of-the-art.

The FP ePlay MakerSpace process can be said to be both valid in terms of the state-of-the-art nature of its theoretical and conceptual foundations, and its novelty within teacher professional development in South Africa.

### 5.3.5.2 Formative evaluation of the enactment and implementation procedure

The formative evaluations of Iteration 2 indicate that the design was well received and teachers participated at a high level in the enactment. While many strengths can be identified in the enactment of Iteration 2, challenges and shortfalls can also be identified from the enactment, that should be addressed for future iterations. This formative evaluation is therefore structured to identify procedural strengths, weaknesses, opportunities and threats to the enactment of future FP ePlay MakerSpaces.

#### 5.3.5.2.1 Criteria: Procedural strengths

Various improvements or changes were made to refine the design of the ePlay MakerSpace process following the formative evaluation of Iteration 1 and informed by the 1gDPs. These improvements and refinements resulted in many successes, and can be identified as strengths of the implementation.

The generalist approach suggested by the FP reference group and incorporated in the *FP ICT Integration Course Framework* was a strength in Iteration 1. Following the same generalist approach, the choice of tools and design of learning activities could be applied across the FP subject areas. This made the course more practical and relevant to participants' generalist teaching.

The tool introductory process for the ePlay MakerSpace, developed from Iteration 1 and applied in Iteration 2, can be seen as a further strength. Tools were introduced through the three-step process of playful exposure, task-driven use and direct application. The use of tools such as Edmodo or G/Forms in Iteration 1 had caused some confusion when first introduced. However, following the TIP, when these tools were introduced even teachers with extremely limited technological skills were able to start using the ET tools. All teachers were able to post by responding to thread in Edmodo. FP 10 who was one of the teachers with the lowest technological skillsets, created a G/Slide presentation and G/Form using four different types of questions. In addition, she participated in her group's lesson planning

and created Slide 2 which she also presented. During the session, I had observed her making a collage but unfortunately, she did not share this correctly in Edmodo. Nevertheless, if judged by the ability of the participant with the lowest skillset to access, use and manipulate four entirely new tools in only three days to create pedagogically appropriate learning tools, the TIP appears to have been successfully designed and implemented.

The creation and management of the context in which the FP ePlay MakerSpace took place, can be seen as an additional strength. In contrast to the IP Language group, the FP teachers collectively created the parameters in which the ePlay MakerSpace would take place, and took individual and collective responsibility to uphold these rules. This created a safe and nurturing space in which the different forms of learning took place. FP 18 comments in this regard:

- ◆ FP18: *It really help the groups, cause it said [words omitted] we must not be afraid to make mistakes, or something like that. And yet, coming into it, I was so scared that I don't want to make a mistake and I'm not going to know. But then the rules said that you can ask one another and you must not be scared to make a mistake. Then that made it a bit easier for me also. So that I can feel comfortable, which uhm, I, coming into it, I didn't feel that much confident and comfortable. But going away, leaving, I felt MUch more comfortable AND Confident. Leaving the course.*

The generated rules, following FP18's comments, can therefore be seen as a bridge to support teachers who felt intimidated, scared or afraid to make mistakes. The use of the rules as a bridge across the liminal zone, FP18 notes, led to her feeling comfortable to take risks and make mistakes, and through trying out and trying on new ideas or practices, she developed confidence. Additionally, as FP14 indicates, the rules helped teachers to 'know what to expect':

- ◆ FP14: *I think it's good to to have those rules because then, uhm you know what to expect from from the persons involved and you don't feel as if you're intimidated by or as if you don't have a chance to say whatever you need to say. So but the rules*

*didn't, weren't enforced or anything [words omitted] they made us all feel as if we were on the same level.*

FP14s comment further indicates that the rules created a more egalitarian role distribution between all participants. Whether teachers were leaders or HODs in their school or Level 1 teachers, or whether novice or experienced, the rules served to make them feel '*as if we were on the same level*' (FP14). FP21's comments echoed these sentiments, as she said:

Teachers' positive comments about the rules foreground the advantages of creating and maintaining collectively created rules to set the parameters of the ePlay MakerSpace. The rules served to articulate a mutually shared meaning to define the safe and nurturing space within which teacher would respect and support each other, and would take risks embracing the potential for failure and learning from this. Additionally, the rules created a bridge to support teachers' weight of change as they crossed the edge of chaos, carrying their lack of confidence or fear of failure. Furthermore, the rules created an egalitarian learning space in which every participant was equal. Thus, collectively developing rules to create and maintain the safe and nurturing ePlay MakerSpace is a strength of Iteration 2.

Framing collaboration, and particularly online collaboration as an ET tool, and scaffolding its introduction with the TIP, was a further strength of Iteration 2. This framing had a significant impact on the manner in which teachers collaborated online to create their group lesson plans and their relational learning. In Iteration 1 only one group with the most experienced users, engaged in the online collaboration to create a lesson plan. However, in Iteration 2, all the teachers, regardless of their experience or technological skills, were able to engage in online collaboration to participate in the creation of the group learning design. Scaffolding the introduction of collaboration using the TIP appears to have significantly increased all teachers', especially novice users' access and appropriation of this tool. Therefore, the framing of collaboration of as ET tool is classified as a procedural strength.

Teachers' participation in Iteration 2 is also seen as a strength. The formative evaluation of participation in Iteration 2 indicated a significantly higher participation measure than that achieved in Iteration 1. The FP teachers' participation scores were significantly higher than

the teachers in Iteration 1, regardless of technological skill level, and despite many speaking English as second or third additional language (and accessing all learning material, functions or menus in all the online ET tools in English). This may be due to a combination of factors, or even be the sum of the strengths listed thus far. The generalist approach increased the practicality and relevance of the learning, while the generated rules created a bridge to carry teachers' weight of change in crossing the threshold, and increased the potential for dispositional transformation. Additionally, the TIP was used for all ET tools, including collaboration, ensuring that teachers felt confident and comfortable participating in activities where these tools were appropriated. The increased participation parallels the significantly higher creativity measure of the FP teachers created artifacts, and particularly their CMs from Day 1 and 3 compared to the IP Language teachers' CMs. As has been argued, participation and creativity measures can be correlated the transformation of teachers' dispositions in the liminal zone. Therefore, the increased participation, and increased creativity measures, are seen as strengths since these point to the increased potential for the transformation of dispositions.

#### 5.3.5.2.2 Criteria: Procedural weaknesses

Procedural weaknesses are framed as negative aspects of the implementation that detract from the optimal enactment of the ePlay MakerSpace and hinders its progression. The formative evaluation addresses procedural weaknesses that are within the control of the designer/facilitator to address.

The facilitation of the FP ePlay MakerSpace and assistance offered to teachers was indicated as a weakness. FP04 reflected on Day 2 as follows:

- ◆ FP04: [text omitted] *What I didn't like, you know when I want to learn and I want to learn. Show me, don't do it for me. What I like is... when you teach me something new. Teach me, guide me, so I can learn, if I do something wrong don't do it for me, but let me do it.* [text omitted]

FP04's comment referred to way in which I had assisted her the day before when she wanted to know how to insert images in her G/Slide. I had taken the mouse and modelled the process for her. She was asking for a different type of assistance, to be told the steps that she could follow, rather than be shown how to do it. This foregrounded the autonomous foundations of the ePlay MakerSpace. In order to respect the autonomy of each teachers' crossing of their liminal zone and the manner in which they choose to engage in the ePlay MakerSpace process, a standard or uniform manner of assistance cannot be adopted. This is a potential weakness and fails to uphold the autonomous foundations of the ePlay MakerSpace. Instead, assistances should be provided as requested by the participant, and when they are unclear, the facilitator should first clarify how the teacher would prefer the assistance, for example, to be *shown* or *told* how to use an ET tool.

A further weakness relates to the design of the manual. During the reflections on Day 2, three teachers, include FP02 asked for "*more detailed instructions*". Whilst the manual provided instructions for the different activities, in this comment, FP02 indicates that the instructions were not detailed enough. On Day 1 teachers were provided with a step-by-step guide printed on A4 of how to connect to the Wi-Fi, and supported in accessing this. FP02 compared this to manual and requested more step-by-step instructions in the manual. Subsequent iterations and manuals will therefore need to address this and include more detailed instructions.

A goal of the ePlay MakerSpace was to support teachers' networking and collaboration during and after the session. The Edmodo online community was established as a tool for teachers to network and share resources after the ePlay MakerSpace had concluded. However, Edmodo was not extensively used after the ePlay MakerSpace. In the weeks directly after the session, FP05 and FP15 posted in the Edmodo group, and some teachers responded. Furthermore, despite me posting helpful links and pictures, only one or two people visited Edmodo and read these or 'liked' the posts. During the interviews following the ePlay MakerSpace, FP16 explained that they had difficulty accessing Edmodo:

- ◆ FP16: *Ok, for me, I enjoyed it, I was in my element because like when you were there, you knew what to do but now we're back at school, ask her, FP02 and myself, we couldn't, we still can't get into Edmodo, and so we went to IPL15.*
- ◆ MrD: *But is it technical?*
- ◆ FP16: *It doesn't take our emails, the address, it says, when we want to log in, it ask for a group code, or a something, so we couldn't.*

Teachers could connect to Edmodo during the ePlay MakerSpace, but as FP16 indicates, had difficulty connecting to the platform when back at their schools, explaining the low interaction in the group. This is not a weakness per se of the process in the course, but should be addressed in future iterations, possibly providing opportunities for teachers to bring their devices and log into Edmodo on these during the sessions.

#### 5.3.5.2.3 Criteria: Procedural opportunities

Procedural opportunities relate to potential positive external factors that may be exploited in the field, or related fields, to improve the implementation of the learning from the ePlay MakerSpace. Different potential opportunities were identified.

The skill differential between experienced and novice users in Iteration 2 was considerable, with some novice users not even able to manipulate the mouse or follow drop-down menus. Although the ePlay MakerSpace is inclusive, the office of ICT Integration suggested that it may be beneficial to teachers with severely limited technological skills to first attend the competency-based technical skills training they offered, before attending the ePlay MakerSpace. However, the suggestion has not been enforced

The continued transformation of dispositions and transformative ET integration, may be increased with institutional support. When teachers return to their classrooms, a lack of infrastructure, devices and/or connectivity, pose considerable challenges to their ongoing transformational ET integration. The creation of enabling environments in which teachers can freely access the internet, use devices and/or let learners access these, will likely support teachers ongoing transformative ET integration. Additionally, a responsible use

policy that supports teachers' efforts to initiate and manage BYOD programmes will further support teachers' transformative ET integration. Furthermore, schools may consider implementing professional learning communities (PLCs) to provide ongoing support for teachers when implementing changes and transformatively integrating ETs. As suggested to the HODs at School F, this may take the form of short 20-minute sessions that chunk learning into bite-size pieces, and in which time one teacher per week for instance, can share a new tool or pedagogy he/she had explore and implemented.

Where possible, schools should collaborate with the local organisations and Non-Profit Organisations (NPOs) in their communities. As the teachers at School Z indicated, a local NPO had partnered with them to provide teachers with assistance to manage the integration of ETs in their classrooms. Similar NPOs may operate in other communities, and may provide similar support to teachers.

#### 5.3.5.2.4 Criteria: Procedural threats

Procedural threats are those risks that if unattended, may jeopardize the implementation of future ePlay MakerSpaces. The main procedural threat relates to group dynamics during the lesson planning. Once incident was reported where a teacher dominated the group decisions, and others felt they had no voice within the group. During the interview, FP04 described the situation:

- ◇ FP04: *Cause we're talking about collaboration, and I admired all the other groups working so nicely together. You know what I mean? And then, uhm, and uhm, then when it came to our group, I .. didn't feel like doing anything.*
- ◇ IT: *Oh ja, I remember you standing on the edge when you were presenting.*
- ◇ FP04: *It's just that. Because whenever you sense a person saying, when we saying something, Oh not like this, we can't like this. Oh, so I told her one, then if she wants to do it like that, then let her do it then.*
- ◇ IT: *So we need to look more carefully at how we, our groups collaborate together.*
- ◇ FP04: *That's right.*

When FP04 shared her opinion, another teacher in the group dismissed this and it appears, unilaterally decided how to conduct the lesson planning. After this, FP04 did not comment again and let this teacher manage the group. The teacher FP04 was referring to, was also an FP HOD at her school, and it appears, her leadership style may have been somewhat hierarchical. Consequently, when she worked in the group, this same hierarchical leadership style was employed. Even though the ePlay MakerSpace context was framed by the rules and supported egalitarian role distribution and respect, in this instance these rules were not followed. Although FP04 did not engage in the face-to-face session, she did however collaborate online and presented the slide she had made. Another teacher may not have responded in the same way in a similar situation, and such an incident may cause them to withdraw from the process, negatively impacting the transformation of dispositions. Thus, while the framing of collaboration as an ET tools is previously identified as a strength, the support provided in the session to ensure egalitarian role distribution during the group learning design sessions, is identified as a threat. Relational learning may need substantial support, depending on the participants and how they choose to constitute each group, to avoid this threat.

### **5.3.6 Evaluating change**

This section explores the changes teachers implement during and after the ePlay MakerSpace.

#### **5.3.6.1 Change measured during Iteration 1**

The inculcation processes and enabling conditions of the ePlay MakerSpace are designed to transform teachers' dispositions to impact how teachers integrate ETs in their teaching. Different learning processes capacitate teachers to create and innovate using ET tools. Therefore, a measure of the potential change in terms of creativity, may indicate whether dispositional transformation took place while teachers participated in the ePlay MakerSpace.

FP teachers created different artifacts during the three-day FP ePlay MakerSpace. On Day 1 and 3 they created concept maps, reflecting on their conceptual understanding of *ICT Integration in Education*. As with Iteration 1, the concept map protocol developed in Chapter 3 was strictly adhered to in order to increase comparability of findings (Benney and Hughes, 1956) and descriptive validity. Teachers also created G/Slide presentations of 21<sup>st</sup> century skills, collages using Befunky.com and G/Forms for eAssessment. While the FP teachers also created Vokis and mind-maps (using Mindmup.com), the links to these were not shared to Edmodo and therefore these created artifacts are not included herein. Also excluded from teachers' individual creativity measurement are the collaboratively created group lesson plans.

The individually created artifacts were measured using the standardised measurement tool developed in Chapter 3. The creativity in the created artifacts was measured in terms of fluency, flexibility and originality. A rubric to standardize the creativity measured in each artifact, was iteratively developed, trialled and tested in conjunction with the IP Language teachers' creativity measurement. In both the IP Language and FP measurement tools' development, similar descriptors for originality, fluency and flexibility were used to increase comparability of findings, although still capturing the differences in each set of artifacts. The creativity measuring tools were iteratively developed and refined over the course of almost a year, with the assistance of colleagues who trialled the tools, to achieve internal consistency (see Appendix B). The final results were collected on a G/Sheet and visually represented (see Figure 20).

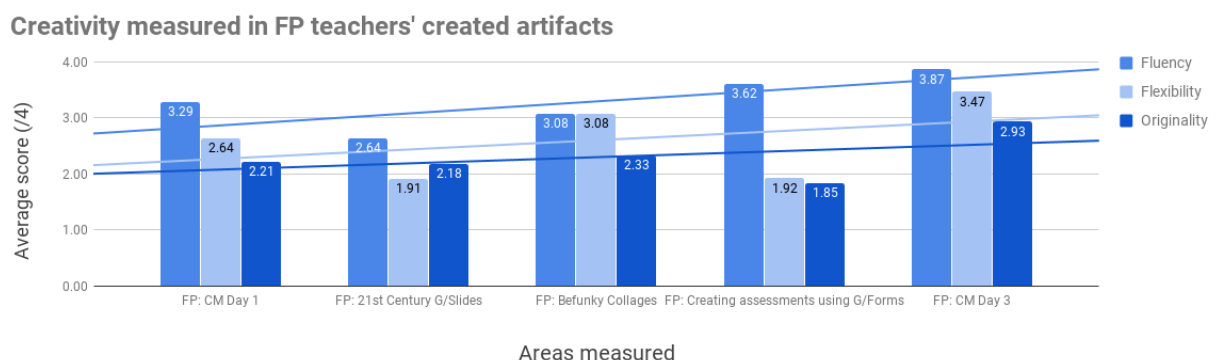


Figure 20 Creativity measured in FP teachers' created artifacts

Cognisant that novice users' creativity measure may be impacted by challenges they experienced with device or ET tool use, the emphasis in this comparison falls on the CM scores since these were done on paper, a familiar and comfortable tool to all users.

As can be seen from the chart (Figure 20), the trend lines indicate that in all three aspects of creativity, fluency, flexibility and originality, the FP teachers' measurements increased over the three-days of the ePlay MakerSpace. Significantly, their Day 1 and 3 CMs showed a marked difference in creativity. Fluency scores increased from 3.29 →3.87 (0.58 increase), flexibility increased from 2.65→3.47 (0.83 increase) and originality increased from 2.21→2.93 (0.72 increase). In the same activity, the IP Language teachers' scores varied: while fluency decreased from 2.96→2.80 (0.16 decrease), flexibility increased from 2.46→2.56 (0.1 increase) and originality increased from 1.92→2.28 (0.36 increase). For ease of reference these scores are compared in *Table 1*:

*Table 1 Comparison between Creativity measure in CMs between IP Language and FP teachers*

	IP Language Teachers			FP Teachers		
	CM Day 1	CM Day 3	Difference	CM Day 1	CM Day 3	Difference
Fluency	2.96	2.80	-0.16	3.29	3.87	0.58
Flexibility	2.46	2.56	+0.10	2.56	3.47	0.83
Originality	1.92	2.28	+0.36	2.21	2.93	0.72

Reading the data from *Table 1*, there is a marked difference between IP Language and FP teachers' creativity measures. FP teachers' measures of fluency, flexibility and originality was higher in their CMs on Day 1 than the IP Language teachers'. Also, the increase in

creativity between Day 1 and 3 for FP teachers was significantly higher than for the IP Language teachers. Particularly the measurement of fluency between Day 1 and 3 for FP teachers increased by 0.58 points, while the IP Language teachers' fluency measure decreased by -0.16 points. When the creativity measured for FP teachers created artifacts was compared to that of the IP Language teachers', similar findings were made. Not only did FP teachers' start with higher creativity measures on Day 1, their scores for fluency, flexibility and originality increased at a significantly higher rate than that of the IP Language teachers' measurements.

The significantly higher creativity measurement in FP teachers' creativity during their participation in the ePlay MakerSpace, may be interpreted in different ways. One could argue that the generalist approach in FP classrooms, requires FP teachers to be more fluent and flexible in their approach. They must adapt pedagogies and learning environments throughout their day, teaching Mathematics in one session, and Languages or Life Skills in the next. This requires fluency to generate any number of pedagogic tools or approaches suited to each subject area and learning environment, and flexibility to quickly switch between different subjects and pedagogic requirements for each. Consequently, they may already have dispositions structured to support fluency and flexibility, as perhaps suggested by their higher creativity measures on Day 1 when compared to the IP Language teachers scores.

However, the opposite argument can also be made. Since IP Language teachers are frequently required to teach other subjects, not only languages, this may also require flexibility and fluency to navigate between these. Similarly, IP Language teachers would be required to move between classes, teaching for instance Grade 4 -7, which also requires fluency and flexibility to navigate between learners' in the different classes, their learning needs and the CAPS requirements. Therefore, it could be argued that IP Language teachers require similar fluency and flexibility in their teaching as FP teachers, and may already access similar dispositions as the FP teachers.

An argument to correlate the difference in Day 1 creativity scores with teachers' classroom practice, may not be valid. Furthermore, while other factors may be considered to explain this difference, it should be noted that the reasons for the increased creativity score on Day 1 between the two iterations, is not the focus of this study. Rather, data captured in the table emphasizes the different manner in which creativity measures increased over the three-days in the IP Language and FP ePlay MakerSpaces. The data indicates that Iteration 2 teachers' fluency, flexibility and originality measures increased significantly, more than the increase in Iteration 1.

In addition to the marked differences in creativity measures (Figure 20), as was argued in 5.3.4 the participation measure in Iteration 2 (Figure 19) differed significantly from that in Iteration 1. The FP teachers' participation measure was significantly higher than the IP Language teachers' participation measure. While different factors may have contributed to this, the difference may be significant in the changes effected in schools following the ePlay MakerSpace.

Having established that creativity and participation measures in Iteration 2 were much higher than in Iteration 1, the next section questions whether these increases translated into changes at classroom or school level after the ePlay MakerSpace.

#### **5.3.6.2 Changes reported after the FP ePlay MakerSpace**

During Iteration 2 of the ePlay MakerSpace, there was a marked increase in creativity measured over Day 1 – 3. This parallels the significantly higher participation measures for FP teachers than IP Language teachers. These two measures raise the question of whether the greater creativity and participation could be indicative of dispositional transformation. This section documents different changes FP teachers initiated following their engagement with the FP ePlay MakerSpace, to answer this question.

On Day 3 of Iteration 2, the FP teachers completed their Roadmap to Change G/Slides. In diagnosing their pedagogic positions on the TCF, ten (10) teachers self-identified their pedagogic approach as situated in Quadrant A, three (3) positioned in Quadrant B (FP11

## The Teaching Change Frame

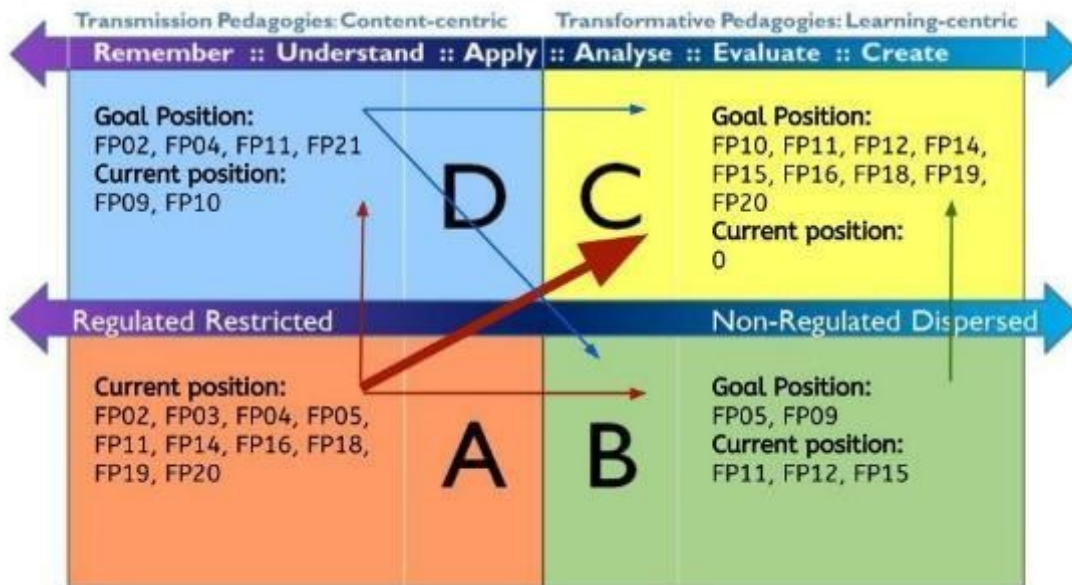


Figure 21 FP teachers' self-identified current and goal positions on the TCF

placed herself in both A and B), and two diagnosed their teaching as situated in Quadrant D. Teachers' self-identified positions are included in the TCF in Figure 21, as well as their goal positions.

As can be seen from the Figure 21, teachers set goals for themselves of the type of teaching they want to achieve within six months of attending the FP ePlay MakerSpace. Nine (9) teachers wanted to move to Quadrant C; while four (4) teachers set goals to move to Quadrant D, and two wanted to move to B. The FP teachers' goals differed from the IP Language teachers in that no IP Language teachers set goals to achieve Quadrant B-type teaching. With their goal positions on the TCF in mind, FP teachers set 3 – 5 goals that they could immediately implement when back at school. In accordance with the autotelic and autonomous foundations of the ePlay MakerSpace, teachers were not restricted when setting goals and could target any area they wanted to change.

Three to five weeks after Iteration 2, the researcher visited Schools F, O, Y and N, and conducted semi-structured interviews with teachers. The changes teachers reported during these site visits are subsequently reported.

### 5.3.6.2.1 School F: FP04 and FP16

The teachers at School F had implemented some changes after the ePlay MakerSpace, and FP04 and FP16's changes are reported herein. Although FP02 at first attended the interview, she excused herself soon after it started, and then came in and out of the interview, without making many contributions.

Although School F is a model school, resources were at the time of the interview, not yet abundantly available. For instance, each Grade had a laptop and projector that was shared among the four teachers, and they had to book the devices out at the office. Moreover, the school's laptops only intermittently picked up the Wi-Fi so teachers were rarely confident that they could access the internet for a lesson. Also, the classrooms were fitted with dark green chalkboards, even though the school was only completed in 2014. Therefore, as FP16 comments, teachers innovated different methods to cover the chalkboards with cloth or paper when they wanted to use the projector:

◆ FP16: *But you know what, the Grade 1 teacher, she has a table cloth, a big table cloth so at the back it's white. It makes a lovely screen yes. It's very big so you put that on, then you get the screen.*

FP16 is one of the Grade 1 teachers. She created a WhatsApp group earlier in the year to share information and homework with her class' parents. After the ePlay MakerSpace, she changed how she used the WhatsApp group and started using it to support learning in and outside of the class. She related an example of this: The theme in the class was My Pet, so FP16 posted on the WhatsApp group, asking parents to let their children take photos of their pets, or a pet in a magazine if they do not own a pet, and share it to the group. Then she posted seven questions on the group that learners had to use to prepare an oral for presentation in class. Initially it was unclear that the questions were for the WhatsApp group, so she explained:

- ◇ FP16: *No I post, I sent it home to the parents on the chat [A WhatsApp group she created], so we used it as an oral so they had to prepare them. And we also gave marks for, uhm (MrD speaks over her)*
- ◇ MrD: *The WhatsApp group?*
- ◇ FP16: *Yes it's a WhatsApp group. And we also gave marks for you know for speaking in full sentences. Because sometimes when they do an oral, uhm, they don't speak in full sentences. So we sent the questions home and the parents had to prepare them at home and then they had that.*
- ◇ IT: *It's wonderful that you're using this technology in that way.*
- ◇ MrD: *Absolute, I'm I'm quite... almost said stunned. (Laughter)*

Learners then returned to school and spoke about their pet, having prepared for this using the questions from the WhatsApp Group (although I asked FP16 to share the photos with me on WhatsApp, this did not happen.) This activity was designed for a Grade 1 class, and while FP16 had previously used the WhatsApp group to share homework with parents, the use of the tool to support learning was new. FP16 self-diagnosed her position as working in Quadrant A in her class. This activity indicates that she had moved to Quadrant D: she regulated the use of the tool, and restricted learners by creating the activity as an individual oral, neither giving them the choices to choose different tools, or who they wanted to collaborate with. The integration of the tool (WhatsApp) supported learners to remember facts about their pet, and present these facts to their friends. Therefore, since she drew on Lower Order Thinking Skills, and regulated and restricted the learning activities, her pedagogical approach is situated in Quadrant D. Furthermore, FP16 started showing learners videos (The Three Little Pigs) that she had downloaded, and she shared her lesson and photos from this during the interview, which further correlates to Quadrant D teaching.

The examples FP16 shared during the interview, indicates that she changed pedagogically from Quadrant A→D. On the TCF, she wanted to move from Quadrant A→C. Her activities indicate that while change had occurred, to affect the A→C change, she would still need to effect epistemological change to her pedagogic approach. Furthermore, she commented:

'we also gave marks', indicating that she transferred this practice to the other three Grade 1 teachers at the school. In this way, her change in the use of WhatsApp impacted not only her class' learners, but also other teachers and learners in the grade and potentially the school.

FP04 is a Grade 3 teacher at School F. As FP16, following the ePlay MakerSpace, she also changed how she used ETs. On the last day, she set herself goals to start showing videos, make collages and use sound. During her interview, she noted that she had achieved two of these goals, using video and making collages, but not using sound. She excitedly and animatedly related how she achieved this:

◆ FP04: [words omitted] *We were doing, public safety and then one day I showed them a video about public safety, and then I, and we doing for phonics, we doing silent letters. And then I made collages with the silent K and then silent this and the silent this. And then I had a video with AAALLL the letters of the silent, silent letters from a till z. Then the video comes up in a slide. And now, and now there's still a lady speaking and she says the, and here my children just, they just, they they loved it [words omitted] ... the words! I mean the words. They could say the word before the person says the word! I had to stop them, WAIT, wait, just listen, look and listen. Then I asked them questions. [words omitted].*

As this example indicates, FP04 had downloaded videos of songs and teaching about silent letters for her class. She showed it to them and they responded excitedly to the songs, singing and saying the words even before the presenter on the video could. This high level of engagement by learners was noticed by other teacher who noted how excited the learners were about learning. She also created collages for her teaching.

FP04 had not used video or collages before attending the ePlay MakerSpace, and only implemented changes after her engagement with the session. The transformational learning and goal setting in the ePlay MakerSpace can therefore be seen to have equipped her to start changing how she used ETs in her class - showing learners video and making collages to

## Creativity measure of artifacts created by teachers at School F

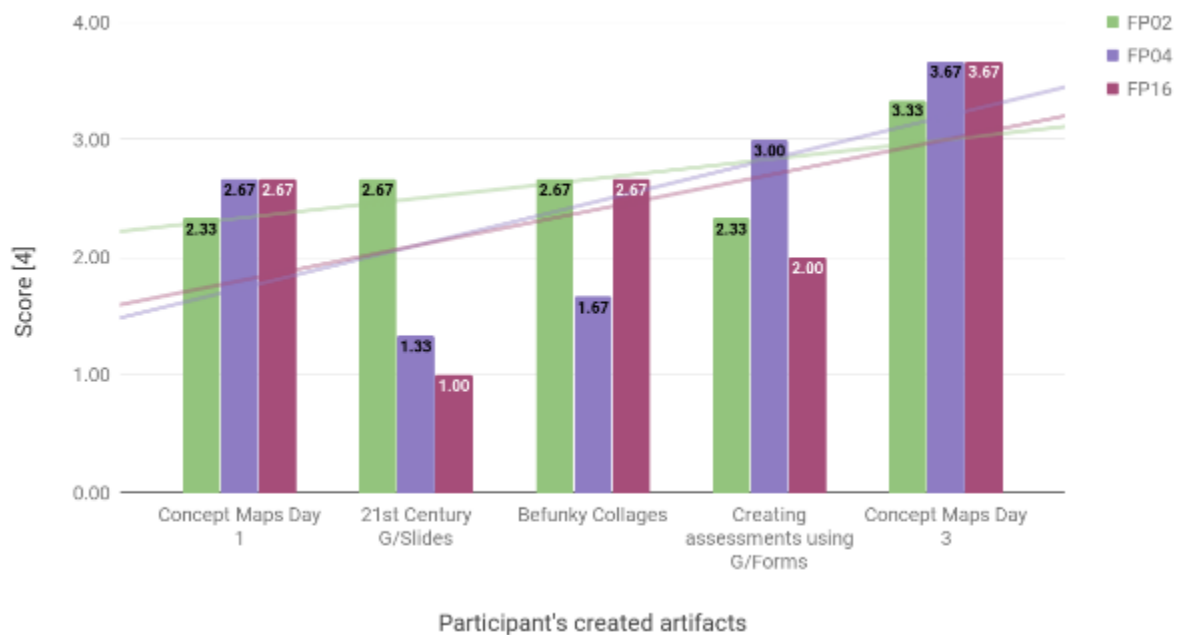


Figure 22 Creativity measure of artifacts created by teachers from School F

support learning. On the TCF she had self-identified as being in Quadrant A, and set her goal to move to Quadrant D. Using the school's projector to show the videos she had downloaded, indicates that she had moved on the TCF. Although she may not have change her pedagogical approach to target higher order thinking skills for instance, she was autonomously managing her change process. In this way, the ePlay MakerSpace had capacitated her to effect change to her pedagogic practices. The excitement and enthusiasm with which learners responded to her changed practice, may serve to reinforce this changed practice.

If one compares the changes within the ePlay MakerSpace in terms of FP04 and FP16' creativity measures, and their participation, with the changes following the ePlay MakerSpace, parallels can be identified. Both FP04 and FP16's CMs from Day 1 to 3, show a significant increase in their creativity measures, both increasing from 2.67 to 3.67 as indicated in Figure 22. However, while FP04 scored high in fluency, and relatively low in flexibility and originality, FP16 scored more evenly across the three areas of fluency,

flexibility and originality for the different artifacts, increasing over the three days in all three areas.

The different creativity measurements for FP04 and FP16 parallel how both teachers chose to change their practice. FP04 used video and collages to support learning, appropriating these two ET tools in different scenarios. As such, her capacity to generate different ideas of how to use the tools in different ways is related to a high level of fluency. On the other hand, FP16 displayed more flexibility by using a tool she had already introduced to parents to support information-sharing, to support learning in and outside of the class. Also, her idea to get learners to take photos of their pets and sharing it with the WhatsApp group, is novel and unusual compared to the rest of the FP teachers, indicating a higher measure of originality. Lastly, her use of video in her class, and desire to let learners create collages with the pet photos they had taken, indicates flexibility: she was able to switch between ideas and generate multiple different uses for the ET tools. Sharing her practice with other teachers at her school, also parallel's Bateson and Martin's (2013) definition of innovation. FP16 not only generated practical behaviours to implement creative ideas, but shared such new ideas and behaviours with her colleagues, and making her ideas more widely adoptable.

Formative Evaluation of Participation for Teachers at School F

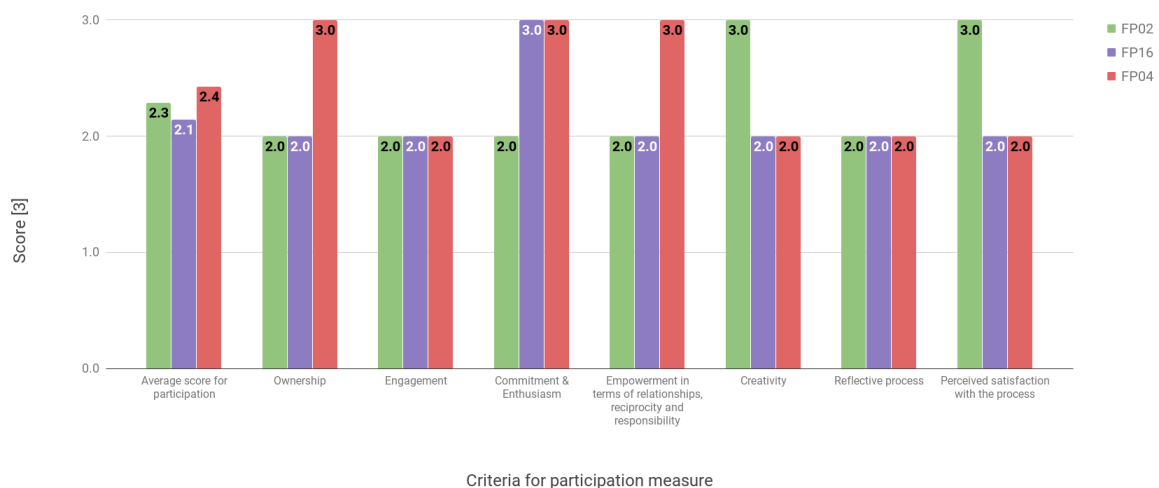


Figure 23 Participation measure by teachers from School F

When analysing FP04 and FP16's participation, both appear to have participated at a lower level in the ePlay MakerSpace (see Figure 23). FP04 scored 3s for ownership, commitment and enthusiasm, and empowerment, however only 2s for engagement, creativity, reflection and perceived satisfaction. She was unhappy with the group she worked with to create the collaborative group lesson plans, feeling that her opinions were not being heard within the group. Subsequently, she refrained from participating although completing and presenting her slides in the group design. On the other hand, FP16 scored highest on commitment and enthusiasm (3) but only achieved 2s for the other six indicators. Both teachers scored 2s for engagement, creativity and participation in the reflective learning sessions, and both only scored 2 for their perceived satisfaction with the process.

In both FP04 and FP16's cases, there is clear evidence of individual innovation and change. Both moved from Quadrant A→D on the TCF, and although the movement from Quadrant A→D does not signify significant epistemological evolution, it does indicate that they autonomously managed their own change process. Also, both teachers' participation measure was at an average 2/3, indicating that both engaged in the process, and reflected on their learning.

#### 5.3.6.2.2 School O: FP11, FP14 and FP15

FP11, FP14 and FP15 teach at School O. During the ePlay MakerSpace, FP11 displayed the highest technological knowledge of the three teachers, followed by FP14, while FP15 displayed relatively low technological knowledge. Despite not being the most technologically skilled teachers, after the ePlay MakerSpace, FP14 and FP15 innovated novel and unexpected pedagogical practices, that impacted their classrooms and the other teachers in the school.

At the end of the ePlay MakerSpace, FP15 set three goals in her Roadmap to Change, the first being:

◆ *The school to buy into the idea of knowing that Technology is a must in our schools*

Upon her return, and as HOD, she insisted that all the FP administration and learning support documents be moved to a shared G/Drive. Prior to the ePlay MakerSpace, the teachers prepared learners' half-year reports using memory sticks to save reports on. Unfortunately, FP15s memory stick was corrupted and she lost all her reports, and had to rewrite these in the week after the ePlay MakerSpace session. Grasping the affordance of G/Drive, she insisted that all the FP teachers to move their documents to the cloud. Following this, the rest of the school also moved their documents to the cloud. Thus, the changes FP15 initiated impacted the entire school. She notes of this:

◆ FP15: *I think it affects the whole school, and I think they were excited. They were excited.* [text omitted]

In addition to integrating the G/Drive into the school's administration, FP14 and FP15 initiated a BYOD programme in their classes, which was later adopted by the Grade 5 and 6 class as well. Since the school has no access to devices for learners, these two teachers decided to try a BYOD approach. On the first day back at school after the ePlay MakerSpace, FP15 asked her Grade 3 learners if they had devices that they would be allowed to bring to school the next day. FP15 described the start of the BYOD programme as follows:

◆ FP15: [text omitted] *I could see that it's it's gonna take time for me to get a data projector, and you know, everything in place, so let me start somewhere. They were excited! The following day I had like 11 of them with their devices. And in that week, I have almost, like 20 - 25 with devices. And what I like about it is that they have tablets, like that Vodafone thingy, that works well, and that works perfect.*

The school does not provide any Wi-Fi connectivity in the classrooms either. Thus, while FP15s learners had brought devices, she was not sure how she would use these. On Day 2 she therefore asked the learners for advice, and they suggested she install the app, Share-It, on her phone to share apps with them. After Share-It was installed, FP15 could share apps, documents and learning material with the learners without using data. Although at the time

it was a new experience for her, during the interview she was confident about installing and using the app, and described the process as follows:

- ◆ FP15: *What we've done, we've downloaded Share-It. That is a Share-It whatever. We've downloaded that. If a child comes to school, and the child doesn't have that, then we ask the teaching assistant to go to the office area where there is Wi-Fi. So the teaching assistant will download that. When we come to school, we come like, I will download maybe a town, you know the apps that I am going to use. Then when I get to class, then we just share that, we spend time to share that, and then we work on that particular app. But that is without Wi-Fi or internet and all that. It doesn't use data.*

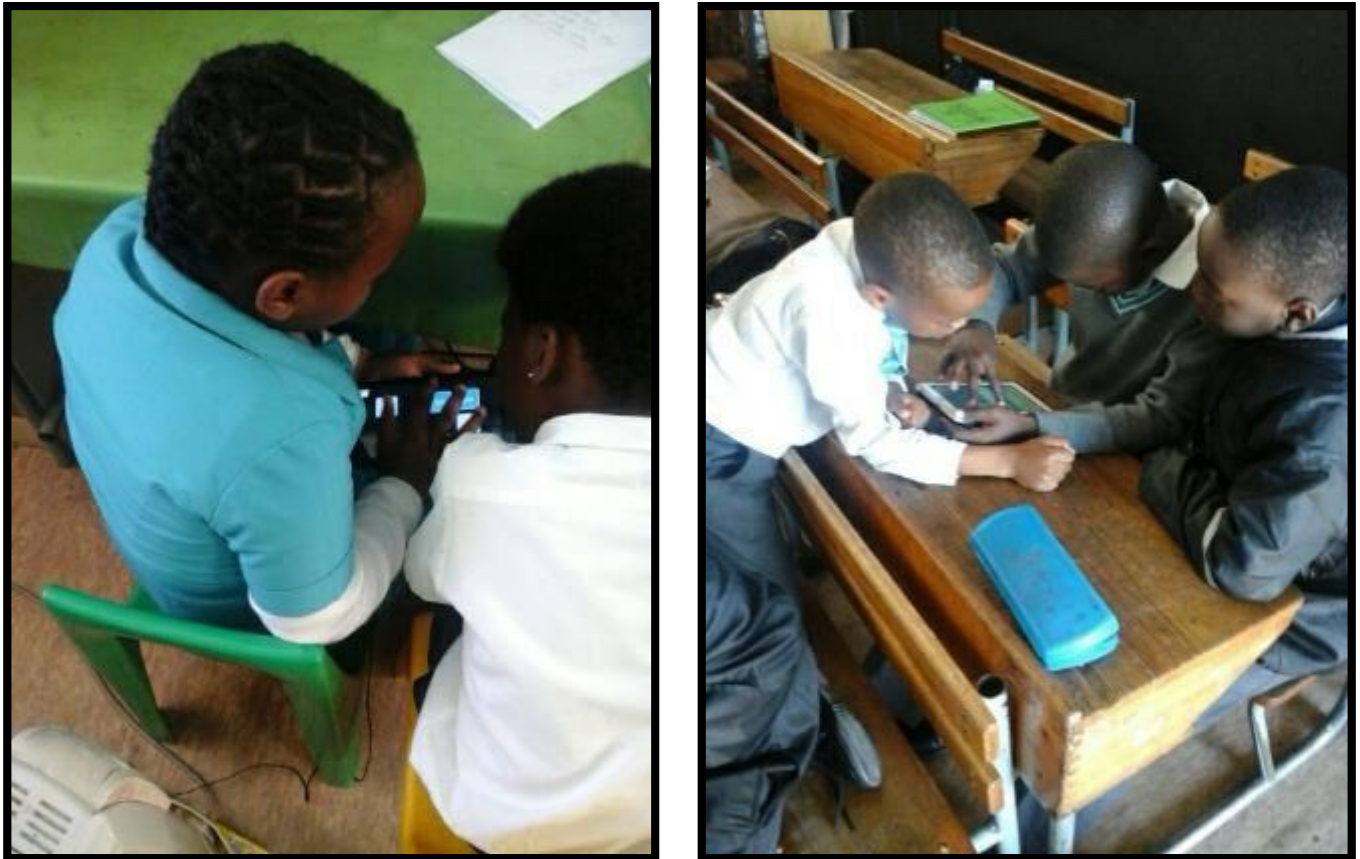
Following FP15's successful implementation of BYOD and Share-It, at the end of Day 2, the principal sent a letter to parents notifying them of the protocol when sending devices to school. In the letter, she cautioned parents to only send devices if their child's teacher explicitly requested this. Thereafter, FP14 invited her Grade 1 learners to bring their devices for use in the class. The Grade 1s were able to load Share-It in the office's small Wi-Fi environment, assisted by a teacher assistant. FP14 describes the process:

- ◆ FP14: *Uhm ... I think with with many of them, some of them just have to have a little bit of data so we can download the actual app for them, but they don't need to have internet. But we use Share-It App.*

The devices are used to support learning in the FP subject areas. FP14 explains how she uses the devices in her class.

- ◆ FP14: *So I've been using it for Maths and Phonics mostly. And for listening to stories as well. And at the end of the day we'll sometimes have a story-time session, so instead of me reading to them, they listen to it. So they're listening to The Gingerbread Man, they listen to Goldilocks and the Three Bears, and its two stories that I taught them before, so they know the story, they're familiar with it. But to see*

*the pictures, that excites them. And to hear someone else reading the story, also excites them.*



*Figure 24 Grade 1 (left) and Grade 3 (right) learners at School O using their own devices in the class*

FP15 uses the devices in similar ways in support of learning in her class. For example, she uses spelling and language games for learners to practice their site words, or Mathematics games for them to learn their bonds and tables. When visiting the school a few weeks after the interview, I observed learners in both classes using their devices in this way. Figure 24 shows photos of FP14's Grade 1 and FP15's Grade 3 learners using the devices they had brought from home in their classrooms (photos are used with parents' and learners' consent).

FP14 and 15 reported that the BYOD approach resulted in unexpected learning situations. One such a result is that the children had to learn how to not only virtually share, but also physically share with each other. With devices only available for approximately half of class,

children had to learn to share their devices and particularly apps with their friends. Since they cannot individually log into a game or complete an activity, they take turns to complete a challenge or add in an answer, then pass the device to the next child who adds in their answer. During my visit to the two classes, the learners were collaboratively completing their activities. Having been a Grade 3 teacher for many years, I noted with surprise the collegial and friendly atmosphere in the groups, and commented on this to the teachers. They explained that this was a result of an unexpected learning opportunity that first arose after they introduced the BYOD system. When they first started using learners' devices and learners had to collectively complete games or apps, some learners would get very angry and frustrated when their friends added incorrect answers in a game or activity, since this would often result in them losing points which they had collected up to that point in the game. Both FP14 and FP15 explained that the learners would then call each other terrible names and get angry with the child in question. This led to a learning situation where FP14 and FP15 had to explicitly teach learners how to embrace failure as part of learning, and how to support and encourage each other to keep trying. Weeks later during my visit, learners had seemingly adopted this positive approach to failure as a natural way of being and acting, and as noted, were encouraging and supporting each other in their groups.

Another unexpected outcome of the BYOD approach, was learners' increased concentration on their learning. FP15 noted that on Day 1, when she first asked learners to bring devices, she was not sure if they would need headphones, but decided to first see how the activity unfolds. However, once the learners started using their devices, they remained engaged throughout the activity, and did not disturb other groups. FP14 observed the same behaviour, explaining:

◆ FP14: *I found even when they, where they, when they work in a group, they don't disturb one another. Like I could have two groups on the matt, both working on like let's say Maths or something, and the group that's here will just be focused on what's in front of them, they won't want to see what happening there and what they're doing.*

Lastly, the use of BYOD led to learners' changed behaviour outside of school. During my second visit, I had a chance to talk to some of the Grade 3 learners. I inquired about the kind of games they played during the holidays a few weeks prior to my visit. One group of four boys I spoke with, said they played Grand Theft Auto or World of War, which are extremely violent games especially for Grade 3 children. I then asked them what games they played the weekend before my visit, to see whether anything had changed. The Grade 3 four boys reported that they had played the language and Mathematics games from class, and that they had shared it with their friends and siblings, who also played these. In this way, the apps shared by FP14 and FP15 using the BYOD approach, impacted learning beyond the classroom and learners not even in their class.

The innovation from both FP14 and FP15 changed how learning happened in their classes. Their learners individually and collectively engaged with the learning tasks, freeing teaching time for FP14 and FP15 to engage individually or in small groups with learners not using devices. This provided more opportunities for individualised rather than collectivised learning, especially in terms of reading and writing (with learners working on the matt with the teacher and on their devices). Thus in terms of Hoadley's (2012) findings, the BYOD approach in FP14 and FP15's classes had led to improvement of teaching and learning. However, some of the reading and language activities chosen for the Grade 3 were well below the expected norm of Grade 3 learners, which as Hoadley's (2012) study foregrounded, places low cognitive demand on learners and should be addressed. Nevertheless, the learning support provided through the use of the apps on learners' devices, was closely integrated into the CAPS learning areas that teachers were covering in the class, as FP14 explains:

- ◆ FP14: [words omitted] *They love coming to the matt and just sitting with it, and it's all very applicable to what they're learning at the moment. Building three letter words, uhm also matching the correct beginning or the end sounds to the words.*

(I had requested learners' marks for their end of year and mid-year reports to compare whether outcomes had been impacted but the use of these devices, but these were not made available.)

The use of devices and apps on learners' devices seamlessly embedded ET tools to support learning, and can be argued, led to a higher level of ET integration. A lower level of ET integration was also evident in School O, as the case of FP11 illustrates. Compared to FP14 and FP15's innovative use of BYOD, FP11 integrated ETs in different ways in her Grade 2 class. As noted previously, she had raised money for a television set for her class, and during my second visit to the school, had the television in her class. However, she used the television to support collectivised reading, flashing site words accompanied by images on the screen and letting the whole class read the words, repeating the activity a few times. Thereafter she played a read-aloud storybook on the television with the text placed under each story. Learners then had to read the story as a whole class activity, and then completed six comprehension questions about the story in their workbooks. This correlates to Hoadley's (2012) findings that learning in South African primary schools, is often collectivised rather than individualised, slowly paced, and that there is a lack of individualised reading and writing time. In addition, learners were not given explicit feedback but instead, FP11 repeatedly asked them to read the same words over and over until she felt they had reached a significant level of collective performance.

Both incidences illustrate different forms of change effected by the three teachers, which parallel's findings from the formative evaluation of the changes during the ePlay MakerSpace. Two graphs are included below: Figure 25 visually represents the creativity measured in FP11, FP14 and FP15's artifacts, and Figure 26 represents the participation measure of the three teachers in the ePlay MakerSpace. As can be seen from Figure 25, FP11's creativity measure showed the most significant increase over the three days, while FP14 and FP15's measure remained almost unchanged. However, FP14 and FP15's participation measure was significantly higher than FP11s (as indicated in Figure 26). FP11's participation measure indicated that she took low ownership of her change process, was seemingly less engaged and committed to changing, and displayed low levels of empowerment or reflection. Subsequent interview and observational data indicates that once FP11 had received the device (television), she substituted this for traditional pedagogic tools, and did not effect change to her pedagogy. FP11 self-identified as working in both Quadrants A and B before the ePlay MakerSpace, and set her goal to work in Quadrants C and D. The lesson observed in her class, was situated in Quadrant D, being highly regulated and restricted, and targeting Lower Order Thinking Skills (LOTS) (Bloom *et al.*, 1956; Krathwohl, 2002). During the interview, FP11 also indicated that she would not allow learners to bring devices to her class, following an unfortunate incident of theft. In the

Creativity measure of artifacts created by teachers at School O

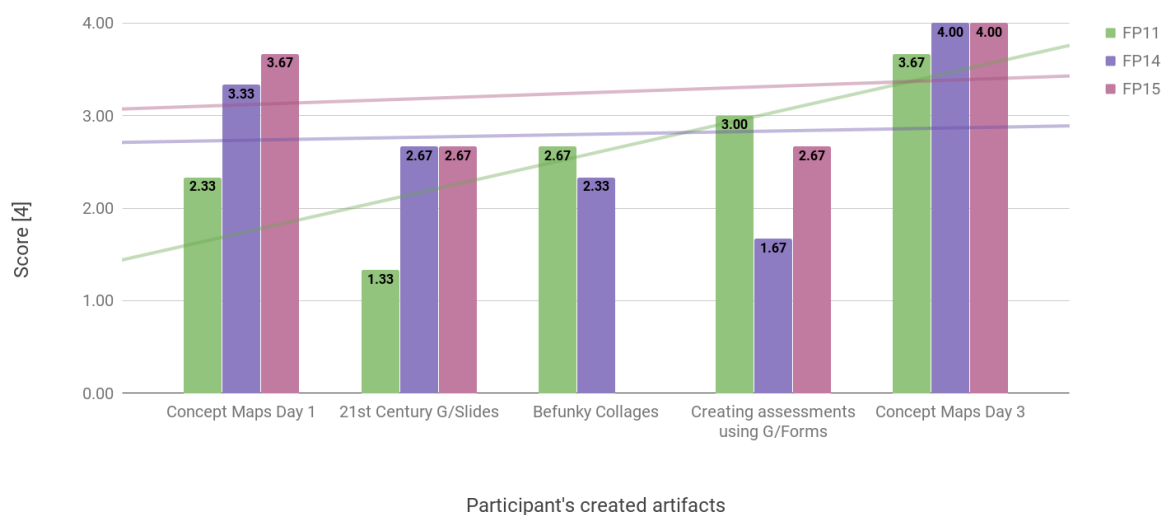


Figure 25 Creativity measure of artifacts created by teachers from School O

### Formative Evaluation of Participation for Teachers at School O

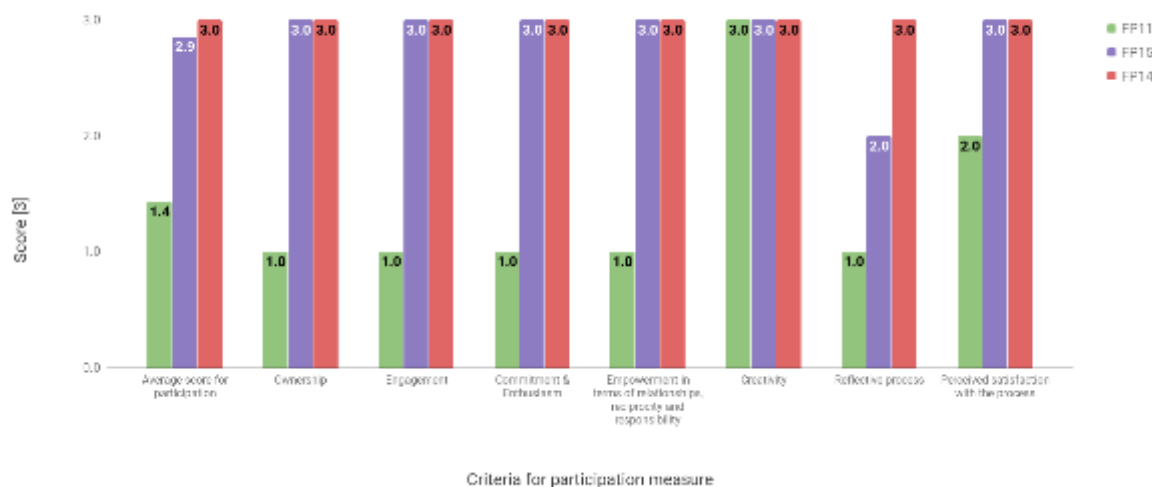


Figure 26 Participation measure of teachers from School O

absence of the school procuring devices, and without implementing a BYOD approach, it is doubtful that she would operate in Quadrant C in the near future. Thus, while she had moved from Quadrant A→D, and to some degree effected innovation and change, the data does not provide evidence of any epistemological change.

On the other hand, FP14 and FP15 had made significant changes to their pedagogical practice. FP14 self-diagnosed as teaching mostly in Quadrant A and FP15 as teaching in Quadrant B, and both had set the goal of teaching in Quadrant C. The BYOD approach they initiated did not restrict learners to a device, and while teachers regulated the use of apps, they did not stop learners who finished one app from going onto the next. However, their pedagogical approach still targeted LOTS as the different apps did not require learners to critically engage, evaluate, analyse or create using devices. Therefore, their practice can be diagnosed as functioning on the border between Quadrant D and C, being non-regulated and dispersed, but still targeting LOTS. Both FP14 and FP15's participation measures were at the highest level, and judging the creativity measured in their CMs from Day 1 and 3, their creativity measure increased over the three days.

The changes effected by FP11, FP14 and FP15 indicate that all three teachers' changes resulted in their movement on the TCF quadrants. FP11s movement was an example of

substitution, although there appears limited evidence that her epistemology changes. However, FP14 and FP15's movement from Quadrant A or B and to the permeable boundary between Quadrant D and C indicates that some epistemic change may have started to occur to their pedagogic beliefs and perceptions. Significantly, FP15 and FP14 displayed lower levels of technological knowledge and skill than FP11 in the ePlay MakerSpace. The data however indicates that while all three teachers effected change, the transformative ET integration enacted by FP14 and FP15's was significantly higher than that of FP11, despite their lower technological knowledge and skill. This parallels the participation measure, with FP11 scoring significantly lower in terms of ownership, engagement, commitment and enthusiasm, empowerment and reflection, than FP14 and FP15. It indicates that basic technological knowledge does not deter transformative ET integration, nor does high technological knowledge determine it.

#### **5.3.6.2.3** Additional examples of change: FP19 and FP20, and FP12 and FP05

Three further examples of change were documented from FP19 and FP20 at School E, FP12 from School Y and FP05, working as special needs teacher in School O and another school. In the interest of brevity, the individual cases are summarised, and the changes these teachers enacted reported. This is then compared to the teachers' creativity and participation measures (see respectively Figure 27 and Figure 28).

FP19 and FP20 teach at School E. Unfortunately, the school experienced some leadership challenges during 2016, and the acting principal had to convert the computer lab into a classroom in which to teach. Therefore, access to the computer lab was limited. Also, access to the internet was strictly regulated, and teachers were not allowed access to the Wi-Fi password in the administration block. While the school has a projector, the cable to connect

### Creativity measure of artifacts created by teachers at School E

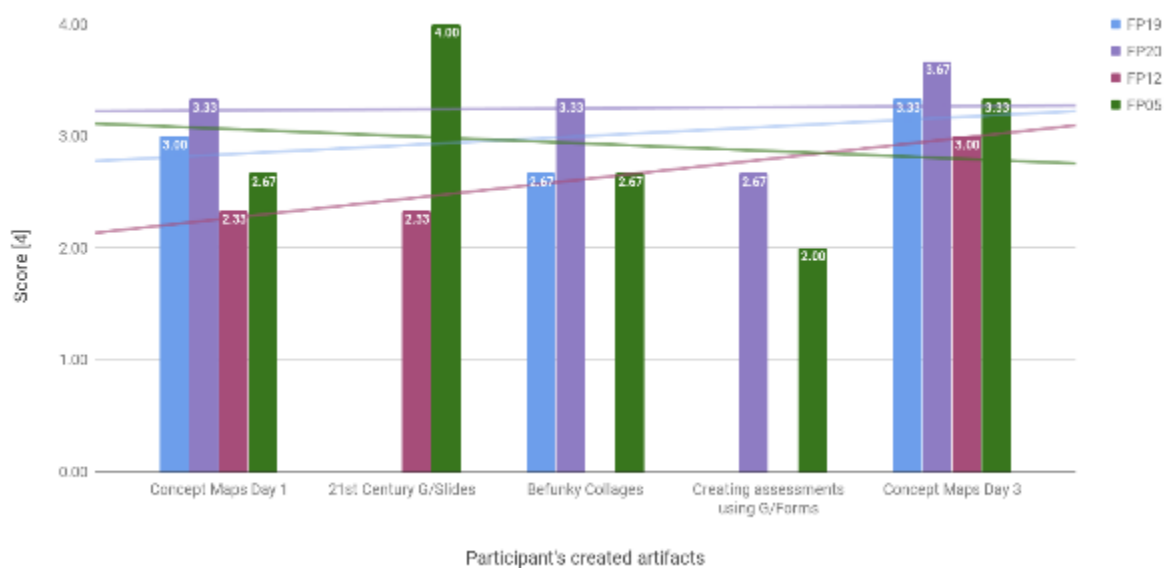


Figure 27 Creativity measure of artifacts created by FP19, FP20, FP12 and FP05

it to the laptops seems to be broken, and therefore it cannot be used. The environment at the school therefore did not support the use of devices or online resources. Despite this, FP19 and FP20 innovated different ways to implement what they had learnt during the ePlay MakerSpace. FP19 tried to initiate a BYOD programme to let learners work on the G/Drive. However, once she realised learners needed Gmail accounts to access the G/Drive, she was unsure of how to proceed. She explains:

- ◆ FP19: Yesterday I told her [referring to FP20], the previous days I asked my children to bring their phones if they've got phones because we working on the email so that I can introduce that to them on the phones. But then now I've got a problem, I must now create a Gmail for all of them. But I ask them they must ask their mommy or their daddy whoever must sign them up for Gmail so that they can send that information to me. But there was only three kids. So some of the parents asked me what am I gonna do with those who haven't got. So I said no but they can use my tablet just to introduce it to them, and they were very excited. [text omitted]

### Formative Evaluation of Participation for FP19 and FP20, and FP12 and FP05

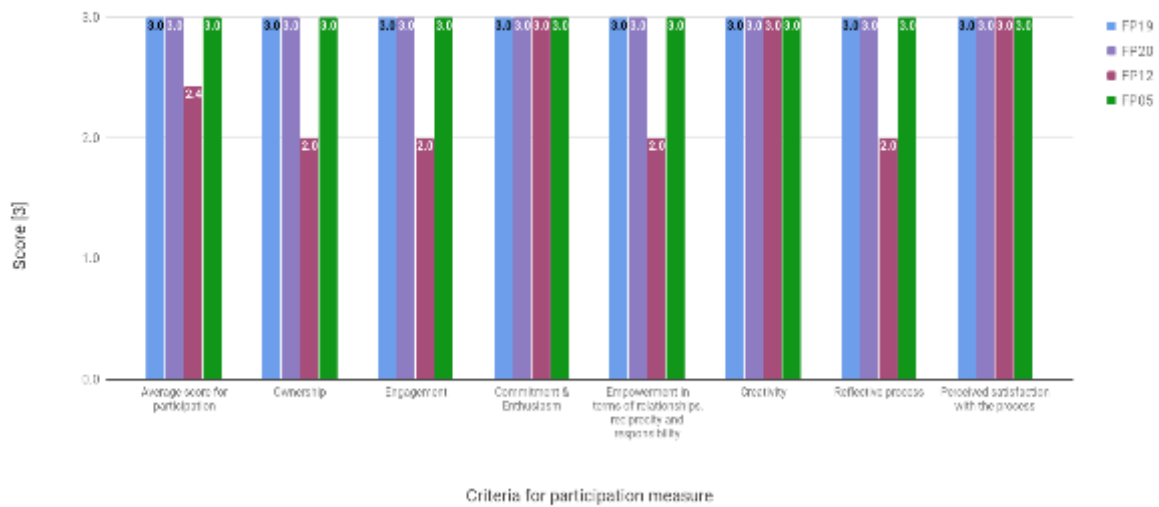


Figure 28 Participation measure of FP19, FP20, FP12 and FP05

Similar to the experience of the teachers at School K, FP19 discovered that the use of the G/Drive supported by a BYOD approach, requires that learners access their own email addresses. Although FP19 requested parents' help in creating these, only three parents created email addresses. FP19 also created a WhatsApp group for the parents in her class to share information and homework. At the time of the interview, FP20 had not implemented similar initiatives at the school, but both teachers used what they had learnt outside of school.

Although FP19 and FP20 were determined to effect change following the ePlay MakerSpace, the school environment did not support the use of ETs. Prior to the ePlay MakerSpace, in May 2016, FP19 and FP20 had set up a learning support centre in FP20s lounge with a laptop and desktop computer, and were hoping to grow this during the year. Following the ePlay MakerSpace, FP19 and FP20 implemented what they had learnt during the session in their learning support centre. Additionally, FP19 created G/Slide presentations to celebrate the birthdays of friends. FP20 also implemented what she had learnt in the ePlay MakerSpace to foster collaboration in her Church's Sunday School team as they creating a

curriculum. She described her excitement at being able to work in the drive and collaborate with the other Sunday School teachers:

◆ FP20: *I am involved with other organisations like my Sunday school group. We writing our own curriculums and things like that so we use Google Drive and so I was so excited getting back to them because I mean the last time they asked, Who knows how to work on Google Drive (much laughter) Nah! So this time around I was more excited about it so now we're share more often on the Google Drive.*

As FP19 and FP20s examples illustrate, although the school did not provide the enabling environment for change, both teachers started to integrate ETs into their activities beyond their classrooms. FP19 wanted to initiate a BYOD approach, and created G/Slide presentations for her friend's birthday, while FP20 collaborated with her Sunday School group on a shared G/Drive. When compared to the trendlines on their creativity measure, both these teachers' creativity measures increased between Day 1 and 3 of Iteration 2. Additionally, both teachers' participation was measured at the highest level. The solutions they found to integrate ETs that can address their needs and requirements, is indicative of innovation, creating practical solutions to implementation. However, there is insufficient evidence as to whether epistemological change occurred.

FP12 teaches at School Y, a school for learners with special education needs. During the ePlay MakerSpace, she displayed extremely limited technological knowledge, to such an extent that manipulating the mouse to follow a drop-down menu was a challenge. This impacted her active learning in the session, as she was always a few steps behind everyone else, and I had to keep returning to her computer to catch her up. In addition, English is her third language. Since all the functions and online tools are presented in English, and English was used as language of communication in the session, she was at a disadvantage with regards to technological skill and language. However, her tenacity was inspirational. Both the creativity measure and participation measure could not adequately capture the progress she made in only three days, as a result of her remarkable determination. She would not give up, despite the challenges she faced, and remained determined to complete every task

and participate in every session. Once she returned to her school, FP12 went to the school's strong room and found a visualizer that had been there for a few years, unused. She taught herself to use the visualiser, taught the school's bus driver and the occupational therapist, and later taught other teachers. She now regularly uses the visualizer in the class. FP12 has an IWB in her class but confessed that she had not completely learnt how to use it, and at the time of the interview, was mainly using the visualizer to enhance her teaching. FP12's class windows were brightly painted in primary colours, which she explained, blocked sunlight when she wanted to teach with the visualizer in the mornings – since she could not afford to buy curtains, she painted the windows instead.

FP12s change process was sustained over time. During the October 2016 school holidays, she returned to the CTLI to learn how to use the IWB, despite being mugged on her way to the CTLI that morning. The examples herein illustrate that FP12 displayed a high level of innovation, in both painting the windows and developing practical steps to start integrating technology into her class' teaching and learning. Her innovative practices were later adopted by other teachers in the school, further supporting the finding that she displayed high levels of innovation. However, there does not appear evidence to indicate that FP12 engaged in epistemological evolution.

FP05 is lastly discussed. She is a special needs teacher, and is placed at different schools depending on the WCED's requirements. At the time of the ePlay MakerSpace, she was teaching at School O for three days a week, and at another school for two mornings. FP05 can be classified as an experienced user with high technological knowledge. She participated enthusiastically in all the sessions and spontaneously supported teachers sitting near her when they required assistance. After the ePlay MakerSpace, she implemented various changes. I had shown teachers a few examples of read-aloud books ([www.storylineonline.net](http://www.storylineonline.net)). When FP05 returned to School O, she had downloaded one of the books, and shared photos to the Edmodo group of different FP classes coming to her room to listen to the stories. However, during a telephonic conversation with FP05, she complained that most read-aloud books are in English, and not Afrikaans. We spoke about ways in which she could create her own read-aloud books with the technology available to

her. Subsequently, using her mobile phone, a bedside lamp and her daughter to hold the phone, she created a read-aloud book: '[Vang die monster](#)' (link embedded). She also used G/Forms to create various assessments for her learners in the different schools – some of which are included on the website, W3.3. These examples illustrate a high level of innovation by FP05, and provide evidence that she moved from Quadrant A→D on the TCF as she had planned to do at the end of Iteration 2. This evidence however does not indicate that epistemological innovation had taken place, even though FP05 had made substantial changes. Parallel findings indicate that her participation was sustained at the highest level throughout the three-days, however her creativity fluctuated, although her Day 1 and 3 CM creativity measure improved significantly.

#### 5.3.6.2.4 Findings from changes observed

The study seeks to understand how the transformation of teachers' dispositions impacts their transformative integration of ETs. The ePlay MakerSpace processes capacitate teachers to create and innovate using ETs. The various artifacts teachers created, were evaluated to establish a creativity measure in terms of fluency, flexibility and originality, and to establish whether teachers' creativity potentially increased in the three-days of the ePlay MakerSpace. Secondly, teachers' participation in the ePlay MakerSpace process was formatively evaluated using a rubric to standardize the evaluation across Iteration 1 and 2. Both creativity and participation measures were shown to parallel changes teachers effected following the ePlay MakerSpace, either in their schools or classrooms.

The changes teachers effected after participating in the ePlay MakerSpace, can be classified in different ways, using the TCF (Tarling and Ng'ambi, 2016) or the SAMR model (Puentedura, 2013b). FP04 and FP16, FP11, FP12 and FP05 provided evidence that the transformation of dispositions increased their transformative ETs integration to support learning. The pedagogic choices of these five teachers however remained highly regulated and restricted, and targeted LOTS (Bloom *et al.*, 1956; Krathwohl, 2002). Hence their movement on the TCF can be classified as from Quadrant A→D. On the other hand, FP14 and FP15 significantly redesigned how teaching and learning took place in their classrooms

using a BYOD approach. Their pedagogic choices were less regulated and restricted, however since both were still relying on apps that support LOTS rather than HOTS, their movement on the TCF is classified as from Quadrant A→D/C, situated on the permeable border between Quadrants D and C.

The pedagogical choices these seven teachers effected can also be described using the SAMR model for technology integration (Puentedura, 2013b). FP11's change can be classified as substitution since she directly substituted traditional, paper-based pedagogical tools with a flat screen television, with no functional change. FP04 and FP12's started using ET tools to functionally improve teaching and learning, and can be classified as augmentation. FP14 and FP15 used technology to significantly redesign learning using a BYOD approach, while FP16 redesigned how she uses WhatsApp to foster learning in and outside the class; therefore, both are examples of modification. Lastly, FP05 used tech to create a read-aloud book, and created her own eAssessments, which can be defined as redefinition on the SAMR model. The description of teachers' changes on both the TCF and SAMR models indicate that they autonomously managed how they effected change and that transformation of dispositions occurred to achieve this.

The examples of change listed here, can also be classified according to impact. FP04, FP11 and FP05 enacted change to their own practice, impacting the learning of children in their classrooms. FP12 and FP16 impacted other teachers and parties at their schools, sharing their innovative ideas and behaviours with their colleagues and even the school's bus driver. FP14 and FP15's innovative ideas and behaviours impacted both the FP and IP teachers, as well as the greater community: while the Grade 5 and 6 classes also initiated a BYOD approach following their example, as shared G/Drive was created in the whole school's administration system. Also, the apps FP14 and FP15 shared with learners, impacted learners beyond their classrooms or even school, as the learners from their classes shared these with their friends and relations. Lastly, FP19 impacted her colleagues and friends with her birthday G/Slide presentation, while FP20 used G/Slides with her Sunday School group to design the curriculum. These teachers' changes can thus be seen to not only impact their own practice, but that of colleagues and the greater community. Evaluating these changes

in terms of their design, it is clear that the changes were highly practical, usable and appealing to users, as well as relevant to meet users' and the greater community's needs. Where teachers shared their knowledge and skills beyond their own classrooms, the potential for sustainability was increased. Lastly, each change can be said to be state-of-the-art from the users' perspective. From FP04s videos for teaching silent letters, to FP14 and FP15's BYOD approach: the learners and teachers in the school experienced these innovations as exciting, new and novel, ideas and behaviours worth adopting, and followed their example, adding validity to the change measures.

In short, the evidence supports findings that the FP teachers' changes reported herein, resulted from the transformation of their dispositions. Teachers' increased creativity and participation measures parallel the changes they effected in and outside of their classrooms. These parallel findings suggest that transformative ET integration was affected as an outcome of the transformation of teachers' dispositions and increased capacity to create and innovate. This finding impacts the refinement and elaboration of the design principles (DPs).

## 5.4 Elaborating and refining the design principles

After Iteration 1, parallel analysis elaborated and refined the global design principles (GDPs), forming first-generation design principles (1gDPs). The 1gDPs guided the design of Iteration 2 for Foundation Phase teachers as reported in this chapter. In this section, each of the 1gDPs are evaluated according to the documented evidence from the design, enactment and formative evaluation of Iteration 2.

**1gDP1)** The ePlay MakerSpace processes and enabling conditions develop teachers' capacity to create and/or innovate with emerging technologies to transform dispositions.

The creativity measure for the artifacts teachers created during the Iteration 2, on average, shows an increase in all three aspects of fluency, flexibility and originality. This increase suggests that the changes measured in terms of creativity during the ePlay MakerSpace,

correlate changes effected in teachers' schools and classrooms as a result of the transformation of dispositions. The data therefore supports 1gDP1 and does not indicate further refinement or elaboration.

1gDP2) The ePlay MakerSpace process and enabling conditions can restructure individual and/or collective beliefs, practices and/or perceptions by transforming dispositions that formed these.

This chapter reported various examples of change enacted by FP teachers following the ePlay MakerSpace in their classrooms and in their schools. In each case, innovation can be identified. The examples of FP14 and FP15 indicate that while they engaged in significant innovation within the whole schools, they may also have started to engage in epistemological change, moving towards Quadrant C on the TCF. The data therefore supports 1gDP2 and does not indicate further refinement or elaboration.

1gDP3) The ePlay MakerSpace creates the enabling conditions and carries the weight of change to support teachers' entry into the liminal zone where the transformation of dispositions can occur.

Various changes were made to the design and enactment of Iteration 2 following the findings from Iteration 1's formative evaluation. These changes were intended to create more effective enabling conditions to support teachers in crossing the threshold into the liminal zone and ways to carry their weight of change.

On the first morning, teachers collectively created and took responsibility to uphold the rules to structure the safe and nurturing environment of the ePlay MakerSpace to structure the engagements that take place. Since only 16 teachers completed the three-day session, the number of participants impacted the type of support provided. There was more time to support and extend different participants, to engage in reflection after each session, and to spend time building mutual trust. Also, the devices and internet connectivity remained stable and functioning throughout the three days. Teachers could seamlessly log on and experience the different ET tools, play with these and explore without the challenges the IP

Language teachers had experienced. This served to carry the weight of change for teachers, especially those teachers who were novice or not-yet-comfortable users, to take risks and to make mistakes. The defined context of the ePlay MakerSpace, fewer teachers, stable device and internet connectivity, and the greater trust appear to have all contributed a significantly higher participation measure.

After the ePlay MakerSpace, teachers enacted changes in their classrooms and schools. The transformation of teachers' dispositions and subsequent transformative ET integration could be classified and described using both the TCF and the SAMR models. When compared to the creativity and participation measures of teachers created artifacts in the ePlay MakerSpace, the increased fluency measures correlated to the different ways in which teachers transformatively integrated ETs. Consequently, the transformation of dispositions initiated in the ePlay MakerSpace can be correlated to the transformative ET integration teachers enacted thereafter. Hence, it can be concluded that the enabling conditions within the ePlay MakerSpace successfully carried the weight of teachers' change and entry into the liminal zone where transformation of dispositions occurred, confirming 1gDP3.

1gDP4) The ePlay MakerSpace assumes teachers are autonomous and self-directed and is sensitive to and inclusive of the needs of all participants.

As discussed above, the use of the TCF and the SAMR model indicated that teachers' dispositions were transformed. Pertinently, the data indicates that regardless of technological skill level, teachers were able to transformatively integrate ETs as FP14 and 15, and FP12's examples illustrate, while the opposite, that high technological skill does not determine transformative ET integration, was also shown to be true. This confirms the needed for a sensitive and inclusive, autonomous and autotelic approach in the ePlay MakerSpace to support transformation of all participants' dispositions. 1gDP4 is thus confirmed.

1gDP5) The ePlay MakerSpace process models sophisticated applications and pedagogical possibilities of the transformative integration of emerging technologies that are chosen to be immediately applicable and relevant to teachers' unique needs.

The evaluation and analysis of teachers' transformational ET integration at their schools, indicated that the ePlay MakerSpace process and transformative ET integration modelled, was highly practical and relevant, sustainable and valid to teachers, impacting their colleagues and the wider community. 1gDP5 is thus confirmed.

1gDP6) The ePlay MakerSpace process systematically scaffolds and provides opportunities for reflective learning.

As in Iteration 1, the FP teachers engaged in individual, shared and group reflection. Reflection was systematically introduced and where appropriate, teachers' reflections were included in Edmodo or on a G/Form to capture and display such reflection, leading to further learning. The reflective learning was well received by teachers who reflected beyond a skill or task-level reflection to a cognate level reflection, where as a group, they reflected on their learning and experiences of this learning. The individual and aggregate participation measure for reflection in Iteration 2 was significantly higher than in Iteration 1, indicating the higher degree of reflection that the FP teachers applied. The data thus confirms 1gDP6.

1gDP7) The ePlay MakerSpace process systematically scaffolds and provides directed opportunities for professional learning.

As in Iteration 1, in Iteration 2 professional learning included the integration principles and Bloom's revised taxonomy, intended to inculcate, through the awakening of consciousness and pedagogic work, different dispositions of the mind. The design of the professional learning, introduction and scaffolding of concepts, was guided by the TIP (see Figure 15). In particular, since teachers in Iteration 1 experienced difficulty with the application of Anderson's (2004) model, it was introduced in Iteration 2 using the TIP. Subsequently, teachers were introduced to the model using Slide 25 of the presentation, and immediately thereafter re-watched a video from the previous day to identify incidences where different forms of interaction were evident. This made use of task-driven use, in which the task, *identifying different forms of interaction*, is foregrounded rather than the tool, *Anderson's model*. In the third step of the process, direct application, teachers then applied Anderson's model (the tool) to create the collaborative group learning design, and applying the tool.

Bloom's revised taxonomy and 21<sup>st</sup> century skills were introduced in a similar way. Teachers were introduced to the tool, applied it in task-driven use (creating G/Slide presentations of the four Cs for instance) and then applied it to create a task for immediate application (applying Bloom's revised taxonomy to develop group lesson plans). The use of the tool introductory process limited the time between introduction and application, and appeared to increase the deep and meaningful learning taking place as evident in teachers' successful implementation of the professional learning and the integration principles in their group lesson plans.

Furthermore, the professional learning that took place served to improve teaching and learning regardless of teachers' technological knowledge. Three teachers' comments in their *course* reflections on the last day are included:

- ◆ FP09: [text omitted] *I truly found every aspect of this short, packed course most useful and enjoyable. From the five ICT Integration Principles; the 21st Century 4 C's; to the practical activities such as navigating through Google Drive, Edmodo as well as BeFunky and Voki.*
- ◆ FP11: *Things were introduced gradually. Everything accessible and made easy.*
- ◆ FP12: *Better ways of teaching .The Four C's will reinforce learning (Integration of CAPS into technology need to be celebrated. ( I can calibrate and use the write with the Mimmio pen [sic]*

These teachers' comments are included because they represent different levels of technological skill and knowledge. FP09 is an experienced user, FP11 a comfortable but not yet experienced user, and FP12 a novice user. The inclusion of the three types of users' comments above, support the finding that regardless of teachers' level of use and technological knowledge, the ePlay MakerSpace capacitated teachers with professional and active learning (as indicated below) to effect change at different levels. The data thus confirms 1gDP7.

1gDP8) The ePlay MakerSpace process supports dynamic, emergent and active

learning and introduces new tools using the tool introductory process.

Following the findings from Iteration 1, the active learning in Iteration 2 was structured by the TIP. Teachers participating in Iteration 2 commented positively on the active learning taking place as FP18, a novice user, states:

◆ FP18: *I found the course very interesting en enlightening. I am definitely more confident and feel positive going back to school and implementing it.*

The tool introductory process appears to have introduced all users, whether novice or experienced, in a playful and light-hearted manner to the different tools. The TIP also nurtured the playful context of the ePlay MakerSpace, to carry all teachers' weight of change through ePlay, exploration and discovery. Although the TIP was implicitly applied, teachers noted the structured, scaffolded application in their *course* reflections, and comments from novice and experienced users, indicate that they responded positively to this scaffolding and structure.

However, teachers also noted challenges in the session particularly with regards to the manual. Three teachers noted that the manual could better support the active learning with more explicit guidelines as FP02's comment indicates:

◆ FP02: *The course is good, but it would be enhance the course if there will be tips of how to open the tools, copy and paste it. As you know it while you in the class, but there are so much information to remember that you need to go back to refresh your memory by checking your notes.*

Although the active learning is not in question, the format and design of future manuals should be more carefully structured to support teachers' continued active learning.

However, since this does not impact the format of the 1gDP8, no further refinement and elaboration is required.

1gDP9) The ePlay MakerSpace process systematically and explicitly introduces

collaboration and provides opportunities for different forms of relational learning.

The relational learning was well received and all teachers engaged in the Edmodo group, the online collaboration and the presentation. Most significantly, the framing of collaboration as an ET tool, and its introduction using the TIP, produced very positive results. All the teachers, regardless of their degree of technological skill or knowledge, engaged in online collaboration to create the group lesson plans. The transformation of dispositions as an outcome of this online collaboration serves to underscore the importance of framing collaboration as an ET tool and systematically introducing this using the TIP. Teachers' overall satisfaction with the interaction and collaboration is summarised by FP09's comment:

◆ FP09: *Definitely. I needed to gain more knowledge and understanding regarding the true meaning and application of ICT Integration in my classroom and a new door has opened for me through this course. My existing skills set has been broadened, I could connect with other teachers and share ideas and resources through an online platform and I think bigger than two days ago :-)*

The data thus confirms 1gDP9.

1gDP10) The ePlay MakerSpace systematically and explicitly scaffolds transformational learning.

The transformational learning included in Iteration 2 again included the Roadmap to Change document, but importantly, was timed differently than in Iteration 1. An hour was set aside for the session to prepare and equip teachers to manage their change processes, before going to lunch and returning to present their group lesson plans. This meant that teachers were not in a hurry to leave, and engaged fully in the learning. As the various examples included in 6.3.4 indicate, teachers implemented the changes they planned in their Roadmaps to Change, and managed their ongoing transformative ET integration in their classrooms and/or schools. The data thus confirms 1gDP10.

The parallel analysis of the 1gDPs following Iteration 2 indicates that all DPs have been confirmed. Although in some cases, elements were noted for revision, such as teachers' observations for the manual's design and the new format for the Integration Framework for ETs, these elements did not alter the 1gDPs. This signals that the DPs for the ePlay MakerSpace process are likely fully elaborated and refined. The 1gDPs can therefore be seen as the outcome of this study to guide the development of future ePlay MakerSpaces.

## 5.5 Concluding comments

This chapter documented the problem identification, design, enactment and formative evaluation of Iteration 2 of the ePlay MakerSpace with FP teachers from disadvantaged schools in the Western Cape, from 4 – 6 July 2016. The evidence from the changes FP teachers experienced during the ePlay MakerSpace, and the transformative ET integration they enacted thereafter, as recorded in the chapter. The data indicates that teachers' dispositions had transformed as an outcome of their engagement in the ePlay MakerSpace, and that teachers in different ways, transformatively integrated ETs at their schools. The ePlay MakerSpace process thus served to capacitate teachers to manage their own change processes and how they chose to integrate ETs in their classroom contexts. Data generated in this chapter indicated that the 1gDPs for the ePlay MakerSpace process were fully refined and elaborated, signalling the conclusion of the study.

The next retrospectively analyses the ePlay MakerSpace process and outcomes through a Bourdieuan lens.

## Chapter 6 Analysis

This chapter retrospectively analyses the data and findings that emerged from the two iterations to refine the theoretical contribution of this study. The preceding two chapters reported the design, enactment and formative evaluation of Iteration 1 and 2 of the ePlay MakerSpace and refined and elaborated the design principles (DPs). A design-epistemology was employed to imagine, design, conceptualise and develop the ePlay MakerSpace model, and two iterations of the ePlay MakerSpace for IP Language and FP teachers. In order to achieve sophisticated and critical analysis, and yield valid and warranted theory, the critical socio-cultural epistemology of the theoretical frame (see section 1.4.1) is employed in this chapter.

The retrospective analysis uses social topology to analyse the data-set. Social topology analyses locations and position-takings within the field (Bourdieu, 1984, 1998b) and the “*relative positions and ... objective relations between these positions*” (Bourdieu, 1998b, p. 16) using a relational mode of thinking. Social topology provides a mechanism to explore the objective relations between positions occupied within the field, the distribution and flow of resources as different forms of capital, and how this impacts “*the competition for the appropriation of scarce goods of which the social universe is the site*” (Bourdieu, 1998b, p. 17). The chapter is structured according to the analytic frame, and refines theory in terms of domain theory regarding teacher change, the design framework for the ePlay MakerSpace process and enabling conditions, and the design methodology.

### 6.1 Refining teacher change theory

Situated within South Africa’s disadvantaged primary school classrooms, the study seeks to understand how transforming teachers’ dispositions may impact their transformative integration of ETs, as conceptualised in section 1.2. This section reports on the retrospective analysis of the data to refine domain theory regarding teacher change.

The data-set was analysed in three phases. The first phase used quantitative analysis techniques to analyse data sources separately and quantify the immediately observable data from each data source. Data sources include teachers created artifacts, the textual data from concept maps (CMs) and Word-Associations (WAs) and Edmodo posts, transcriptions of group and individual written reflections, and the interview data. The second phase started moving beyond the immediately observable data and analysed individual data sources for emergent themes, and then compared emergent themes across the data to identify recurrent themes. Phase 2 analysis used Nvivo11 software to facilitate thematic analysis from all five data sources, as well as G/Sheets and wordclouds.com. Appendix E and the website page W1.2), as well as the G/Sheet [Analysis of Data](#) (link embedded) provides a detailed description of Phase 1 and 2 analysis processes. The analytic work in Phase 1 and 2, was repeated a number of times using different tools to refine analytic instruments and yield trustworthy and valid results, and to ensure internal and theoretical validity of the Phase 3 analysis.

Phase 3 uses social topology (Bourdieu, 1984, 1998b) analysis and is structured by the Bourdieuan analytic-trio of field, capital and habitus (Bourdieu, 1984, 1990, 1998a). The social topology analysis thus explores the field, the capital valued therein, and the habitus of agents functioning in the field. As stated, none of these elements are understood as dominant, primary or causal, but relational, inter-dependent and co-constructed (Thomson, 2008).

### **6.1.1 Field and Capital**

This section presents an analysis the field in which teachers operate, and their perception of cultural capital structuring the field, as evidenced in and through the data.

The capital/s valued in a field are both the process within and product of the field, and serve to structure the field, the rules at play and how the capitals are distributed (Thomson, 2008). In this section, Bourdieu's thinking tools of field and capital are used to analyse data coded for field conditions, and sub-codings of this, from FP and IP Language teachers' data.

Teachers participating in the two ePlay MakerSpace iterations function within the broader field of education globally, and locally. FP15, the FP HOD at her school during 2016, defines the field, agents operation therein and the meaning she associates with ET Integration in the field, in her Day 1 CM:

◇ FP15 CM Day 1: *monitoring* → *school management; district officials; Support* → *school management; WCED; Parents; outside organisation; SGB; training; Background* → *where are the learners? Where are the teachers? Where is the school management?*

She situates the school within a community (*Parents; outside organisations*), managed by the *school management* and School Governing Body (*SGB*) and overseen by departmental structures (the *WCED* and *district officials*). FP15's description frames the field in which teachers operate, attesting to the value of ETs as tools to monitor operations within the school, and teachers' performance. She values ETs as a means to monitor the position of the school and all stakeholders operating therein, in terms of the broader field of education, to locate and potentially improve the school's position and standing in the field of education. While learning outcomes may appear to determine the position of a school within the field of education, using Bourdieu's thinking tools, it is the cultural capital accumulated through learning and measured as learning outcomes that determine the position of the school within the field. FP15 values ETs as a means to measure the cultural capital accumulated by learners in the school, and improve on the school's position within the field.

Additionally, in support of the goal to improve the school's position in the field, the second value ETs offer, according to FP15, is to measure the acquisition of cultural capital. ETs can be used to monitor the distribution and acquisition of cultural capital within school by measuring teachers' adherence to the greater field requirements (*Where are the teachers?*), to measure learners' performance (*where are the learners?*) and to measure the school leadership's effectiveness in managing the requirements of the field (*Where is the school management?*). ETs are therefore valued as a means to monitor and measure the flow of

cultural capital and subsequent location of the school within the field of education. This framing of ETs as measuring and monitoring tool is reflected within the field as well.

ETs are used within the field of education to monitor and measure the flow of cultural capital with the aim of increasing return on investment as measured in increased learner achievement. CAPS places significant pressure on teachers to increase curriculum coverage and pace of delivery, and thus to increase the flow of valued cultural capital within the field. The delivery and pace with which this valued cultural capital flows within the field, is enforced and supported by bureaucratic processes and overseen by curriculum advisors in schools. Return on investment is calculated in terms of the cultural capital accumulated by the system through measuring learner outcomes in accordance with CAPS assessment requirements. Teachers' performance is monitored as FP15 indicates, and measured to ensure the flow of capital.

In order to increase teachers' performance and increase the flow of cultural capital, teachers' time and professional practice is regulated and restricted through various mechanisms. The restrictive boundaries and oversight places pressure on teachers to ensure the flow of capital and meet minimum CAPS requirements to increase learner achievement (Fullan, 1995, 2001; see also Parsons *et al.*, 2016). Teachers' interview data identified the Integrated Quality Management System (IQMS) as a regulatory mechanism used in the field to shape their pedagogic choices, and which specifically impacted their choice to use ETs in their classrooms and schools:

- ◆ IPL04: *We're definitely going to do it because we're busy with IQMS and classroom inspection in the next few weeks.*
- ◆ IPL06: [text omitted] *I wasn't going to use it at all. Until the Principal said, you know, for the IQMS you have to. And then once I started preparing then I saw it wasn't so bad.* [text omitted]
- ◆ IPL21: *For my IQMS ja, that was a separate thingy. For my IQMS lesson I used the PowerPoint.* [text omitted]

- ◆ IPL23: *We use the projector for our IQMS, and for the CAs its used, and then they can see our objectives, and our videos. [CA = Curriculum Advisor]*

The Integrated Quality Management System (IQMS) was introduced in 2008. The DBE defines the IQMS as a performance management system that monitors institutional effectiveness and teacher performance, in order to hold schools and teachers accountable for learner outcomes (SACE 2014). As such, the IQMS is used to assess the performance of all role players in a school. Teachers, school leaders and in some cases, curriculum advisors, measure performance according to predefined criteria as quantified by the DBE. Schools and teachers who meet these criteria, are then rewarded with, for example, additional institutional resources, individual pay progression and other incentives as demonstrated in Figure 29 (SACE 2014). The flow chart in Figure 29 illustrates the process of performance monitoring from Block 1 to 4, that culminates in rewarded behaviour in Block 4 using the equation: *'Results = performance = value for investment'*. The equation foregrounds the investment made by the DBE into the system and rewards performance that meets predetermined criteria and produces a return on investment.

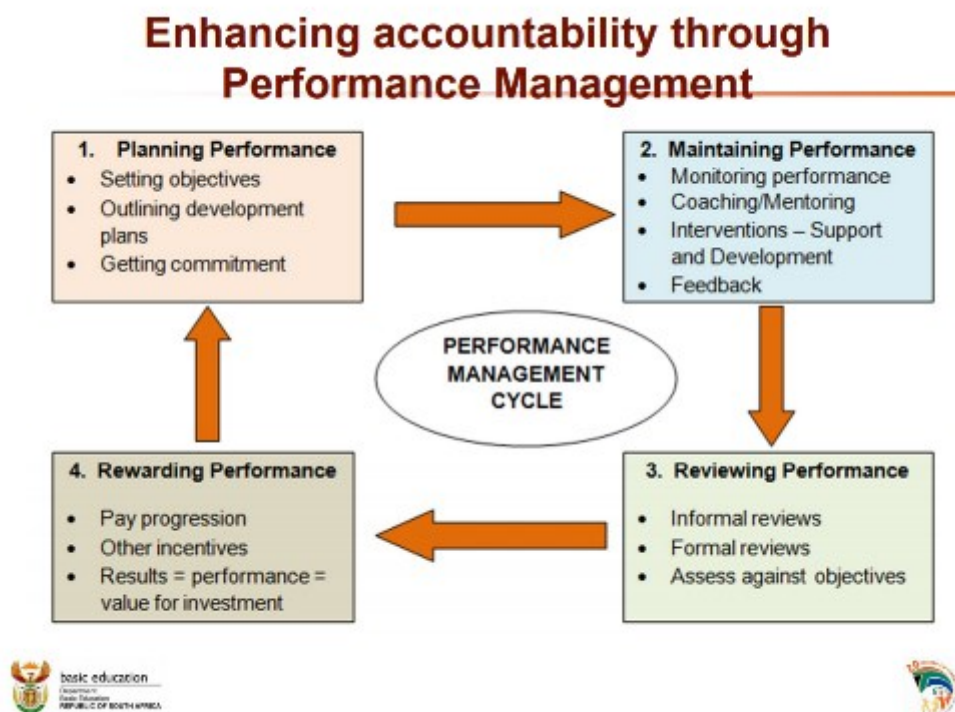


Figure 29 The DBE IQMS process (SACE 2014)

The IQMS system is a mechanism that hierarchically structures the field. The system measures the flow of specific forms of cultural capital by rewarding schools and teachers who manage this flow, and withholding rewards from those who do not. In this way, the IQMS legitimises and reinforces the capital valued within the field by rewarding the accumulation and reproduction of legitimate cultural capital. The manner in which the IQMS legitimates the flow of valued cultural capital in the field is illustrated by the equation: *'Results = performance = value for investment'*, Block 4, Figure 29. The equation makes explicit that improved learning results as the measure of the acquisition of valued cultural capital, is used to measure teachers' performance and is an indication of the value or return on investment made by the DBE.

Teachers capable of maximising the acquisition of legitimate cultural capital as measured by learners' results, are rewarded for their performance, and occupy higher positions in the field than those unable to do so. Therefore, teachers who themselves possess legitimate cultural capital, are able to increase the transmission of such cultural capital, and can retain or improve their position in the field. Inversely, teachers who possess limited access to the cultural capital valued within the field (but possibly valued within another field), potentially occupy less powerful positions and have limited potential to improve their positions in the field, or that of their learners. (While a similar argument can be made with regards to learners and access to legitimate cultural capital, that is not the focus of this study.) The *Results = performance = value for investment* equation can therefore be seen as a mechanism to maintain and reinforce the hierarchal structure of the field.

The manner in which the IQMS as monitoring mechanism shapes teachers' choices, is illustrated in IPL04, IPL06, IPL21 and IPL23's comments. Teachers within the field vie for positions and access to the valued cultural capital to increase their position within the field. Their comments demonstrate how the IQMS impacted their pedagogic choices to *'use the PowerPoint'* (IPL21) or *'use the projector'* (IPL23), or *'do it'* (IPL04), with reference to the use of ET tools, to increase their position in the field. In addition, IPL06 notes that the principal placed pressure on the teachers at School A to *'use it'*, meaning ET tools, for their IQMS. In doing so, the principal legitimised the cultural capital associated with the use of ETs, both as

process (teachers' know-how to use ETs) and product (increased learning outcomes). His insistence that teachers use ETs for their IQMS, positions those with the cultural capital (know-how) to integrate ETs in their classrooms and/or the rest of the school, at a higher position in the field than those without this cultural capital. Since teachers with the know-how to appropriate ETs would potentially achieve higher results on their IQMS, and potentially higher learner outcomes, they would potentially receive greater rewards and a higher position in the field. Bourdieu (1984) refers to this as distinction, cultural capital that hold exclusives or scarcity value, and which positions the agent at a higher position in the field, and is discussed in the next section.

The section analysed the field of education, and teachers' position and response to the requirements, structures and monitoring tools of the field. Teachers' interview data foregrounded the IQMS as a performance management tool. The IQMS was subsequently analysed and found to be a mechanism that hierarchically structures the field by regulating the acquisition and flow of legitimate cultural capital valued within the field. Schools and teachers are rewarded for increasing the flow of legitimate cultural capital, while rewards are withheld from those who do not. In this way, the capacity to manage and increase the flow of legitimate cultural capital is reflected in the inequalities related to the possession of such cultural capital (Moore, 2008). Teachers who possess cultural capital to increase the flow of legitimate cultural capital, can increase the distribution and acquisition thereof (by learners), while those who have limited access to the legitimate cultural capital also have limited means to increase its flow in the field.

### **6.1.2 Accumulating cultural capital in the ePlay MakerSpace**

Based on the analysis of the conditions of the field and the legitimate cultural capital valued therein, one can deduce that teachers likely attended the ePlay MakerSpace as a means to acquire cultural capital to improve their position within the field. This section analyses the capital valued, produced and distributed within the field.

Bourdieu describes the accumulation of cultural capital as similar to the formulation of the habitus (Moore, 2008). Cultural capital exists in three forms: as objectified in objects or artifacts, as embodied, and as expressed in the habitus as attitudes and dispositions. Economic capital can be transferred to acquire objectified cultural capital. Cultural capital that is embodied and expressed in the habitus however, must be personally acquired and cannot be divorced from the person. Additionally, Thomson (2008) frames capital as either the product or process of the field. These parameters were applied to analyse the Day 1 and 3 textual content of teachers' CM data. The word-frequency tables generated from Phase 1 and 2 analyses, were coded in terms of Bourdieuan codes:

- Field
- Actors
- Cultural capital general as the **product** of the field
- Embodied Cultural Capital as **process** of the field, typically verbs which can be prefixed by can
- Objectified material cultural capital
- Habitus as an expression of cultural capital with two subdivisions:
  - Dispositions of the mind that shapes how the person forms perceptions, beliefs and practices
  - Emotions

Results from the Bourdieuan coding of the word-frequency analysis, provided an indication of the type of cultural capital acquired in the ePlay MakerSpaces, within each iteration and in general. The collated results from the Bourdieuan coding of the CM data from Iteration 1 and 2, are included in Table 2 and visually represented in Figure 30.

Table 2 Collated results from Bourdieuan coding of CM data from Iteration 1 and 2

	Field	Actors	Cultural capital general	Cultural capital: embodied	Cultural capital: material / objectified	Total cultural capital	Total Habitus (including dispositions and emotions)
CM Day 1	164	62	199	255	334	788	148
CM Day 3	141	130	199	344	341	884	146
Percentage difference between Day 1 & 3 CM	-14%	110%	0%	35%	2%	12%	-1%

### Bourdieuan coding analysis for Iteration 1 and 2 CM data

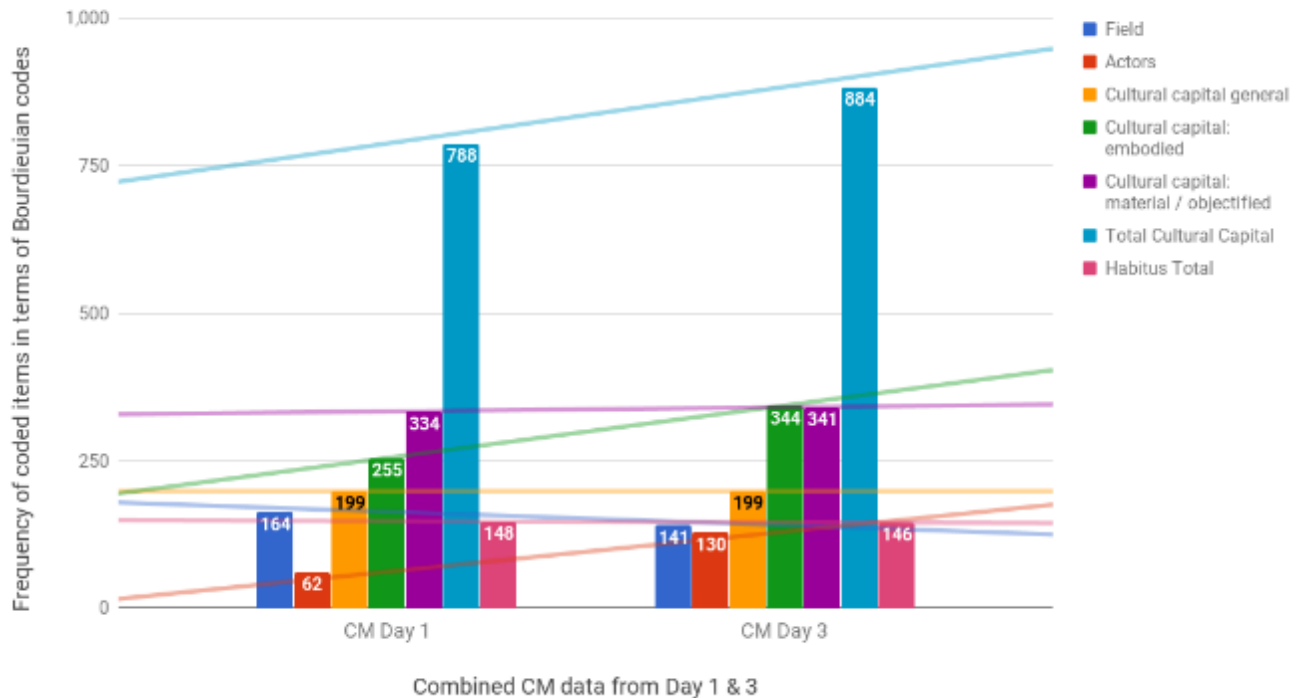


Figure 30 Collated results from Bourdieuan coding of CM data from Iteration 1 and 2

Following the item analysis in terms of Bourdieuan codes, notable differences could be seen between items listed on Day 1 and 3 in teachers' CMs. Most significantly, items coded as 'actors' showed the greatest increase in frequency over the three days, increasing by 110% from Day 1 to Day 3. Between Day 1 and 3, the frequency with which teachers included items marked as 'actors' increased from 62 to 130 times. Learners, for instance, were mentioned 10x in the IP Language teachers' and 15x in the FP teachers' Day 1 CM, but in Day 3 CMs 'learners' are mentioned 18x by IP Language teachers, and 40 times by FP teachers. Similarly, the frequency with which the item: 'teachers' was included in CMs, increased from 4 (IP Language) and 2 (FP) on Day 1, to 14 (IP Language) and 21 (FP) on Day 3. The increase in the FP group is noteworthy since only 15 FP teachers compared to 26 IP Language teachers' CMs are analysed, with a significantly higher average word-per-teacher count for FP teachers. As indicated in Table 2, as well as the frequency analysis from Iteration 1 and 2, indicates similar contrasting findings. Since the same CM protocol was strictly followed in both iterations to increase comparability (Benney and Hughes, 1956), the differences between the CMs constructed by teachers from Iteration 1 and 2, suggest that the manner in which cultural capital was accumulated as reflected in the CM content, differed in the two iterations.

This analysis emphasized the importance teachers attached to the accumulation of embodied cultural capital, and refined the understanding of the process through which dispositions are transformed. Cultural capital, similar to habitus, is formed through systematic inculcation over time (Bourdieu, 1984, 1986, 1990). Principles of selection that are implicit in a field, are translated through systematic cultivation into principles of consciousness (Moore, 2008), which translate into dispositions that structure practices, expressions, beliefs and perceptions. The ePlay MakerSpace process thus provides a systematic process to cultivate principles of selection. The different forms of learning structured the process to inculcate principles of selection into principles of consciousness. This translated into dispositions to structure practices, beliefs and perceptions, and cognitive propensities.

Furthermore, agents make investment into processes or pedagogic activities, based on an expectation that their investment would yield results, of which Bourdieu (1986, p. 18) notes:

*“The work of acquisition is work on oneself (self-improvement), an effort that presupposes a personal cost... an investment above all of time... and sacrifice”.*

Teachers attending the ePlay MakerSpace sessions, invested time and effort during their winter holidays to acquire cultural capital. Drawing on Bourdieu’s conception of capital, teachers’ willingness to invest time and effort is related to the capital they value and aspire to accumulate, in order to secure or improve their position within the field. The CM data from Day 1 provides some indication of the cognitive propensities that structure the cultural capital teachers aspired to acquire, while the Day 3 data provides some indication of the cultural capital formed during the ePlay MakerSpace.

A comparison between the textual elements from Day 1 and 3 for IP Language and FP teachers, indicates noteworthy differences. This suggests that cultural capital was formed differently in Iteration 1 and 2 of the ePlay MakerSpace as evidences in the cognitive propensities observed in teachers’ CMs from Day 1 to 3. The results of the IP Language and FP word-frequency analysis in terms of Bourdieuan codes are included in Table 3, and visually represented in Figure 32 and Figure 31.

The word-frequency analysis in terms of Bourdieuan codes indicate vast differences between Iteration 1 and 2 in items coded as cultural capital and habitus, and some similarities in terms of items coded as field. In both Iteration 1 and 2, items coded as ‘field’, are less frequently listed in Day 3 CMs compared to Day 1 CMs, reducing by 22% in IP Language and 21% in FP Maths. This suggests that while engaged in the ePlay MakerSpace, teachers may have been less impacted by the conditions of the field, as they experienced the playful environment and fun-filled, safe space. In contrast, a content analysis of the field word-frequency lists for Day 1 and 3, reveals that words such as *new* and *work* were often collocated to time-related items such as *timesaving* and *everyday*, or as IPL08’s text indicates: *new ways of thinking* → *working smarter and not harder*.

Table 3 Word-frequency analysis in terms of Bourdieuan codes for Iteration 1 and 2

	Field	Field time	Actors	Cultural capital total	Cultural capital general	Cultural capital: embodied	Cultural capital: material / objectified	Habitus Total	Habitus (general)	Dispositions	Emotions
<i>IP Lang CM Day 1</i>	72	7	30	421	104	154	163	94	10	48	36
<i>IP Lang CM Day 3</i>	56	11	41	380	52	145	183	57	9	34	14
<i>Percentage difference between Day 1 &amp; 3 CM</i>	-22%	57%	37%	-10%	-50%	-6%	12%	-39%	-10%	-29%	-61%
<i>FP CM Day 1</i>	77	8	32	367	95	101	171	54	6	23	25
<i>FP CM Day 3</i>	61	13	89	504	147	199	158	89	14	52	23
<i>Percentage difference between Day 1 &amp; 3 CM</i>	-21%	63%	178%	37%	55%	97%	-8%	65%	133%	126%	-8%

## Bourdieuian coding analysis for IP Lang teachers' Day 1 & 3 CMs

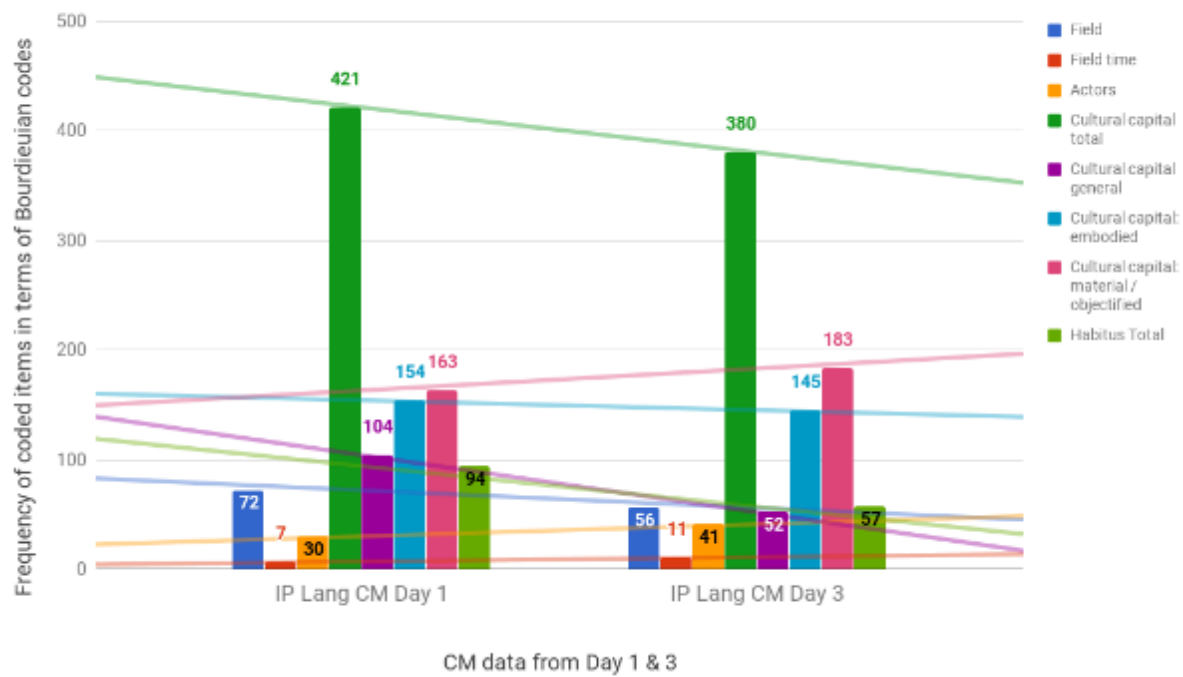


Figure 32 Bourdieuan coding analysis for Iteration 1 (IP Language) Day 1 and 3 CM data

## Bourdieuian coding analysis for FP teachers' Day 1 & 3 CMs

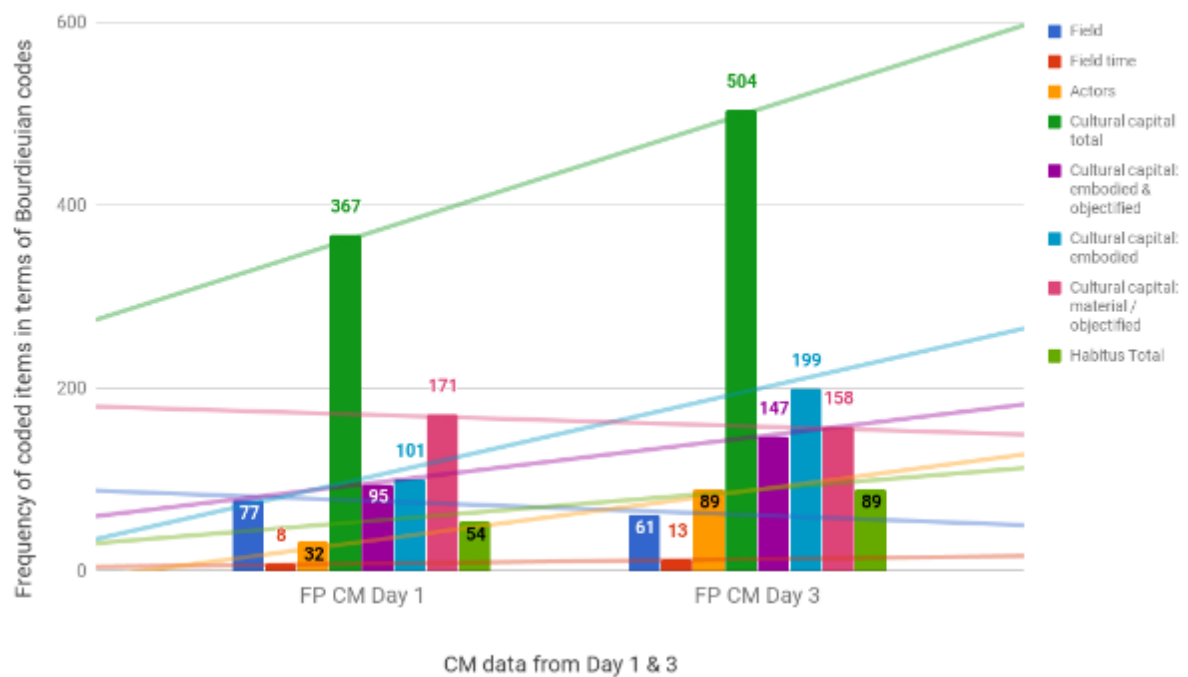


Figure 31 Bourdieuan coding analysis for Iteration 2 (FP) Day 1 and 3 CM data

Teachers' time and *work* are symbolic capitals that are transubstantiated in the field for economic capital. They are invested in maximising the differential between time spent working, and economic capital exchanged for this. The differential equation infers that the more time teachers spend working, the lower the difference between economic capital exchanged for cultural capital. Alternatively, the less time spent working, the greater the differential between economic and cultural capital exchanged. Therefore, to maximise the economic and cultural capital exchange, teachers value cultural capital that saves time and work.

Compared to the field-coded items, the items coded for cultural capital in terms of objectified, embodied or habitus-related aspects, differed substantially across the two iterations of the ePlay MakerSpace. An analysis of the IP Language Day 1 and 3 CMs suggest that rather than gaining cultural capital, after the ePlay MakerSpace, the IP Language teachers had reduced quantities of cultural capital. However, as noted previously, although all CM protocols were followed, the IP Language teachers appeared to rush to finish their CMs on the last day, which appears to be reflected in the dramatically reduced items included in their CMs. In contrast, their individual *course* reflections indicate that teachers were highly satisfied with the *course*, and five teachers indicated that the course exceeded their expectations. Some of the teachers who displayed the lowest technological cultural capital in the ePlay MakerSpace, commented as follows when asked if the *course* met their expectations:

- ◆ IPL12: *Yes, as I always heard people talking about ICT integration now I have more chances to be involved in this matter*
- ◆ IPL14: *Yes it was beyond and I am proud of myself that I can do more.*
- ◆ IP25: *Yes. I did not like using a computer but now I am starting to enjoy it.*

These three teachers quantified the cultural capital they gained as:

- ◆ IPL12: *I enjoyed the whole Edmodo course especial on e secoond day and the third day; Integration of ICT in the classroom - I gained a lot of information on this regard*

- ◆ IPL14: *How to download G/drive and Edmodo.; Planning of a lesson using ICT integration, exposure in new website.*
- ◆ IP25: *Mind-mup, lesson-planning, evaluation, use of Edmodo and G/drive,; Using Google Chrome – Edmodo [sic]*

IPL12, IPL14 and IPL25's comments suggest that they identified a lack in their cultural capital prior to engaging in the ePlay MakerSpace. IPL12 comments that other people spoke about ICT Integration, but that he lacked the cultural capital to participate in such discussions. His lack of cultural capital potentially limited his position in the field, and also his capacity to produce the cultural capital necessary to advance in the field, reproducing the inequality and hierarchical structure of the field. IPL14's comment reflects her perception that she lacked capacity and ability, in other words, embodied cultural capital, prior to the ePlay MakerSpace, which she felt she gained through her engagement. Lastly, IPL25's comment suggests his habitus was structured to form perceptions and practices that align with the conditions under which they were formed, as reflected in his negative attitude and disposition towards computers. Following the ePlay MakerSpace, he notes the differences, that he started enjoying 'computers', potentially since he had gained cultural capital to use ET tools and to design learning that transformatively integrates ETs as reflected in his second comment. In these three teachers' case, as with other teachers in the ePlay MakerSpace, although their CMs did not indicate a significant increase in their cultural capital, data from their Edmodo entries, reflections and formative evaluations of their created artifacts and participation, support the finding that their cultural capital increased as a result of their engagement in the ePlay MakerSpace.

Compared to the CMs from Iteration 1, the FP teachers' CMs indicated noteworthy increases in almost all aspects of cultural capital. Most significantly, the frequency with which FP teachers included items coded as embodied cultural capital increased by 97% (101 → 199) while items coded as dispositions and habitus increased in frequency respectively by 126% (23 → 52) and 133% (6 → 14). The most frequently coded items for embodied cultural capital were *learn* (12 → 28), *use* (4 → 15), *make* (1 → 10), and *teach* (5 → 9). Words not

included in Day 1 CMs, but which were frequently included in Day 3 CMs, were *collaborate* (4), *collaboration* (4), *communicate* (5) and *eTeacher/eTraining* (4). When viewed in conjunction with FP teachers' significantly higher formative evaluation scores for participation, creativity measures of teachers' artifacts and reflections, it suggests that the teachers in Iteration 2 accumulated a far greater volume of cultural capital than Iteration 1 teachers.

The Bourdieuan coding analysis indicated some changes over the three days of the ePlay MakerSpace, more significant in Iteration 2 with FP teachers, than in Iteration 1 with IP Language teachers. These results support the findings from the formative evaluations that the design and enactment of the FP ePlay MakerSpace more effectively supported the different forms of learning. The FP ePlay MakerSpace also achieved higher participation measures and teachers' creativity measures increased most significantly during this session, parallel to the cultural capital accumulated in the session. The manner in which teachers appropriated this cultural capital once they return to school, is discussed in the next section.

### **6.1.3 Appropriating cultural capital to effect change**

Prior to the IP Language and FP teachers' engagement in the ePlay MakerSpace, in the majority of cases, tablets, computer labs or other SmartClassroom technologies were locked away and were unused. Bourdieu (1986) notes of capital that it is accumulated labour both in terms of material and incorporated or embodied form, which, if appropriate, enables agents to appropriate social advancements. Both the objectified/material and incorporated/embodied state of cultural capital take time to accumulate and have the potential capacity to produce profits and to either reproduce identically or in an expanded form. However, in order to exploit the potential of objectified/material capital, Bourdieu (1986) argues, embodied capital is required.

Since embodied cultural capital is required to access objectified cultural capital (Bourdieu, 1984, 1986, 1990), a lack of such embodied cultural capital limits the potential for teachers to access the potential of objectified cultural capital in the form of devices and

SmartClassroom technologies present in many schools. If teachers are to exploit the potential of objectified cultural capital represented by SmartClassroom technologies, and transformatively integrate ETs, they require the embodied cultural capital to do so. Additionally, Bourdieu (1990) argues for the inculcation of the principles of selection of the field, which inculcates dispositions and structures teachers' beliefs, practices and perceptions. The ePlay MakerSpace process was designed to transform teachers' dispositions through embodiment of competencies and inculcation (Bourdieu, 1984, 1986, 1990) to generate dispositions of creativity, innovation, experimentation and risk-taking. Although theoretically speaking, dispositions cannot be examined, the effect of changing dispositions can be subjected to analysis, based on the logic that that changed dispositions would be evident in changed practices, beliefs or perceptions.

The formative evaluation results and specifically the interview data produced following the ePlay MakerSpace, and teachers' ongoing reportage of their change journeys, was retrospectively analysed. The focus of this analysis was to determine patterns in the changes teachers effected and spoke off following the ePlay MakerSpace. As reported in Chapter 4 and 5, different forms or types of changes were reported, and analysed, with patterns in teachers' change journeys (Fullan, 1995) emerging. Similar to Bourdieu (1984, 1986, 1990), Gundy and Berger (2016) describe teacher change as a developmental process that occurs in stages involving growth in knowledge and skill, creativity and innovation. Hence, in describing teachers' change journeys, the analogy of a seed sprouting and growing came to mind, and was used to visually represent the five different change journeys teachers reported, see Figure 33.

### 6.1.3.1 The seeds of change

Teachers like IPL09, IPL14, IPL16, IPL18 and IPL26 for various reasons scored mostly 1s and a few 2s for participation in the ePlay MakerSpace, and those who agreed to be interviewed, remained largely unresponsive in during the interviews, despite efforts to engage them. Of the teachers who participated in the interviews (IPL09, IPL16, IPL18 and IPL26) none had made any changes bar a sporadic visit to the computer lab to get learners to log into the

system the day before the interview. Their work in the ePlay MakerSpace however showed some promise. IPL18 for instance, received a creativity measure of 3 for her Day 1 CM, her mind-map and 2.3 for her Day 3 CM. Similarly, IPL16's Day 1 CM and Mindmup achieved 3.3 and her advert mind-map and Day 3 CM achieved 3.6 (total /4). In order to achieve these relatively high creativity scores, these two teachers needed to embody the skills and knowledge needed to use the ET tools to create their artifacts. However, in their schools they appear to have made little to no changes following the ePlay MakerSpace. It appears the teachers in the Seeds of Change group, profoundly experienced the effects of hysteresis, which at School Z was accompanied by a collective habitus (this is the school where the IWBs and 40 tablets had been locked in the strong room for a number of years.) It thus appeared that while the teachers embodied cultural capital needed to access objective capital in the form of the devices, they may not have embodied the cultural capital to exploit the potential of ETs to transform their current practices. Therefore, they can be said to have inculcated the seeds of change but these have not yet sprouted.

### 6.1.3.2 Sprouts of change

The next group of teachers related, during the interviews, different changes they had enacted following the ePlay MakerSpace, corroborated in many instances by their colleagues attending the interview. IPL04 and IPL16 for instance, reported their use of videos or a WhatsApp group with parents, IPL05 and IPL17 reported their attempts to use the tablets and desktops the day before the interview, and FP11 used her newly purchased flat screen television to play videos she had downloaded and let her learners collectively read the text on the screen. The teachers enacted change at a local level in their classrooms, but not beyond that. As such, they reproduced the embodied capital they had acquired in the ePlay MakerSpace to access the objectified cultural capital of ETs, and also accessed the embodied knowledge of change to effect change to their practice. The reproduction of this embodied capital however did not expand beyond an almost identical reproduction. These teachers' change journeys are thus classified as being 'Sprouts of change', having started to change but leaving much room for growth.

# Teachers' journeys of change

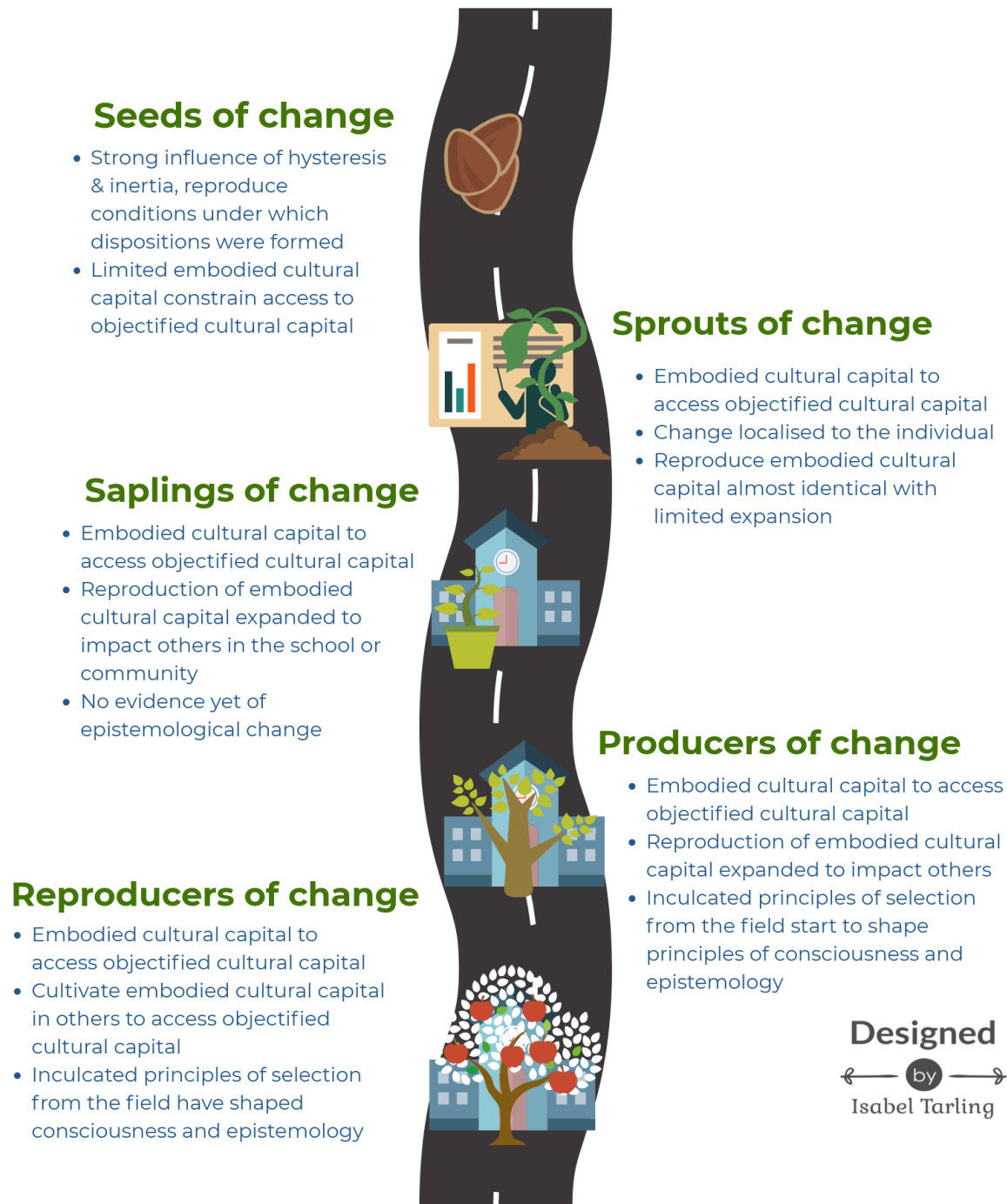


Figure 33 Teachers' journeys of change

### 6.1.3.3 Saplings of change

The next group of teachers enacted change both individually and collectively, their embodied cultural capital impacting not only their own practice, but the wider school community. Having embodied the cultural capital to access the objectified capital of ETs at their school, as the sprouts of change did, the four teachers at School A, IPL6, IPL21, IPL22 and IPL23, enacted changes to their classroom practices, but also extended this change to impact the rest of the school. Similarly, FP12 taught herself to use the visualiser, then taught the school's driver and other colleagues, while IPL13 set up 'Cyber Quickies' in the school for teachers to learn from each other's practice. Hence, these teachers did not merely identically reproduce embodied cultural capital, but extended this to impact others and in creative, previously un-imagined practices. However, there appeared little evidence in their actions for epistemological change. Instead, their practices exemplified the use of ETs to support and extend their existing practices, rather than transform teaching and learning. In keeping with the CAPS requirements, the *Saplings of Change* thus fulfilled the mandate for TPD, to increase the flow of systemically legitimate cultural capital through the use of ETs.

### 6.1.3.4 Producers of change

The changes effected by FP14 and FP15 at School O, and FP05 (working between schools), build on the description of change in the *Saplings of Change* group. However, other than the *Saplings of Change*, the *Producers of Change* provided evidence of some epistemological change, seeing themselves not only as reproducers within an existing knowledge and meaning-making system, but as active in the creation of meaning and knowledge, and involving learners in this process. The strict hierarchies between learners and teachers, strongly supported the previous three groups, appear to have relaxed in the *Producers of Change* group. FP15 for instance, invited her learners to share ideas of how they could use their devices, and both FP14 and FP15 created more egalitarian role divisions to learn with and from their learners. Similarly, being frustrated by the lack of read-aloud books in Afrikaans, FP05 created her own using her mobile phone to video herself reading the story. These epistemological changes suggest that these three teachers had not only embodied

cultural capital, but also inculcated the principles of transformative ET integration and started changing their epistemology.

### 6.1.3.5 Reproducers of change

One teacher, IPL15, falls into the *Reproducers of Change* group. She embodied the cultural capital needed to access a vast range of objectified cultural capital, reproducing this embodied cultural in a vastly extended manner. More significantly, she deliberately and purposefully exploited the inculcated principles of transformative ET integration to change epistemologically, creating less-regulated and restricted activities for learners to engage in, and opening the learning space for learners to create. Additionally, she became an ICT champion teacher at her school, coming second in the Provincial rounds of the National Teacher Awards in 2017. She actively supports not only the embodiment of cultural capital to access the objectified capital of SmartClassroom technologies at the school, but also to manage and support change within her colleagues. Therefore, she is classified as a *Reproducer of Change*.

The five categories are based on teachers' interview data, so not all teachers who attended the ePlay MakerSpace sessions are included in these categories. Of those who did participate in the interviews, the different groups are represented as follows: Seeds of Change (5), Sprouts of Change (10) and Saplings of Change (8), Producers of Change (3) and (1) Reproducer of Change. This suggests that of the greater majority of teachers not only started dispositional transformation in the ePlay MakerSpace but continued this transformation by implementing changes at their classrooms and schools. The Seeds of Change group represent 18.5% of the teachers who were interviewed, indicating that 81.5% of teachers effected change in various ways following their engagement with the process. It can thus be concluded that the ePlay MakerSpace model supported the transformation of the majority of teachers' dispositions, equipping them to transformatively integrate ETs.

In the next section of the study, the retrospectively analysed identifies the processes that support the transformation of dispositions.

## 6.2 Refining the design framework for the ePlay MakerSpace

The theoretical frame developed in Chapter 1, and the literature review in Chapter 2, informed the conceptual development of the ePlay MakerSpace as providing both the inculcation processes and enabling conditions to support the transformation of dispositions. Bourdieu's (1977; 1990, 2000) conception of dispositions as both durable and generative, emphasize that unless teachers' dispositions are transformed, teaching and learning will likely remain unchanged. The literature review indicated the need to transform teachers' existing dispositions of conformity and reproduction, to dispositions of creativity and innovation (Hargreaves, 2003), experimentation and risk-taking (Koehler *et al.*, 2011). The design principles broadly indicate inculcation processes (Bourdieu and Passeron, 1977; Bourdieu, 1990) to inculcate dispositions of creativity and innovation, and enabling conditions to inculcate experimentation and risk-taking. This section retrospectively analyses the design principles (DP) to refine the design framework for the ePlay MakerSpace.

**DP1) The ePlay MakerSpace processes and enabling conditions develop teachers' capacity to create and/or innovate with emerging technologies to transform dispositions.**

Using Bateson and Martin's (2013) work, creativity is understood as the generation of novel thoughts and ideas, and innovation as the development of practical means to implement such novel thoughts and ideas.

Findings from Iteration 1 with IP Language teachers emphasized the manner in which innovation, and not necessarily creativity was appropriated at School A, with teachers finding practical means to implement change. Creativity was also extensively measured in artifacts and showed a marked increase, despite most teachers using ETs for the first time to create, over the three-day period of the ePlay MakerSpace. In view of the high

implementation of different forms of change at schools, the development of teachers' dispositions to create and innovate was correlated in both iterations to their potential to engage in the transformative integration of ETs. However, although results are encouraging, this is not a golden ticket to effecting individual teaching change, as teachers in the '*Seeds of Change*' group indicated.

**DP2) The ePlay MakerSpace process and enabling conditions can restructure individual and/or collective beliefs, practices and/or perceptions by transforming dispositions that formed these.**

The literature review emphasized the need to see teacher change as impacted by the structures, political and cultural factors within the field of education and the schooling environment. In particular, the collective habitus and memory shapes how beliefs, practices, values and perceptions are formed within the school. However, although the study emphasized dispositional transformation in individual teachers, findings indicate that teachers at School A, O and Y in particular, refocused this. This data indicates that the teachers from these schools dispositional transformation impacted the restructuring of collective practices, beliefs and/or perceptions at their schools. In school Y's case, FP12 was an individual effecting change; in School O, a HOD and Grade 1 teacher worked together; and at School A, four teachers worked together. This suggests that although collective participation as Desimone (2009) suggests, is ideal, as in FP12's case shows, transformative ET integration can be effected, however the individual may have to work much harder to achieve their goals.

**DP3) The ePlay MakerSpace creates the enabling conditions and carries the weight of change to support teachers' entry into the liminal zone where the transformation of dispositions can occur.**

The first iteration of the ePlay MakerSpace foregrounded the reality of teachers crossing the threshold and entering the liminal zone, as well as the weight of change they experienced in this process. The FP teachers appeared to experience this crossing with less anxiety and

more excitement. Using both the SAMR and TCF models, teachers were shown to have changed and that their movement in the liminal zone was autonomous and self-directed. In addition, the changes teachers enacted following the ePlay MakerSpace was correlated to their dispositional transformation. These findings emphasize the need to support the weight of chance when teachers cross the threshold and enter the liminal zone, and also confirmed the link between their movement in the liminal zone and the transformation of dispositions.

The IP Language teachers in Iteration 1 reported a greater weight of change than the FP teachers in both groups' reflection sessions at the start of second day. As teachers approached the edge of chaos and experienced the cognitive dissonance accompanying this, many experienced strong emotions such as anxiety or discomfort, while others enjoyed the experience. One of the greatest surprises for me in conducting the two iterations, was the unexpected magnitude of teachers' weight of change. Although I had conceptualised this from literature and theory, I was surprised, at the energy I had to expend in carrying this weight of change, or how draining this would be. In iteration 2, I was better prepared and made sure I had enough rest before the sessions to be mentally and emotionally strong and able to carry teachers' weight of change. It is therefore imperative that future designers of the ePlay MakerSpace model or derivatives of this contend with the reality of teachers' weight of change, and prepare to carry this effectively.

Additionally, the playful, light-hearted and fun-filled context of the ePlay MakerSpace, created the enabling environment in which teachers could approach their threshold and cross into the liminal zone. The ePlay MakerSpace design included the five learning areas, each further carrying the weight of teachers' change and enabling the transformation of dispositions.

**DP4) The ePlay MakerSpace assumes teachers are autonomous and autotelic and is sensitive to and inclusive of the needs of all participants.**

The autonomous and autotelic nature of the ePlay MakerSpace model was enacted in both iterations. Teachers were repeatedly reminded of their status as professionals and experts

from an empathetic vantage point. They were repeatedly reminded that they had power of choice, giving them choices and adhering to their decisions. This deliberately shifted the power differential to making teachers feel autonomous and empowered to make their own choices. In turn, the analysis of their change journeys using the SAMR and TCF models, and the participant scores, indicated that teachers took responsibility and ownership for their change journeys, and many transformatively integrated ETs following the sessions. Hence, breaking with the deficit discourse prominent in the field of education in South Africa (Samuel, 2008), the ePlay MakerSpace process departs from the assumption that teachers *are* autonomous and self-directed, and builds on this. The success of this approach can be seen in the numerous complements from teachers in the *course* reviews, and more so, in their changed practice.

DP5) The ePlay MakerSpace process models sophisticated applications and pedagogical possibilities of the transformative integration of emerging technologies that are chosen to be immediately applicable and relevant to teachers' unique needs.

Twining *et al.* (2013) and Tondeur *et al.* (2016) emphasize the importance of modelling sophisticated application and pedagogic possibilities of ETs in teacher professional development. Where unsophisticated uses of ETs are modelled, teachers invariably replicate this (Zhao *et al.*, 2002; Tondeur, Van Braak and Valcke, 2007; Harris, Mishra and Koehler, 2009). In their *course* reflections, teachers repeatedly commented on the 'new ways' of using ETs or discover ETs they never knew existed. Following the session, teachers innovated new uses for devices already available to them at their schools. The sophisticated application of ETs in the ePlay MakerSpace not only embodied cultural capital to access the objectified capital in ETs, but also dispositions to create and innovate imaginative and novel uses for devices, to solve pedagogic challenges or address school-wide priorities. The sophisticated modelling thus inculcated embodied capitals with which teachers accessed the means to increase the flow of capital in the field and improve their position therein.

DP6) The ePlay MakerSpace process systematically scaffolds and provides opportunities for reflective learning.

Reflection as individuals, in shared informal groups or as a formal group activity, proved valuable supports to carry the weight of teachers' change, and also to help teachers articulate their learning and experiences of learning. Since the IP Language teachers did not always record their reflections digitally, key reflective moments were not recorded. Hence, it is recommended that as much as possible, teachers first capture their reflections digitally before engaging in face-to-face reflections. This finding was implemented in Iteration 2 and as indicated in participants' formative evaluations, the FP teachers scored significantly higher for reflection than the IP Language teachers, attesting to the usefulness of this process. Moreover, in Iteration 2, the importance of the collectively created rules to define the safe and nurturing ePlay MakerSpace, as well as the systematic and scaffolded design of reflective learning, contributed FP teachers' reflection not only on skills or challenges, but on their learning processes and cognition.

DP7) The ePlay MakerSpace process systematically scaffolds and provides directed opportunities for professional learning.

As a TPD model for South African teachers from disadvantaged primary schools, the ePlay MakerSpace was designed to include professional learning to support and extend current teaching and learning practices. Consequently, Bloom's revised taxonomy (Krathwohl, 2002), widely used in the CAPS documents, supported pedagogic knowledge development in keeping with systemic requirements and findings that teachers' pedagogic knowledge was limited (Taylor, 2008; Spaul, 2013). Therefore, teachers' higher order thinking skills were developed, as well as their 21<sup>st</sup> century skills of collaboration, communication, critical thinking and creativity. Anderson's (2004b) model of interaction was included to explicitly address Hoadley's (2012) finding that collectivised, communal learning in South African primary schools posed significant challenges to learning. The model allows teachers to explicitly structure and design learning to foster different forms of interaction. Additionally, as requested by the eLearning Game Changer, teachers were introduced to the concepts of

eTeaching and eLearning, and, using the TCF, could plan how they would implement either or both approaches. Teachers' received this structured inculcation of professional learning very positively and repeatedly commented that they felt confident to integrate ETs with CAPS.

**DP8) The ePlay MakerSpace process supports dynamic, emergent and active learning and introduces new tools using the tool introductory process.**

The inclusion of active learning as that in a MakerSpace, proved to be a highly successful strategy. The active learning components provided teachers with an embodied experience of the actual application of transformative ET integration, based on the principle to train teachers to meaningfully integrate one must transformatively integrate ETs in the training. A key finding from the formative evaluation and analysis of Iteration 1, was the need for a process to structure how tools or concepts are introduced within active learning sessions. Hence, the Tool Introductory Process (TIP) was conceptualised. The TIP is a three-step process and includes a) playful exposure, b) task-driven use and c) direct exposure. The TIP was successfully implemented in iteration 2, and especially in connection with the scaffolding of teachers' introduction to Edmodo and collaboration. Even though TIP is an implicit process, in their *course* feedback, teachers repeatedly commented positively on the structured and scaffolded manner in which they engaged with active learning.

A challenge to the active learning however, was the manual's design. The manuals should be more carefully structured to support teachers' ongoing learning.

**DP9) The ePlay MakerSpace process systematically and explicitly introduces collaboration and provides opportunities for different forms of relational learning.**

Relational learning provided teachers with collegial support as they moved into the liminal zone in the ePlay MakerSpace. Although Anderson's (2004b) model was initially used to structure and design learning in the ePlay MakerSpace, the language used in his model

became problematic. Hence a new model, The Interaction Model for Teacher Professional Development was developed based on Anderson's model for greater clarity in future designs of the ePlay MakerSpace. Furthermore, the online Edmodo group and teachers' interaction in this, provided teachers with an embodied experience they were not aware of, or conceived as possible in their classrooms. All of the teachers confirmed that they had never experienced the use of a backchanneling tool, and while some had experience of Moodle, the general consensus was that Moodle was too difficult to use. However, the intuitive interface and easy-to-learn tools in Edmodo greatly supported the relational learning in the group. Lastly, the structured and explicit introduction of collaboration in Iteration 2 to support teachers' in collaborating first through posting feedback, then through shared writing and later through the collaborative and synchronous creation of lesson plans, proved highly beneficial. Even teachers with extremely low technical skills, engaged in the activity and made positive contributions.

One challenge transformative ET integration pertains to language. I had inadvertently used the concept of a postcard in the Roadmap to Change activity, which for many teachers who do not share the same cultural background to me, was a foreign concept. Hence, rather than writing a postcard, teacher need to 'write letters' to themselves. Linguistic barriers became more pronounced in Iteration 2, possibly because the group was smaller and I had more time to focus on individual teachers. FP12 could not understand what I meant when asking her not to close tabs on her computer. Tabs were a foreign and inaccessible concept, and only when I spent time with her, showing her the tab and the red 'x' did she understand what I meant. Similarly, teachers who did not speak English fluently, found it difficult to understand words I used without thinking, such as 'up'. When working with FP13, who used two hands to manipulate the mouse, I kept telling her to 'go up' with the mouse, pointing on the screen where I wanted her to go. In reality, 'up' means moving the mouse forward on the desk surface, a realisation I only gained after spending time with FP13.

The ePlay MakerSpace inculcation processes and enabling conditions create a design framework to guide future ePlay MakerSpace designs. Language and assumptions based on

cultural nuances proved a barrier and language should be problematised and interrogated in future designs of the ePlay MakerSpace.

### DP10) The ePlay MakerSpace systematically and explicitly scaffolds transformational learning.

One of the key contributions this study makes, is the explicit and structured inclusion of transformational learning with regards to transformative ET integration, and the emphasis on inculcating embodied dispositions to support change through creativity and innovation. Although literature is frequently calls for individual teacher change and lists features, models and findings of incidences when teachers change, few studies articulate the actual individual change process and fewer still include transformational learning as a key enabler of change. It appears, teachers are assumed capable of transforming their existing practices and effecting change to this. The transformational learning enabled teachers explicitly and systematically structure how they would transformatively integrate ETs into classroom routines and plan the changes they wanted to enact.

The transformational learning process, and especially the Roadmap to Change document was well received by teachers. In view of the high rate of change recorded after the ePlay MakerSpace sessions, this explicit and structured inclusion and development of capacities to change, yielded positive results. The timing of the Roadmap to Change activity is however crucial as teachers need time to engage with the thinking and processes. They spend at least ½ hour writing to themselves, deeply engaged in thought and when asked to finish, many teachers in the FP group (and in many subsequent sessions since then) are unwilling to end their reverie.

The design framework is summarised by describing the role of the facilitator in the ePlay MakerSpace. The ePlay MakerSpace facilitator creates a safe and nurturing climate, free from everyday external pressures, rights or wrongs, and the fear of failure. Since “*play is derived, mediated and situated by the use of rules*” (Sicart, 2014, p. 8), the facilitator guides participants to collaboratively decide on rules to create a safe and nurturing space. These

rules are open to renegotiation as needed, but all role-players commit to upholding the rules and collectively creating and nurturing a safe and supportive ePlay MakerSpace environment. The facilitator is also an active participant in the process, opening conversations, using humour to generate and maintain the light-hearted, relaxed atmosphere, and modelling engagement in the pleasures of ePlay and different forms of learning.

The facilitator encourages intentional risk-taking, experimentation and discovery. They model transformative ET integration and the sophisticated application and pedagogical advancements of ETs, and coach teachers by setting achievable tasks that require skills or knowledge (slightly) beyond teachers' capacities, while providing encouraging and supportive feedback (Meyer, 2010). In this way, the facilitator guides teachers' learning and reflection, and also models pedagogic strategies that transformatively integrate ETs. The facilitator also uses reflective learning and open-ended questions to help teachers problematise their current practices, beliefs or perceptions, bringing them to the edge of their meaning-making system. Thereafter, using active and professional learning, the facilitator acts as guide to help teachers cross the threshold and enter the liminal zone. Once in the liminal zone, the facilitator carries teachers' weight of change, encouraging, reassuring and supporting teachers' emotional experiences.

Having refined the design framework, the last part of the retrospective analysis concerns the design methodology.

### **6.3 Refining the design methodology**

This section retrospectively analyses the design process of the ePlay MakerSpace iterations, to identify the design methodology for ePlay MakerSpace. The previous section refined the design framework for the ePlay MakerSpace inculcation process and enabling conditions, and together with the refined the design methodology, guide future design of the ePlay MakerSpace.

The problem identification, design process and evaluation of each iteration was retrospectively analysed. In both iterations, a reference group was assembled to clarify the problem and identify the priorities to be addressed by each ePlay MakerSpace. Although a clearly defined shared meaning for ET integration was not widely shared in both reference groups, the socially embedded, progressive transformation perspective employed in the study, assumes that meaning emerges through local improvisation and therefore the conceptual development of transformative ET integration was not forced on the group. The framework developed from the reference group critically guided the design of the ePlay MakerSpace process to address local needs and priorities.

The design of the two iterations was critically informed by the evolving Global Design Principles for the ePlay MakerSpace. Time was however a constraint. The manuals for each iteration had to be developed with enough lead time to have these printed and bound. This meant that the manuals were designed to address the framework for each *course*, and the GDPs for the ePlay MakerSpace. Thus, while the Foundation Phase ePlay MakerSpace drew on the manuals in the three days, the design and enactment of this iteration was informed by the first-generation design principles.

The design of the programme was a further challenge. The office of ICT Integration requested a clearly defined programme, articulating the activities in each session. However, the programme itself caused some anxiety during Iteration 1, in light of the challenges with the venue and devices, and frequent work-arounds and on-the-spot changes. Instead, Iteration 2's programme was designed to be more flexible and less clearly articulated each session. This inserted flexibility into the programme design and removed unnecessary anxiety when problems arose.

The design process also addresses the choice of tools for each ePlay MakerSpace. Tools should be chosen to strategically and directly correlate to teachers' contextual requirements. Since the ePlay MakerSpace is characterised by building, making, construction or modelling, rapid-prototyping and testing of ideas and intuitive 'hunches' tools should enable and not constrain this. Also, tools need to be share-able to support

online collaboration, and adaptable to allow novice to experienced users functional access. To support sustained transformative ET integration within resource constrained schools, tools should also be easily and freely accessible on a range of devices.

The design of the two iterations followed the DBR cycle of problem identification, design, enactment and testing. The use of a mapping process is suggested to define the design methodology, as illustrated in Figure 34. **Forward-mapping** (Charko *et al.*, 2016) refers to the problem identification and design of an ePlay MakerSpace, **mapping** to the enactment and collection of evidence, and **backward-mapping** to the reflection within the sessions, and the formative evaluation of the session as a whole. The facilitator thus uses **forward mapping** to design the session to align to the unique needs and requirements of groups of

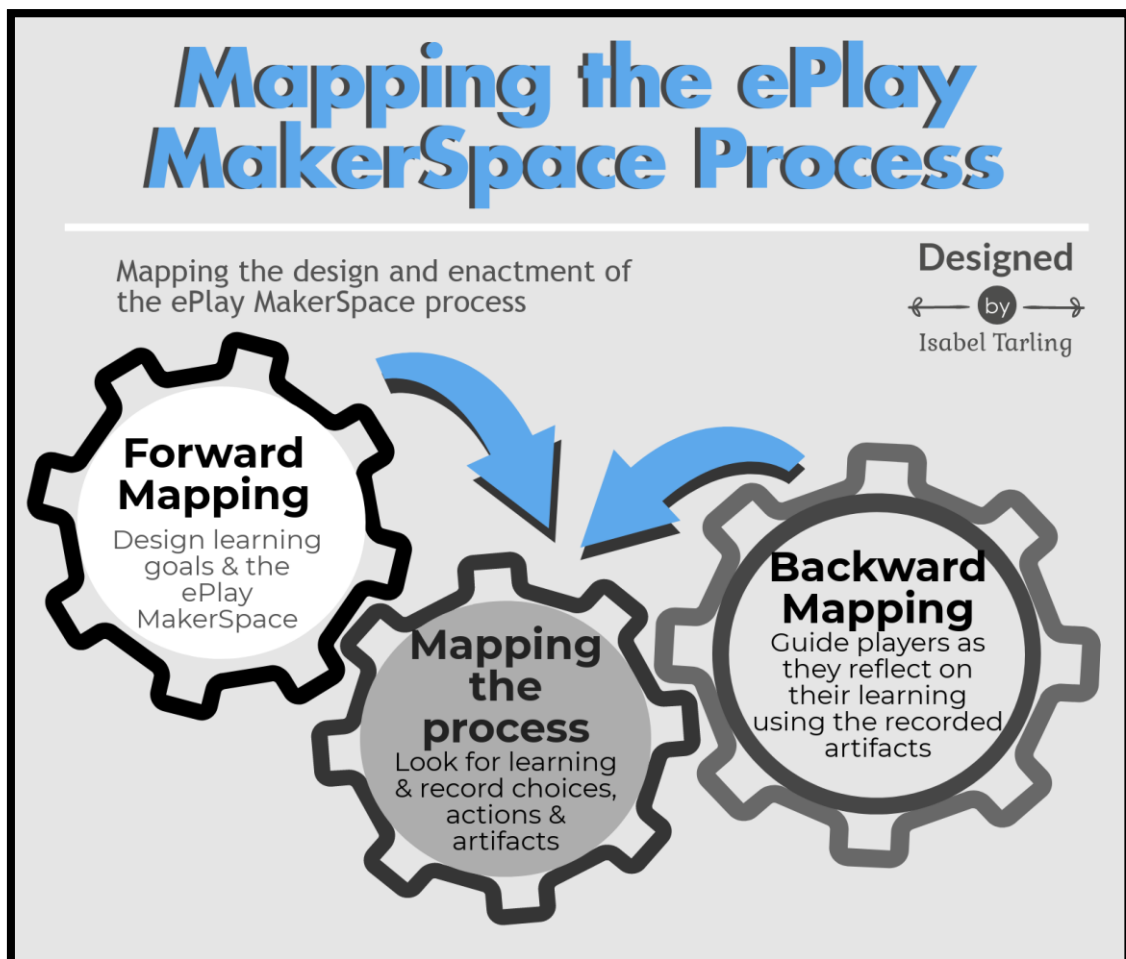


Figure 34 Mapping the ePlay MakerSpace process

teachers and schools. During the session's enactment, the facilitator *maps* the learning taking place, recording, photographing or collecting participants' created artifacts (Reid and Wood, 2016), or documenting teachers' choices using for example handwritten, video- or voice-notes. The facilitator uses *backward-mapping* to guide teachers' reflection on their learning using the collected artifacts, recordings or documented evidence as prompts. The facilitator also uses backward-mapping to reflect on, analyse and evaluate their own learning and participation in the ePlay MakerSpace process.

## 6.4 In summary

This chapter reported the retrospective analysis of the data produced in this study. Social topology analysis was used to analyse findings from both ePlay MakerSpace iterations and documented changes, according field, capital and habitus. Different categories of change were identified and related to different forms of dispositional transformation. The social topology analysis revealed the process through which teachers' dispositions are transformed and emphasized the role of the ePlay MakerSpace as mechanism through which teachers accumulate embodied cultural capital to access the objectified cultural capital represented by ETs, in order to improve their position in the field of education. This analysis also refined the design framework of the ePlay MakerSpace as a systematic process to cultivate principles of selection into principles of consciousness, which translate into dispositions. The cultivation and inculcation processes and enabling conditions of the ePlay MakerSpace model the transformative integration of emerging technologies, cultivating principles of selection implicit in the field. The systematic and scaffolded processes cultivate principles of consciousness which translate into dispositions. Lastly, the design methodology was refined, and structured using a process of forward-mapping, mapping and backward-mapping.

## Chapter 7 Conclusion

This chapter discusses findings and concludes the study. Four sections are included: a discussion of key findings, the review of the research process, the contribution the study makes, and the limitations and further research areas.

### 7.1 Key findings

The study employed a critical, socio-cultural design-based approach, and design-based methodology. Informed by a socially embedded, progressive transformation perspective (Avgerou, 2010), it was assumed that ETs have the capacity to improve learning, but that the form and process of improvement and change is locally developed by teachers. The study was situated within disadvantaged South African primary schools functioning in contexts of multiple deprivation and poverty (Mooketsi and Chigona, 2016), where learning has been persistently constrained (Taylor, 2008; Christie *et al.*, 2010; Spaul, 2013). Although ETs are increasing availability in disadvantaged schools, teachers within the schools either underutilise or do not use these (Chigona *et al.*, 2010; Ford and Botha, 2010; Bladergroen *et al.*, 2012), constraining the potential of ETs to support the improvement of teaching and learning. Globally as well as in South Africa, reform initiatives have however widely failed to achieve widespread and sustained change to teaching (Hord *et al.*, 1987; Fullan, 1995; Hargreaves and Fink, 2007; Gundy and Berger, 2016). Using Bourdieu's (1984, 1990, 1998a) logic of practice, it was argued that sustained change to teaching requires the transformation of dispositions (Bourdieu and Passeron, 1977; Bourdieu, 1990), transforming teachers' dispositions of reproduction and conformity, to dispositions of creativity and innovation (Hargreaves, 2003), experimentation and risk-taking (Koehler *et al.*, 2011). The study thus asked:

*How can the transformation of teachers' dispositions effect meaningful integration of emerging technologies in classrooms?*

Three sub-research questions were identified and are respectively reviewed, to show how each question was answered in the study.

1. *How can teachers' dispositions be transformed through the transformative integration of emerging technologies?*

The ePlay MakerSpace was theoretically and pragmatically designed as a teacher professional development model, to inculcate dispositions of creativity and innovation, experimentation and risk-taking. Although defined based on Bourdieu's theory of practice, *how* dispositions are transformed somewhat vaguely defined. For instance, does merely capacitating teachers to create and innovate transform their dispositions, or does the awakening of consciousness, pedagogic work and transmission transform dispositions which results in capacities to create and innovate? The three-phase retrospective analysis of the entire data set, and particularly the social topology analysis in Phase 3 mapped the process to transform dispositions.

The process of dispositional transformation starts with a systematic process to cultivate principles of selection implicit in the field (Bourdieu, 1984, 1986, 1990). This included the five learning processes, reflective, professional, active, relational and transformational learning, that inculcate principles of selection into principles of consciousness. In turn, the principles of consciousness are translated into dispositions that structure beliefs, perceptions and practices.

The refinement and elaboration of the design principles (DPs) illustrate the growing understanding that developed in the study of the process of dispositional transformation. The global design principles (GDPs) drew from Bourdieu's conception of inculcation processes, and the necessity to create enabling conditions for transformation of dispositions. The enabling conditions were identified from play-theory while the literature review of teacher professional development research identified the five learning processes. However, the refinement of the GDPs emphasized a growing realization of the importance of deliberately and systematically scaffolding each learning processes, as can be seen in the first-generation DPs, which were found to be fully elaborated DPs for the ePlay MakerSpace

included herein as Figure 35. Yet, only once the retrospective analysis and particularly the social topology analysis was conducted, did the data reveal the emphasis teachers placed on accumulating embodied cultural capital to access the objectified cultural capital represented by ETs, increase the flow of legitimised cultural capital and improve their position in the field.

Moreover, a link was established between teachers' level of participation and their developing capacities to create and innovate within the ePlay MakerSpace, and the level of transformative ET integration and transformation of dispositions achieved. The retrospective analyses also revealed the patterns in changes that were enacted through teachers' transformative integration of ETs at their schools, indicating that the transformation of dispositions occurs in dynamic and emergent ways, impacting not only the beliefs, practices and perceptions of individuals, but potentially also communities. The five change categories also indicated that the transformation of dispositions can also lead to the active reproduction of such dispositions in other.

Analysing the data produced through the two iterations of this study, using social topology, enabled such hidden meanings to emerge and critically, provided the answer to '*how can dispositions be transformed through the transformative integration of emerging technologies*'.

The DBR process that refined and elaborated the GDPs to form 1gDPs and finally design principles for the ePlay MakerSpace, provided the answer to the next two sub-questions.

## ePlay MakerSpace design principles

# ePlay MakerSpace **DPS**

- DP1) The ePlay MakerSpace processes and enabling conditions develop teachers' capacity to create and/or innovate with emerging technologies to transform dispositions.
- DP2) The ePlay MakerSpace process and enabling conditions can restructure individual and collective beliefs, practices and/or perceptions by transforming dispositions that formed these.
- DP3) The ePlay MakerSpace creates the enabling conditions and carries the weight of change to support teachers' entry into the liminal zone where the transformation of dispositions can occur.
- DP4) The ePlay MakerSpace assumes teachers are autonomous and self-directed, and is sensitive to and inclusive of the needs of all participants.
- DP5) The ePlay MakerSpace process models sophisticated applications and pedagogical possibilities of the transformative integration of emerging technologies that are chosen to be immediately applicable and relevant to teachers' unique needs.
- DP6) The ePlay MakerSpace process systematically scaffolds and provides opportunities for reflective learning.
- DP7) The ePlay MakerSpace process systematically scaffolds and provides directed opportunities for professional learning.
- DP8) The ePlay MakerSpace process supports dynamic, emergent and active learning and introduces new tools using the tool introductory process.
- DP9) The ePlay MakerSpace process systematically and explicitly introduces collaboration and provides opportunities for different forms of relational learning.
- DP10) The ePlay MakerSpace systematically and explicitly scaffolds transformational learning.

Figure 35 Design Principles for the ePlay MakerSpace

2. *What processes support the transformation of teachers' disposition to transformatively integrate emerging technologies?*

Five learning processes were identified as supporting the inculcation and subsequent transformation of dispositions, and iteratively tested. The refinement of the GDPs for each of these five inculcation processes, illustrates how the iterative design, enactment and formative evaluation process developed the design process for each.

GDP7) The ePlay MakerSpace process provides opportunities for reflective learning.

DP6) The ePlay MakerSpace process systematically scaffolds and provides opportunities for reflective learning.

Although the GDP7 acknowledged the need to include reflective learning, after Iteration 1 the process was refined and the need for a systematic and scaffolded introduction to reflective learning identified.

GDP8) The ePlay MakerSpace process provides opportunities for professional learning.

DP7) The ePlay MakerSpace process systematically scaffolds and provides directed opportunities for professional learning.

Again, the GDP8 emphasized the need for professional learning, but it was only through the enactment and formative evaluation of Iteration 1 that the need to emphasize deep and meaningful learning, rather than wide and general professional learning, was identified. The emphasis on scaffolding professional learning was again noted.

GDP9) The ePlay MakerSpace process provides opportunities for active learning.

DP8) The ePlay MakerSpace process supports dynamic, emergent and active learning and introduces new tools using the tool introductory process.

The formative evaluation of Iteration 1 indicated that teachers particularly valued the dynamic, emergent nature of active learning, and also the need to systematically scaffold the introduction of tools. Hence the tool introductory process (TIP) was developed to guide the introduction of all ETs in the ePlay MakerSpace in the three-step process: 1) Playful exposure; 2) Task-driven use; and 3) Direct application. The TIP was subsequently used in Iteration 2 systematically scaffold the introduction Anderson's Model (2004) and Bloom's

Taxonomy in professional learning, and the introduction of collaboration, in each case achieving positive results.

GDP10) The ePlay MakerSpace process provides opportunities for relational learning.

DP9) The ePlay MakerSpace process systematically and explicitly introduces collaboration and provides opportunities for different forms of relational learning.

During Iteration 1 collaboration as part of relational learning, was identified as a considerable challenge. Subsequently in Iteration 2 it was framed as an ET concept, and introduced with the TIP. The success of this approach can be seen in the manner in which all the teachers in Iteration 2, regardless of their technological skill level, collaborated on Day 2 in creating the group lesson plans using Google Slides.

GDP11) The ePlay MakerSpace process provides opportunities for transformational learning.

DP10) The ePlay MakerSpace systematically and explicitly scaffolds transformational learning.

In Iteration 1, the transformational learning was rushed on the last day, therefore in Iteration 2 the process was given enough time, and was also more systematically and explicitly scaffolded. The transformational learning process resulted in Iteration 2, in teachers' higher engagement with both the Roadmap to Change, and their subsequent management of change at their schools where they transformatively integrated ETs.

3. *What conditions enable or constrain the transformation of teachers' disposition to transformatively integrate emerging technologies?*

Different enabling conditions for the transformation of teachers' dispositions were identified as GDPs and refined through the iterative cycle of the DBR methodology.

GDP3) The ePlay MakerSpace creates the enabling conditions to support teachers' entry into the liminal zone to transform teachers' dispositions.

DP3) The ePlay MakerSpace creates the enabling conditions and carries the weight of change to support teachers' entry into the liminal zone where the transformation of dispositions can occur.

After Iteration 1, the formative evaluation emphasized the need to carry the weight of teachers' change when crossing the edge of chaos and entering the liminal zone, but also clarified the process – that transformation of dispositions takes place when teachers are in the liminal zone.

1. The ePlay MakerSpace creates and nurtures autonomous and autotelic ePlay.
2. The ePlay MakerSpace process is inclusive. Players in the ePlay MakerSpace come from diverse contexts and range in skill, competencies and the command of different kinds of knowledge

(Amalgamated 4 & 5) DP4) The ePlay MakerSpace assumes teachers are autonomous and self-directed and is sensitive to and inclusive of the needs of all participants.

After Iteration 1, the formative evaluation indicated that some teachers found the pace of learning too strenuous, and requested a slower pace, emphasizing the need for an approach that is more sensitive too and enabling of difference. Also, the term autotelic was replaced with self-directed - following the formative evaluation of teachers' transformative ET integration as their schools, the findings indicated that the changes enacted were self-directed rather than autotelic.

Constraining conditions that limit the transformation of teachers' dispositions, after their engagement in the ePlay MakerSpace, were also identified. The context of the school and restrictive policies banning mobile phones, and leadership who failed to create the enabling environment for transformative ET integration, for instance failing to timetable the use of ETs, or locking tablets and devices away for fear of learners damaging these, constrained the transformation of dispositions. In particular, this reinforced the legitimacy of cultural capitals to access paper-based objectified cultural capital, and delegitimised embodied cultural capital to access ETs. The culture and collective habitus of teachers, in conjunction with teachers experiencing high levels of hysteresis and inertia, further limited the transformation of dispositions. When all three of these factors were present, the teachers did not appear to enact any changes.

The design principles described herein, form the major theoretical and practical contribution that this study makes to existing knowledge in the field. The current DPs are

particularly written with regards to the ePlay MakerSpace, and are not generically applicable to the broader field. In order for the DPs to be relevant to a wider audience, the contextual elements of the ePlay MakerSpace is removed in a final refinement of DPs for TPD4ETs.

- TPD4ETs DP 1) Provide opportunities for teacher to create and innovate with emerging technologies to transform dispositions.
- TPD4ETs DP 2) Provide opportunities for teacher to explore new beliefs and practices, individually and collectively.
- TPD4ETs DP 3) Support teachers' change processes before, during and after the TPD4ET.
- TPD4ETs DP 4) Depart from the assumption that teachers are autonomous and self-directed.
- TPD4ETs DP 5) Model sophisticated applications and pedagogical possibilities of transformative emerging technology integration that is immediately relevant to teachers' needs and priorities.
- TPD4ETs DP 6) Systematically scaffold and provide opportunities for reflective learning.
- TPD4ETs DP 7) Systematically scaffold and provide opportunities for professional learning.
- TPD4ETs DP 8) Systematically scaffold and provide opportunities for active learning and introduces new tools using the tool introductory process.
- TPD4ETs DP 9) Systematically scaffold and provide explicit opportunities for collaborative and relational learning.
- TPD4ETs DP 10) Systematically scaffold and provide opportunities for transformational learning.

## 7.2 Review of the research process

The various elements from the study contribute to answer the research question. Chapter 1, in a somewhat unorthodox manner, not only introduced the study and provided the background, but also developed the theoretical and conceptual frames for the study. The

theoretical frame was strategically developed before identifying the research problem, position the theoretical frames as informing each aspect of the study. Consequently, informed by the theoretical frame, the research problem and research question and sub-questions, were framed from theory, which also informed the development of the conceptual frame. Chapter 1 also developed and introduced key concepts relating to the transformative integration of emerging technologies, as framed by a socially embedded, progressive transformation perspective. These concepts, and the theoretical and conceptual frames, were repeatedly employed through the study.

The literature review employed the theoretical frame and particularly Bourdieu's theory of practice, and reviewed literature to understanding the strategies of the field to effect change and the magnitude of change required. The critical, socio-cultural frame provided insight into the plight of teachers and the extensive scope of change required, emphasizing the need for transformation of dispositions. Informed by Bourdieu's inculcation processes, literature was reviewed and five learning processes identified to support the transformation of dispositions. Enabling conditions to support the transformation of dispositions was identified through a review of play theory, leading to the conceptualisation of the ePlay MakerSpace as both an inculcation process and enabling condition to effect the transformation of dispositions. Global design principles were identified at the end of Chapter 2 for the ePlay MakerSpace process and enabling conditions.

The design-based research methodology was developed in Chapter 3, as well as the research instruments to guide the design, enactment and formative evaluation of the two ePlay MakerSpace iterations. The chapter also developed the analytic frame. A design-epistemology was employed to develop the methodology, and dominated in the next two chapters as well. Chapter 4 and 5 reports on the iterative design, enactment and formative evaluation of two iteration of the ePlay MakerSpace, first with Intermediate Phase Language teachers, and thereafter with Foundation Phase teachers. All teachers were from disadvantaged primary schools in South Africa. The GDPs critically informed the design of Iteration 1 with IP Language teachers, and were refined following the formative evaluation of Iteration 1, to form the first-generation design principles (1gDPs). The 1gDPs then

informed the design and enactment of the FP ePlay MakerSpace. Following the formative evaluation of Iteration 2, no further refinements to the 1gDPs were made, and the Design Principles (DP) for the ePlay MakerSpace was considered fully elaborated and refined.

The retrospective analysis of the data set is reported in Chapter 6. An epistemic break was employed to break with the design epistemology and employ the critical, socio-cultural epistemology of the sociologist. A social topology analysis of the data was conducted, to refine the theoretical contribution of the study.

### 7.3 The contribution to research

The study makes both theoretical and practical contributions. Theoretically, it contributes to the understanding of how teachers change their practice, informing the design of teacher professional development and education reform initiatives. In particular, the study contributes the ePlay MakerSpace inculcation processes and enabling conditions to transform teachers' dispositions, as informed from literature and a theoretical foundation. The retrospective analysis identified five change categories to understand different forms of change enacted by teachers when they transformatively integrate ETs.

Change to teaching, although frequently called for, is rarely deliberately, systematically and explicitly included in teacher professional development. The study contributes by emphasizing the need for transformational learning that is both scaffolded and systematically developed, to support teachers as they cross the threshold into the liminal zone, and the transformation of their dispositions. Transformational learning also contributes to understanding of how teachers can be capacitated to plan and manage their own change. Significantly, the process of transforming dispositions further contributes to existing understanding.

The theoretical clarification of the transformative integration of ETs, is a further theoretical contribution. The term, integration, is frequently used, less frequently used clearly understood, and rarely precisely defined. Moreover, in many instances, the term is used from a transfer and diffusion perspective, that assumes tools, innovation, concepts and

advancement originating from advanced economies, are universally applicable in developing countries. Additionally, the transformative potential of ETs is often assumed, but rarely deliberately enacted in education. Therefore, the clarification and definition of transformational ET integration contributes insight into the theoretical and pragmatic potential thereof.

As a consequence of the theoretical clarification of the term emerging technology, the study could also contribute the framing of collaboration as an emerging technology concept and advancement. Collaboration among teachers has long been identified as problematic. The framing of collaboration as an ET, adds a conceptually useful layer to understanding how teachers can learn to collaborate.

The design-based research methodology employed in the study informed the iterative design, enactment and formative evaluation of two iterations of the ePlay MakerSpace. The theoretical frame developed for the study drew on design, and critical, socio-cultural theories and informed the design of the methodology. The researcher therefore oscillated between two epistemological positions at different points, straddling an epistemology informed by Bourdieu's (1984, 1990) critical, socio-cultural theory of practice, and a future-oriented, solution-focused emergent design-epistemology. The appropriation of both epistemologies amplified the strengths of both, and added to the development of among other, research instruments, the documentation of the design process, and development of materials. The need however for an epistemic break (1984, 1990) in the DBR process is a further contribution the study makes.

This study also makes practical contributions. The website and research tools developed as an appendix to the study, contributes a virtual research diary format to research that involves ETs. Flowing from this, various research tools were iteratively developed as practical contributions, including the creativity rubric, formative evaluation of participants, as well as the design process, the solution and the implementation procedure. Additionally, the Tool Introductory Process provides a mechanism to systematically and implicitly

structure and scaffold the introduction of new tools, concepts, innovations and advancements.

Lastly, the study contributes to teacher development within the Western Cape province of South Africa, where it is being scaled for implementation for 1000 teachers in 2018, with plans afoot to scale it across South Africa. The contribution to touching the lives of everyday teachers across South Africa, restoring to them the meaning of their action, and capacities to manage their own change processes, is the study's greatest achievement.

## 7.4 Limitations and future research

Various limitations are identified, as well as possible areas for future research.

The lack of follow-up support provided to teachers after the ePlay MakerSpace potentially limited the continued transformation of teachers' dispositions. Although a session in the September holidays was held, only a few teachers participated. While follow-up support was provided during the interviews, teachers who did not agree to be interviewed could not access this. These teachers' reluctance to participate in the interviews even when invitations and opportunities for participation was repeatedly made available, also limits the insights that could have been gained from their participation.

The study was narrowly focused on teachers' and transforming their dispositions. This limited the scope of the study. Different results, especially with the group of teachers classified as the 'seeds of change', may have been achieved had a more holistic approach included the leaders from teachers' schools. Similarly, learners' results were used to measure impact. Future research in this respect, could take a holistic view of a school, enact the ePlay MakerSpace, and measure the impact of transformative ET integration according to learners' outcomes, to establish possible correlations.

The emphasis on generating dispositions to create and innovate, experiment and take risks, tends to disregard other dispositions that may impact the transformative integration of ETs.

Thus, future research may identify dispositions other than the four focused on in this study, and develop the enabling conditions and processes to inculcate those.

## 7.5 In conclusion

This study has shown that the transformation of teachers' dispositions, and particularly the generation of dispositions to create and innovate, experiment and take risks, through the transformative integration of ETs, translated into teachers, from disadvantaged schools, innovating and creating contextually embedded solutions to transformatively integrate ETs in their schools and classrooms. The ePlay MakerSpace model was shown to cultivate enabling conditions for the transformation of dispositions with ePlay providing a means for teachers from different linguistic and socio-cultural contexts to mediate learning. Through reflective and relational learning, as well as active and professional learning, teachers inculcated different states of cultural capital.

One of the major contributions this study makes is the inclusion of transformational learning in an explicit and structured manner, to support teachers to plan for and manage their ongoing change processes. Five forms of change were identified from teachers' enacted changes: Seeds, Sprouts and Saplings of change, and Produces and Reproduces of change. The produces and reproduces of change were shown to have started changing their epistemology, with the reproducer deliberately sharing transformational learning with other teachers to support their change journeys. Evidenced from the high implementation and diverse changes teachers enacted following their participation in the ePlay MakerSpace, the model presents an alternative to the current teacher professional development, and while it is well suited to South African context, it may even contribute to changing practices in other context.

## References

Adams Becker, S., Freeman, A., Giesinger Hall, C., Cummins, M. and Yuhnke, B.. (2016) *NMC/CoSN Horizon Report: 2016 K-12 Edition*. Austin, Texas: The New Media Consortium. Available at: <http://cdn.nmc.org/media/2016-nmc-cosn-horizon-report-k12-EN.pdf>.

Amiel, T. and Reeves, T. C. (2008) 'Design-Based Research and Educational Technology: Rethinking Technology and the Research Agenda.', *Journal Educational Technology & Society*, 11(4), pp. 29–40.

Anderson, S. E. (1997) 'Understanding Teacher Change : Revisiting the Concerns Based Adoption Model', *Curriculum Inquiry*, 27(3), pp. 331–367. Available at: <http://www.jstor.org/stable/1180105>.

Anderson, S. E. (2010) 'Moving Change: Evolutionary perspectives on educational change', in Hargreaves, A. et al. (eds) *Second International Handbook of Educational Change*. Dordrecht, Heidelberg, London, New York: Springer, pp. 65–84.

Anderson, T. D. (2004) 'Towards a Theory of Online Learning', in Anderson, T. D. (ed.) *The Theory and Practice of Online Learning*. 2nd edn. Edmonton, Canada: AU Press, Athabasca University, pp. 45–74. doi: 10.1111/j.1467-8535.2005.00445\_1.x.

Avgerou, C. (2010) 'Discourses on ICT and Development', *Information Technologies & International Development*, 6(3), pp. 1–18. Available at: <http://www.itidjournal.org/index.php/itid/article/view/560>.

Baily, S., Stribling, S. M. and McGowan, C. L. (2014) 'Experiencing the "Growing Edge": Transformative Teacher Education to Foster Social Justice Perspectives', *Journal of Transformative Education*, 12(3), pp. 248–265. doi: 10.1177/1541344614544373.

Barab, S. and Squire, K. (2004) 'Design-Based Research: Putting a Stake in the Ground', *The Journal of Learning Sciences*, 13(1), pp. 1–14.

- Baszanger, I. and Dodier, N. (2004) 'Ethnography: relating the part to the whole', in Silverman, D. (Ed) (ed.) *Qualitative Research: Theory, Method and Practice*. 2nd edn. London, UK: SAGE Publications Ltd.
- Bateson, P. and Martin, P. (2013) *Play, Playfulness, Creativity and Innovation*. United States of America: Cambridge University Press. doi: 10.2304/forum.2009.51.2.165.
- Belland, B. R. (2009) 'Using the theory of habitus to move beyond the study of barriers to technology integration', *Computers and Education*. Elsevier Ltd, 52(2), pp. 353–364. doi: 10.1016/j.compedu.2008.09.004.
- Bennet, M. and Moriarty, B. (2016) 'Pre-service Teachers, Aboriginal Students and the Cross-cultural "Playing Field": Empowering Futures', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 85–94.
- Benney, M. and Hughes, E. C. (1956) 'Of Sociology and the Interview: Editorial Preface', *The American Journal of Sociology*, 62(2), pp. 137–142.
- Berger, J. G. (2004) 'Dancing on the Threshold of Meaning: Recognizing and Understanding the Growing Edge', *Journal of Transformative Education*, 2(4), pp. 336–351. doi: 10.1177/1541344604267697.
- Besterfield-Sacre, M., Gerchak, J., Lyons, M., Shuman, L. and Wolfe, H. (2004) 'Scoring Concept Maps : An Integrated', *Journal of Engineering Education*, (April), pp. 105–115. doi: 10.1002/j.2168-9830.2004.tb00795.x.
- Bhati, N., Mercer, S., Rankin, K. and Thomas, B. (2009) 'Barriers and facilitators to the adoption of tools for online pedagogy', *International Journal of Pedagogies and Learning*, 5(3), pp. 5–19. doi: 10.5172/ijpl.5.3.5.
- Bladergroen, M. Chigona, W., Bytheway, A., Cox, S., Dumas, C. and Van Zyl, I. (2012) 'Educator discourses on ICT in education: a critical analysis', *International Journal of*

*Education and Development using Information and Communication Technology*, 8(2), pp. 107–119.

Bless, C., Higson-Smith, C. and Kagee, A. (2006) *Fundamentals of Social Research Methods: an African perspective*. 4th edn. Cape Town: Juta & Co. Ltd.

Bloom, B. S. (Ed) *et al.* (1956) *Taxonomy of Educational Objectives: Handbook 1: Cognitive Domain*. New York: Longmans, Green & Co.

Bourdieu, P. (1984) *Distinction*. Edited by T. by R. Nice. Cambridge, Massachusetts: Harvard University Press. doi: 10.1007/s13398-014-0173-7.2.

Bourdieu, P. (1986) 'The Forms of Capital', in *Handbook of Theory and Research for the Sociology of Education*, pp. 15–29

Bourdieu, P. (1990) *In Other Words Essays Toward a Reflexive Sociology*. Edited by T. by M. Adamson. Stanford, California: Stanford University Press.

Bourdieu, P. (1990) *The Logic of Practice*. Edited by Translated by Richard Nice. doi: 10.2307/2804264.

Bourdieu, P. (1990) 'The scholastic point of view', *Cultural Anthropology*, 5(4), pp. 380–391. Available at: <http://www.jstor.org/stable/656183> (Accessed: 3 February 2014).

Bourdieu, P. (1991) *Language and Symbolic Power*. Edited by J. B. Thomson.

Bourdieu, P. (1998a) *Practical Reason*. Stanford, California: Stanford University Press.

Bourdieu, P. (1998b) 'Social Space and Symbolic Power', *Sociological Theory*, 7(1), pp. 14–25. doi: 10.2307/202060.

Bourdieu, P. (1999) 'The weight of the world : social suffering in contemporary society', *Social Semiotics*, p. 646.

Bourdieu, P. (2000) *Pascalian meditations*. Edited by Translated by Richard Nice. Cambridge, United Kingdom: Polity Press.

Bourdieu, P. and Passeron, J.-C. J. (1977) *Reproduction in education, society and culture*. 1990th edn. Edited by Translated from French by Richard Nice. London, UK: SAGE.

Bourdieu, P. and Wacquant, L. (1992) *An invitation to reflexive sociology*. Available at: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:An+Invitation+to+Reflexive+Sociology#0> (Accessed: 27 May 2014).

Brabazon, T. (2016) 'Press Play', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 119–146.

Brodie, K. (2013) 'The power of professional learning communities', *Education as Change*, 17(1), pp. 5–18. doi: 10.1080/16823206.2013.773929.

Brown, S. and Vaughan, C. (2009) *Play: How It Shapes the Brain, Opens the Imagination, and Invigorates the Soul*. New York: Penguin.

Burbules, N. C. and Berk, R. (1999) 'Critical Thinking and Critical Pedagogy: Relations, Differences and Limits', in Popkewitz, T. S. and Fendler, L. (eds) *Critical Theories in Education: changing terrains of knowledge and politics*. London and New York: Routledge, pp. 45–66.

Burkhardt, H. (2006) 'From design research to large-scale impact: Engineering research in education', in van den Akker, J. J. H. et al. (eds) *Educational Design Research*. London: Routledge, pp. 185–228.

Callewaert, S. (1999) 'Philosophy of Education, Frankfurt Critical Theory, and the Sociology of Pierre Bourdieu', in Popkewitz, T. S. and Fendler, L. (eds) *Critical Theories in Education: Changing Terrains of Knowledge and Politics*. New York, New York, USA: Routledge, pp. 117–144.

Castells, M. (2009) *The Power of Identity*. Second. Oxford, UK: Wiley-Blackwell. doi: 10.1002/9781444318234.

Charko, L. Fraser, C., Jones, D. and Umangay, U. (2016) 'Faculty, Candidates, and Children at Play: Perceptions and Dissonances', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 55–72.

Chesbrough, H. (2006) 'Open innovation - A new paradigm for understanding industrial innovation', *Open innovation - Researching a new paradigm*, pp. 1–27. doi: 10.1037/e586602011-001.

Chigona, A., Chigona, W., Kayongo, P. and Kausa, M. (2010) 'An empirical survey on domestication of ICT in schools in disadvantaged communities in South Africa Agnes Chigona , Wallace Chigona , Patrick Kayongo and Moses Kausa', *International Journal of Education and Development using Information and Communication Technology*, 6(2), pp. 21–32.

Chigona, W. *et al.* (2011) 'Educator Discourses on ICT in Education', in *Research Network for eSkills (ReSNES)*. East London.

Chigona, W. and Mooketsi, B. E. (2011) 'In the Eyes of the Media: Discourse of an ICT4D Project in a developing country', *The Electronic Journal of Information Systems in Developing Countries*, 46(6), pp. 1–16. Available at: <http://www.ejisdc.org>.

Chisholm, L. and Leyendecker, R. (2008) 'Curriculum reform in post-1990s sub-Saharan Africa', *International Journal of Educational Development*, 28(2), pp. 195–205. doi: 10.1016/j.ijedudev.2007.04.003.

Christensen, C. M. (1997) *The Innovator's Dilemma: When new technologies cause great firms to fail*. Boston, Massachusetts: Harvard Business School Press.

Christie, P. (1998) 'Schools as (Dis)Organisations: the "breakdown of the culture of learning and teaching" in South African schools', *Cambridge Journal of Education*, 28(3), pp. 283–300. doi: 10.1080/0305764980280303.

Christie, P. (2010) 'Landscapes of Leadership in South African Schools: Mapping the Changes', *Educational Management Administration & Leadership*, 38(6), pp. 694–711. doi: 10.1177/1741143210379062.

Christie, P., Sullivan, P., Duku, N. and Gallie, M. (2010) *Researching the Need: school leadership and quality of education in South Africa*.

Christie, P. (2016) 'Educational change in post-conflict contexts: reflections on the South African experience 20 years later', *Globalisation, Societies and Education*, 14(3), pp. 434–446. doi: 10.1080/14767724.2015.1121379.

Christie, P., Butler, D. and Potterton, M. (2007) *Report of ministerial committee: schools that work*.

Clarke, M. and Meldrum, M. (1999) 'Creating change from below: early lessons for agents of change', *Leadership & Organization Development Journal*, 20(2), pp. 70–82. doi: 10.1108/01437739910259172.

Cobb, P. (1994) 'Where Is the Mind? Constructivist and Sociocultural Perspectives on Mathematical Development', *Educational Researcher*, 23(7), pp. 13–20. doi: 10.3102/0013189X023007013.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R. and Schauble, L. (2003) 'Design Experiments in Educational Research', *Educational Researcher*. American Educational Research Association, 32(1), pp. 9–13. doi: 10.3102/0013189X032001009.

Cohen, L., Manion, L. and Morrison, K. (2007) *Research Methods in Education*. 6th edn. Oxon, London: Routledge.

Csikszentmihalyi, M. (1996) *The Creative Personality*, *Psychology Today*. doi: 10.1177/001698620504900404.

Csikszentmihalyi, M. (1997) 'Flow and Education.', *NAMTA Journal*, 22(2), pp. 36–58. doi: 10.1007/978-94-017-9094-9.

Cuban, L. (1993) 'Computers Meet Classroom: Classroom Wins', *The Teachers College Record*, 95(2), pp. 185–210.

Cuban, L., Kirkpatrick, H. and Peck, C. (2001) 'High Access and Low Use of Technologies in High School Classrooms: Explaining an Apparent Paradox', *American Educational Research Journal*, 38(4), pp. 813–834. doi: 10.3102/00028312038004813.

Darling-Hammond, L., Wei, R., Andree, A., Richardson, N. and Orphanos, S. (2009) *Professional Learning in the Learning Profession : A Status Report on Teacher Development in the United States and Abroad*, National Staff Development Council. Washington, DC. doi: 10.1006/jfbi.2002.2063.

Darling-Hammond, L. (2010) 'Teaching and Educational Transformation', in Hargreaves, A. et al. (eds) *Second International Handbook of Educational Change*, pp. 505–520.

Deer, C. (2008) 'Doxa', in Grenfell, M. (ed.) *Pierre Bourdieu: Key Concepts*. Durham: Acumen Publishing Limited, pp. 119–130. Available at:  
<http://universitypublishingonline.org/ref/id/acumen/CBO9781844654031>.

Department of Basic Education (2011) 'Curriculum and Assessment Policy Statement: Intermediate Phase Grades 4–6 English Home Language', *National Curriculum Statement (NCS)*. Pretoria, South Africa: Government Printing Works, p. 118. Available at:  
[http://www.o-ph.fi/english/education\\_system/basic\\_education](http://www.o-ph.fi/english/education_system/basic_education).

Department of Basic Education (2011) 'Curriculum and Assessment Policy Statement: Intermediate Phase Grades 4 - 6 English First Additional Language'. Pretoria, South Africa: Government Printing Works, p. 122. Available at:  
<http://www.stat.si/StatWeb/en/Field/Index/9/71>.

Department of Basic Education (2011) *Professional Learning Communities - A guideline for South African schools*.

Department of Basic Education (2015) *Action Plan To 2019: Towards the Realisation of Schooling 2030*. Available at: <http://tinyurl.com/2019-DBE-Action-Plan> [Retrieved 16 August 2015].

Department of Education (2004) *White Paper on e-Education, Gazette, Government*.

Department of Education, South Africa. Available at:

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:White+Paper+on+e-Education#2> (Accessed: 10 December 2013).

Department of Education (2007) 'Guidelines for Teacher Training and Professional Development in ICT'. Pretoria, South Africa: Government Printing Works, pp. 1–18. Available at: [http://www.schoolnet.org.za/sharing/guidelines\\_teacher\\_training.pdf](http://www.schoolnet.org.za/sharing/guidelines_teacher_training.pdf).

Design-Based Research Collective (2003) 'Design-Based Research: An Emerging Paradigm for Educational Inquiry', *Educational Researcher*. JSTOR, 32(1), pp. 5–8. doi: 10.3102/0013189X032001005.

Desimone, L. M. (2009) 'Improving Impact Studies of Teachers' Professional Development: Toward Better Conceptualizations and Measures', *Educational Researcher*, 38(3), pp. 181–199. doi: 10.3102/0013189X08331140.

Desimone, L. M. (2011) 'A primer on effective professional development', *Phi Delta Kappan*, 26(6), pp. 68–71. doi: 10.1177/003172171109200616.

DiSessa, A. A. and Cobb, P. (2004) 'Ontological Innovation and the Role of Theory in Design Experiments', *Journal of the Learning Sciences*, 13(1), pp. 77–103. doi: 10.1207/s15327809jls1301.

Donner, J. and Gitau, S. (2009) 'New Paths: Exploring Mobile-Centric Internet Use in South Africa', in *The International Communication Association (ICA)*, pp. 1–2.

Dorst, K. (2011) 'The core of "design thinking" and its application', *Design Studies*. Elsevier Ltd, 32(6), pp. 521–532. doi: 10.1016/j.destud.2011.07.006.

Dorst, K. and Cross, N. (2011) 'Creativity in the design process: co-evolution of problem-solution', *International Journal of Design*, 5(2), pp. 41–52. doi: 10.1016/s0142-694x(01)00009-6.

Drewes, A. (2009) *Blending Play Therapy with Cognitive Behavioral Therapy: Evidence-based and other effective treatments and techniques*. Edited by A. A. Drewes. Wiley.

Dufour, R. and Reeves, D. (2016) 'The futility of PLC Lite', *Kappan*, 97(6), pp. 69–71.

Eberle, S. G. (2014) 'The Elements of Play Toward a Philosophy and a Definition of Play', *American Journal of Play*, 6(2), pp. 214–233.

Edelson, D. C. (2002) 'Design Research: What we learn when we engage in Design', *The Journal of the Learning Sciences*, 11(1), pp. 105–121. doi: 10.1207/S15327809JLS1101.

Edelson, D. C. (2006) 'What we learn when we engage in design: Implications for assessing design research', in van den Akker, J. J. H. et al. (eds) *Educational Design Research*. London: Routledge, pp. 156–165.

Ertmer, P. A. (1999) 'Addressing first- and second-order barriers to change: Strategies for technology integration', *Educational Technology Research and Development*, 47(4), pp. 47–61. doi: 10.1007/BF02299597.

Ertmer, P. A. (2005) 'Teacher pedagogical beliefs: The final frontier in our quest for technology integration?', *Educational technology research and development*, 53(4), pp. 25–39. doi: 10.1007/BF02504683.

Ertmer, P. A. and Ottenbreit-Leftwich, A. (2010) 'Teacher technology change: How knowledge, confidence, beliefs, and culture intersect', *Journal of Research on Technology in Education*, 42(3), pp. 255–284. Available at: <http://www.tandfonline.com/doi/abs/10.1080/15391523.2010.10782551> (Accessed: 9 November 2014).

Euler, D. (2017) 'Design principles as bridge between scientific knowledge production and practice design', *Educational Design Research*, 1(1).

Evoch, C. J. (2007) 'Collaborative Partnerships and the Transformation of Secondary Education through ICTs in South Africa', *Educational Media International*, 44(2), pp. 81–98. doi: 10.1080/09523980701295091.

Fataar, A. (2012) 'Pedagogical justice and student engagement in South African schooling: working with the cultural capital of disadvantaged students', *Perspectives in Education*, 30(4), pp. 52–75.

Fataar, A. and Feldman, J. (2016) 'Dialogical habitus engagement: The twists and turns of teachers' pedagogical learning within a professional learning community', *Perspectives in Education*, 34(2), pp. 98–111. doi: 10.18820/2519593X/pie.v34i3.8.

Feldman, J. and Fataar, A. (2014) 'Conceptualising the setting up of a professional learning community for teachers' pedagogical learning', *South African Journal of Higher Education*, 28(5), pp. 1525–1540.

Fishman, B. J., Penuel, W., Allen, A.-R., Cheng, B. and Sabelli, N. (2003) 'Fostering teacher learning in systemic reform: Linking professional development to teacher and student learning', *Teaching and Teacher Education*, 19(6), pp. 643–658. Available at: <http://www.umich.edu/~hiceweb/papers/2001/newtechnologies/FishmanNARST2001.pdf>.

Ford, M. and Botha, A. (2010) 'A Pragmatic Framework for Integrating ICT into Education in South Africa', in Cunningham, P. and Cunningham, M. (eds) *IST-Africa*. IIMC International Information Management Corporation, pp. 1–10. Available at: [www.ist-africa.org/conference2010](http://www.ist-africa.org/conference2010).

Ford, M. and Leinonen, T. (2009) 'MobilED – Mobile Tools and Services Platform for Formal and Informal Learning', in Ally, M. (ed.) *Mobile Learning: Transforming the Delivery of Education and Training*. Edmonton, Canada: AU Press, Athabasca University, pp. 195–214.

Forest, C. R., Moore, R., Jariwala, A., Linsey, J., Newstetter, W., Ngo, P. and Quitero, C. (2014) 'The invention studio: A university maker space and culture', *Advances in Engineering Education*, 4(2), pp. 1–32.

Freeman, A., Adams Becker, S., Cummins, M., Davis, A. and Hall Giesinger, C. (2017) *NMC/CoSN Horizon Report: 2017 K – 12 Edition*. Austin, Texas: The New Media Consortium. Available at: <https://www.nmc.org/publication/nmccosn-horizon-report-2017-k-12-edition/>.

Fullan, M. G. (1992) *Successful School Improvement: The Implementation Perspective and Beyond*. Buckingham, Philadelphia: Open University Press. Available at: <https://books.google.co.za/books?id=LU3IAAAQBAJ&lpq=PP1&ots=WpK5hhYXVx&dq=Michael fullan 1992&lr&pg=PR3#v=onepage&q=Michael fullan 1992&f=false>.

Fullan, M. G. (1995) *Change Forces: Probing the Depths of Educational Reform*. Bristol, PA: Farmer Press, Taylor & Francis Inc. doi: 10.1017/CBO9781107415324.004.

Fullan, M. G. (2001) *Leading in a culture of change*.

Fullan, M. G. (2005) 'The Meaning of Educational Change: A Quarter of a Century of Learning', in Hargreaves, A. et al. (eds) *The Roots of Educational Change*. Dordrecht, The Netherlands: Springer, pp. 202–216.

Fullan, M. G. (2007) *The new meaning of educational change*. 4th edn. New York, New York, USA: Teachers College Press.

Fullan, M. G. (2013) *Great to excellent: launching the next stage of Ontario's education agenda*. Ontario. doi: [http://www.michaelfullan.ca/wp-content/uploads/2013/09/13\\_Fullan\\_Great-to-Excellent.pdf](http://www.michaelfullan.ca/wp-content/uploads/2013/09/13_Fullan_Great-to-Excellent.pdf).

Fullan, M. G. and Miles, M. B. (1992) 'Getting Reform Right: What Works and What Doesn't', *Phi Delta Kappan*, 73(10), p. 744. doi: <http://dx.doi.org/10.1108/17506200710779521>.

Fullerton, T. (2014) *GAME DESIGNWORKSHOP A Playcentric Approach to Creating Innovative Games 3rd edition*.

Garet, M. S., Porter, A., Desimone, L., Birman, B. and Yoon, K. (2001) 'What Makes Professional Development Effective? Results from a National Sample of Teachers', *American Educational Research Journal*, 38(4), pp. 915–945. doi: 10.3102/00028312038004915.

Gibson, P. A., Stringer, K., Cotten, S., Simoni, Z., O'Neal, J. and Howell-Moroney, M. (2014) 'Changing teachers, changing students? the impact of a teacher-focused intervention on students' computer usage, attitudes, and anxiety', *Computers and Education*. Elsevier Ltd, 71, pp. 165–174. doi: 10.1016/j.compedu.2013.10.002.

Gill, R. (2003) 'Change management - or change leadership?', *Journal of Change Management*, 3(4), pp. 307–318. doi: 10.1080/714023845.

Glover, I., Hepplestone, H., Parkin, H., Roger, H. and Irwin, B. (2016) 'Pedagogy first: Realising technology enhanced learning by focusing on teaching practice', *British Journal of Educational Technology*, 47(5), pp. 993–1002. doi: 10.1111/bjet.12425.

Gould, R. M. (1996) 'Getting from Strategy to Action: Processes for Continuous Change', *Long Range Planning*, 29(3), pp. 278–289. doi: 10.1016/0024-6301(96)00018-0.

Grant, C., Jasson, A. and Lawrence, G. (2010) 'Resilient KwaZulu-Natal schools: an ethics of care', *South African Review of Education*, 16(2), pp. 81–99.

Gravemeijer, K. and Cobb, P. (2006) 'Design research from a learning design perspective', in van den Akker, J. J. H. et al. (eds) *Educational Design Research*. London: Routledge, pp. 45–85.

Gray, P. (2008) *The Value of Play 1: The definition of Play Give Insights*, *Psychology Today*. Available at: <https://www.psychologytoday.com/blog/freedom-learn/200811/the-value-play-i-the-definition-play-gives-insights>.

Grenfell, M. (1995) *The Initial Training of Modern Language Teachers: A Social Theoretical Approach Vol 1, Social Sciences*. University of Southampton.

- Grenfell, M. (2008) *Pierre Bourdieu: Key concepts*. Edited by M. Grenfell. Durham: Acumen Publishing Limited. doi: 10.1017/UPO9781844654031.
- Grenfell, M. (2010) 'Being critical: the practical logic of Bourdieu's metanoia', *Critical Studies in Education*, 51(1), pp. 85–99. doi: 10.1080/17508480903450240.
- Guilford, J. P. (1956) 'The structure of intellect.', *Psychological bulletin*, 53(4), pp. 267–293. doi: 10.1037/h0040755.
- Guilford, J. P. (1957) 'Creative abilities in the arts.', *Psychological review*, 64(2), pp. 110–118. doi: 10.1037/h0048280.
- Guilford, J. P. (1958) 'Can creativity be developed?', *Art Education*, 11(6).
- Guilford, J. P. (1966) 'Measurement and Creativity', *Theory Into Practice*, 5(4), pp. 186–189. doi: 10.1080/00405846609542023.
- Gundy, M. S. and Berger, M. J. (2016) 'Towards a Model Supporting Educational Change', *International Journal of Information and Education Technology*, 6(3), pp. 232–236. doi: 10.7763/IJiet.2016.V6.691.
- Guskey, T. (2002) 'Professional development and teacher change', *Teachers and Teaching: theory and practice*, 8(3). Available at: <http://www.tandfonline.com/doi/abs/10.1080/135406002100000512> (Accessed: 12 August 2014).
- Guskey, T. (2014) 'Planning Professional Learning', *Educational Leadership*, May, pp. 11–16.
- Habermas, J. (1973a) *Knowledge and Human Interest*. John Wiley & Sons, Inc.
- Habermas, J. (1973b) 'What does a crisis mean today? legitimation problems in late capitalism', *Social Research*, 40(4), pp. 643–667.
- Hall, G. E. and Hord, S. M. (2001) *Implementing Change: Patterns, Principles, and Potholes*. Allyn & Bacon.

Hardman, J. (2005) 'An exploratory case study of computer use in a primary school mathematics classroom: New technology, new pedagogy', *Perspectives in Education*, 23(December), pp. 1–13. Available at: <http://web.uct.ac.za/depts/educate/download/Hardman.pdf> (Accessed: 24 November 2013).

Hargreaves, A., Earl, S., Moore, S. and Manning, S. (2001) *Learning to change : teaching beyond subjects and standards, The Jossey-Bass education series*. San Francisco: Jossey-Bass; A Wiley Company.

Hargreaves, A. (2003) *Teaching in the Knowledge Society: Education in the Age of Insecurity*. New York and London: Teachers College Press.

Hargreaves, A. (2009) 'Change Wars: A Hopeful Struggle', in Hargreaves, A. and Fullan, M. (eds) *Change Wars*. United States of America, pp. 1–10.

Hargreaves, A., Lieberman, A., Fullan, M. and Hopkins, D. (2010) *Second International Handbook of Educational Change, Second International Handbook of Educational Change*. Edited by A. Hargreaves et al. Dordrecht, Heidelberg, London, New York: Springer. doi: 10.1007/978-90-481-2660-6.

Hargreaves, A. and Ainscow, M. (2015) 'The top and bottom of leadership and change', *Kappan*, (November).

Hargreaves, A. and Fink, D. (2007) *Sustainable leadership*. San Francisco, CA: Jossey-Bass; A Wiley Company.

Harris, J., Mishra, P. and Koehler, M. J. (2009) 'Teachers' Technological Pedagogical Content Knowledge and Learning Activity Types', *Journal of Research on Technology in Education*. International Society for Technology in Education. 180 West \*th Avenue, Suite 300, Eugene, OR 97401-2916. Tel: 800-336-5191; Tel: 541-302-3777; Fax: 541-302-3778; e-mail: [iste@iste.org](mailto:iste@iste.org); Web site: <http://www.iste.org>, 41(February 2015), pp. 393–416. doi: 10.1207/s15326985ep2803\_7.

Haslam, M. B. (2010) 'Teacher Professional Development Evaluation Guide', *National Staff Development Council*, (Jan). Available at:

<http://learningforward.org/docs/pdf/evaluationguide.pdf?sfvrsn=0>.

Hayes, D., Christie, P., Mills, M. and Lingard, B. (2004) 'Productive leaders and productive leadership: Schools as learning organisations', *Journal of Educational Administration*, 42(5), pp. 520–538. doi: 10.1108/09578230410554043.

van der Heijden, H., Geldens, D., Beijaard, D. and Popeijus, H. (2015) 'Characteristics of teachers as change agents', *Teachers and Teaching: theory and practice*, 21(6), pp. 681–699. doi: 10.1080/13540602.2015.1044328.

Hennessy, S., Ruthven, K. and Brindley, S. (2005) 'Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution, and change', *Journal of Curriculum Studies*, 37(2), pp. 155–192. doi: 10.1080/0022027032000276961.

Herrington, J., McKenney, S., Reeves, T. and Oliver, R. (2007) 'Design-based research and doctoral students: Guidelines for preparing a dissertation proposal', *Educational Technology & Society*, 11(4), pp. 29–40. Available at: <http://researchrepository.murdoch.edu.au/6762/> (Accessed: 2 December 2014).

Herrington, J., Parker, J. and Boase-Jelinek, D. (2014) 'Connected authentic learning: Reflection and intentional learning', *Australian Journal of Education*, 58(1), pp. 23–35. doi: 10.1177/0004944113517830.

Heystek, J. and Lethoko, M. (2001) 'The contribution of teacher unions in the restoration of teacher professionalism and the culture of learning and teaching', *South African Journal of Education*, 21(4), pp. 222–228.

Hicks, M. A., Berger, J. G. and Generett, G. G. (2005) 'From Hope to Action: Creating Spaces to Sustain Transformative Habits of Mind and Heart', *Journal of Transformative Education*, 3(1), pp. 57–75. doi: 10.1177/1541344604270924.

Hitchcock, G. and Hughes, D. (1995) *Research and the Teacher: a qualitative introduction to school-based research*. 2nd edn. London and New York: Routledge. doi: 10.1017/CBO9781107415324.004.

Hlubinka, M. *et al.* (2013) 'Makerspace Playbook', p. 78.

Hoadley, U. (2012) 'What do we know about teaching and learning in South African primary schools?', *Education as Change*, 16(2), pp. 187–202. doi: 10.1080/16823206.2012.745725.

Hohmann, L. (2005) *Innovation Games: Creating breakthrough products through collaborative play*. Boston, Massachusetts.

Honan, E. (2008) 'Barriers to teachers using digital texts in literacy classrooms', *Literacy*, 42(1), pp. 36–43. doi: 10.1111/j.1467-9345.2008.00480.x.

Honan, E. (2010) 'Mapping discourses in teachers' talk about using digital texts in classrooms', *Discourse: Studies in the Cultural Politics of Education*, 31(2), pp. 179–193. doi: 10.1080/01596301003679701.

Hord, S. M., Rutherford, L., Huling-Austin, L. and Hall, G. (1987) *Taking charge of change*. Virginia: Southwest Educational Development Laboratory.

Hughes, B. (2001) *Evolutionary Playwork and Reflective Analytic Practice*. London and New York: Routledge, Taylor Francis Group.

Huizinga, J. (1949) *Homo Ludens: A Study of the Play-Element in Culture*. 1980 editi. London, Boston and Henley: Routledge & Kegan Paul. doi: 10.1177/0907568202009004005.

Inan, F. A. and Lowther, D. L. (2010) 'Factors affecting technology integration in K-12 classrooms: A path model', *Educational Technology Research and Development*, 58, pp. 137–154. doi: 10.1007/s11423-009-9132-y.

Jameson, J. (2006) *Leadership in post-compulsory education: inspiring leaders of the future*. London: David Fulton Publishers.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A. and Ludgate, H. (2013) *Horizon Report: 2013 K – 12 Edition*. Available at: <http://www.nmc.org/publications/2013-horizon-report-k12>.

Johnson, L., Adams Becker, S., Estrada, V. and Freeman, A. (2014) *NMC Horizon Report 2014 K-12 Edition*. Austin, Texas.

Johnson, L., Adams Becker, S., Estrada, V. and Freeman, A. (2015a) *NMC Horizon Report: 2015 Higher Education Edition, Reading*.

Johnson, L., Adams Becker, S., Estrada, V. and Freeman, A. (2015b) *NMC Horizon Report: 2015 K-12 Edition*. K-12. Austin, Texas: The New Media Consortium.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A. and Hall, C. (2016) *NMC Horizon Report: 2016 Higher Education Edition*. Austin, Texas: The New Media Consortium. Available at: <http://cdn.nmc.org/media/2016-nmc-horizon-report-he-EN.pdf>.

Kalekin-fishman, D. (2002) 'Looking at Interviewing : From "Just Talk" to Meticulous Method', *Forum: Qualitative Social Research Sozialforschung*, 3(4), p. 17.

Kampylis, P. (2010) *Fostering Creative Thinking The Role of Primary Teachers*.

Kampylis, P., Bocconi, S. and Punie, Y. (2012) *Towards a mapping framework of ICT-enabled innovation for learning*. doi: 10.2791/89492.

Kapp, R. (2004) "'Reading on the Line": An Analysis of Literacy Practices in ESL Classes in a South African Township School', *Language and Education*, 18(3), pp. 246–263. doi: 10.1080/09500780408666878.

Kasule, D. and Mapolelo, D. (2005) 'Teachers' strategies of teaching primary school mathematics in a second language: A case of Botswana', *International Journal of Educational Development*, 25(6), pp. 602–617. doi: 10.1016/j.ijedudev.2004.11.021.

Khattar, R. and Callaghan, K. (2016) 'Playing with Play: A Playful Reconnaissance', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 27–34.

Kim, K. H. (2006) 'Can We Trust Creativity Tests? A Review of the Torrance Tests of Creative Thinking (TTCT)', *Creativity Research Journal*, 18(1), pp. 3–14. doi: 10.1207/s15326934crj1801\_2.

Kim, K. H. (2011a) 'Proven reliability and validity of the Torrance Tests of Creative Thinking (TTCT).', *Psychology of Aesthetics, Creativity, and the Arts*, 5(4), pp. 314–315. doi: 10.1037/a0021916.

Kim, K. H. (2011b) 'The creativity crisis: The decrease in creative thinking scores on the Torrance tests of creative thinking', *Creativity Research Journal*, 23(4), pp. 285–295. doi: 10.1080/10400419.2011.627805.

Kirkwood, A. and Price, L. (2014) 'Technology-enhanced learning and teaching in higher education: what is "enhanced" and how do we know? A critical literature review', *Learning, Media and Technology*, 39(1), pp. 6–36. doi: 10.1080/17439884.2013.770404.

Koehler, M. J., Mishra, P., Bouck, E., DeSchryver, M., Kereluik, K., Shin, T. and Wolf, L. (2011) 'Deep-play: developing TPACK for 21st century teachers', *International Journal of Learning Technology*, 6(2), pp. 146–163. doi: 10.1504/IJLT.2011.042646.

Krathwohl, D. R. (2002) 'A Revision of Bloom's Taxonomy: an overview', *Theory into Practice*, 41(4), pp. 212–218.

Kreutzer, T. (2009) *Generation Mobile: Online and Digital Media Usage on Mobile Phones among Low-Income Urban Youth in South Africa*.

Kurti, R. S., Kurti, D. L. and Fleming, L. (2014) 'The Philosophy of Educational Makerspaces', *Teacher Librarian*, 41(5), pp. 8–12.

Kvale, S. (1996) *Interviews: an introduction to qualitative research interviewing*. London, UK: SAGE.

Lave, J. and Wenger, E. (1991) *Situated learning Legitimate peripheral participation, Learning in doing*. Edited by R. Pea and J. S. Brown. Cambridge University Press (Learning in doing). doi: 10.2307/2804509.

Lefstein, A. (2008) 'Changing Classroom Practice Through the English National Literacy Strategy: A Micro-Interactional Perspective', *American Educational Research Journal*, 45(3), pp. 701–737. doi: 10.3102/0002831208316256.

Lehohla, P. J. (2016) *Education Series Volume III: Education Enrolment and Achievement*.

Lortie, D. C. (1975) *A Sociological Study*. Second. University of Chicago Press.

Loucks-Horsley, S. (1996) 'The Concerns-Based Adoption Model (CBAM): A Model for Change in Individuals', in Bybee, R. (ed.) *National Standards and the Science Curriculum*. Dubuque, Iowa: Kendall/Hunt Publishing Co.

Louis, K. S. (2010) 'Better Schools Through Better Knowledge? New Understanding, New Uncertainty', in Hargreaves, A. et al. (eds) *Second International Handbook of Educational Change*. Dordrecht, Heidelberg, London, New York: Springer, pp. 3–27.

Lukacs, K. (2015) "'For Me , Change is not a Choice ": The Lived Experience of a Teacher Change Agent', *American Secondary Education*, 44(1), pp. 38–50.

Major, J. and Ayrton, A. (2016) 'Personal Epistemologies and Pedagogical Play: Changing Practice in Teacher Education 14', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 183–204.

Maria Mama, T. and Hennessy, S. (2013) 'Developing a typology of teacher beliefs and practices concerning classroom use of ICT', *Computers and Education*. Elsevier Ltd, 68, pp. 380–387. doi: 10.1016/j.compedu.2013.05.022.

- Maringe, F. and Moletsane, R. (2015) 'Leading schools in circumstances of multiple deprivation in South Africa: Mapping some conceptual, contextual and research dimensions', *Educational Management Administration & Leadership*, 43(3), pp. 347–362. doi: 10.1177/1741143215575533.
- Masondo, S. (2016) 'Angie Motshekga reads riots act', *City Press Newspaper*, 25 January.
- Maton, K. (2008) 'Habitus', in Grenfell, M. (ed.) *Pierre Bourdieu: Key Concepts*. Durham: Acumen Publishing Limited, pp. 49–66.
- Maxwell, J. A. (1992) 'Understanding and Validity in Qualitative Research', *Understanding and Validity in Qualitative Research*, 62(3), p. 279.
- McArdle, F. et al. (2016) 'Team Players', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London, p. 35-.
- McKenney, S., Nieveen, N. and van den Akker, J. J. H. (2006) 'Design research from a curriculum perspective', in van den Akker, J. J. H. et al. (eds) *Educational Design Research*. London: Routledge, pp. 110–143.
- McWhinney, W. and Markos, L. (2003) 'Transformative Education: Across the Threshold', *Journal of Transformative Education*, 1(1), pp. 16–37. doi: 10.1177/1541344603252098.
- Mesthrie, R. (2006) 'Language, transformation and development : a sociolinguistic appraisal of post-apartheid South African language policy and practice', *Southern African Linguistics and Applied Language Studies*, 24(2), pp. 151–163.
- Meyer, P. (2010) 'From workplace to playspace: innovating, learning, and changing through dynamic engagement', p. 232.
- Miller, L., Naidoo, M., van Belle, J.-P. and Chigona, W. (2006) 'School-level ICT adoption factors in the Western Cape schools', *Fourth IEEE International Workshop on Technology for Education in Developing Countries, TEDC 2006*, 2006, pp. 57–61. doi: 10.1109/TEDC.2006.24.

Mishra, P. and Koehler, M. J. (2006) 'Technological Pedagogical Content Knowledge: A Framework for Integrating Technology in Teacher Knowledge', *Teachers College Record*, 108(6), pp. 1017–1054. doi: 10.1111/j.1467-9620.2006.00684.x.

Mooketsi, B. E. and Chigona, W. (2016) 'The impact of contextual factors on the implementation of government e-strategy in previously disadvantaged areas in Cape Town', *Electronic Journal of Information Systems in Developing Countries*, 73(1), pp. 1–20.

Moolenaar, N. M., Daly, A. J. and Slegers, P. J. C. (2011) 'Ties with potential: Social network structure and innovative climate in Dutch schools', *Teachers College Record*, 113.9(9), pp. 1–30. Available at:  
[http://www.tcrecord.org/DefaultFiles/SendFileToPublic.asp?ft=pdf&FilePath=c:%5CWebSite s%5Cwww\\_tcrecord\\_org\\_documents%5C38\\_16180.pdf&fid=38\\_16180&aid=2&RID=16180&pf=Content.asp?ContentID=16180](http://www.tcrecord.org/DefaultFiles/SendFileToPublic.asp?ft=pdf&FilePath=c:%5CWebSite s%5Cwww_tcrecord_org_documents%5C38_16180.pdf&fid=38_16180&aid=2&RID=16180&pf=Content.asp?ContentID=16180) (Accessed: 14 November 2013).

Moore, R. (2008) 'Capital', in Grenfell, M. (ed.) *Pierre Bourdieu: Key Concepts*. Durham: Acumen Publishing Limited, pp. 101–118. Available at:  
<http://universitypublishingonline.org/ref/id/acumen/CBO9781844654031>.

Morocz, R., Levy, B., Nagel, R., Newstetter, W., Grau, K. and Linsey, J. (2015) 'University Maker Spaces: Discovery, Optimization and Measurement of Impacts', *Advances in Engineering Education*. Available at: <https://smartech.gatech.edu/handle/1853/53812>.

Mullis, I. V. S. Martin, M., Foy, P. and Hooper, M. (2016a) *PIRLS 2016 International Results in Reading*.

Mullis, I. V. S., Martin, M., Foy, P. and Hooper, M. (2016b) *TIMMS 2015 International Results in Mathematics Executive Summary Grade 4 Maths results*. Boston, Massachusetts. doi: 10.1787/9789264104815-2-en.

Mullis, I. V. S. *et al.* (2016c) *TIMMS 2015 International Results in Mathematics Executive Summary Grade 8 Maths Results*. Boston, Massachusetts. Available at:  
<http://timssandpirls.bc.edu/timss2015/international-results/>.

Nelson, T. H., Lesseig, K. and Slavit, D. (2016) 'Making Sense of "STEM Education" in K-12 Context', (April). doi: 10.13140/RG.2.1.2380.0725.

Nicholas, Z. and Roosmalen, E. van (2016) 'From Local to Global: International Initiatives in School Leadership', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 95–106.

Novak, J. D. (2010) 'Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations', *Journal of E-Learning and Knowledge Society*, 6(3), pp. 21–30. doi: 10.5860/CHOICE.36-1103.

Novak, J. D. and Cañas, A. J. (2006) 'The origins of the concept mapping tool and the continuing evolution of the tool', *Information Visualization*, 5(3), pp. 175–184. doi: 10.1057/palgrave.ivs.9500126.

Novak, J. D. and Cañas, A. J. (2008) 'The Theory Underlying Concept Maps and How to Construct and Use Them 1', pp. 1–36.

O'Sullivan, M. C. (2002) 'Action research and the transfer of reflective approaches to in-service education and training (INSET) for unqualified and underqualified primary teachers in Namibia', *Teaching and Teacher Education*, 18(5), pp. 523–539. doi: 10.1016/S0742-051X(02)00014-8.

OECD, 2015. *Students , Computers and Learning: Making the Connection*, Paris, France. Available at: <http://dx.doi.org/10.1787/9789264239555-en>.

OECD (2016) *PISA 2015 Results (Volume II): Policies and Practices for Successful Schools*. doi: 10.1787/9789264267510-en.

Oliver, R. and Herrington, J. (2001) *Teaching and learning online: A beginner's guide to e-learning and e-teaching in higher education*. Available at: <http://researchrepository.murdoch.edu.au/6931/1/TALO2.pdf>.

- Opfer, V. D. and Pedder, D. (2011) 'Conceptualizing Teacher Professional Learning', *Review of Educational Research*, 81(3), pp. 376–407. doi: 10.3102/0034654311413609.
- Oppenheimer, T. (2003) 'The Computer Delusion', *Philosophy is Everybody's Business*, X(1), pp. 1–28.
- Pareja Roblin, N., Tondeur, J., Voogt, J., Bruggeman, B., Mathieu, G. and van Braak, J. (2018) 'Practical considerations informing teachers' technology integration decisions: the case of tablet PCs', *Technology, Pedagogy and Education*. Routledge, 5139(January), pp. 1–17. doi: 10.1080/1475939X.2017.1414714.
- Parsons, A. W., Richey, L., Parson, S. and Dodman, S. (2013) 'How do teachers change their practice? Case studies of two teachers in a literacy professional development initiative', *35th Yearbook of the Association of Literacy Educators and Researchers*, pp. 127–141.
- Parsons, A. W., Parsons, S., Morewood, A. and Ankrum, J. (2016) 'Barriers to Change: Findings From Three Literacy Professional Learning Initiatives', *Literacy Research and Instruction*. Routledge, 55(4), pp. 331–352. doi: 10.1080/19388071.2016.1193575.
- Pedgley, O. (2007) 'Capturing and analysing own design activity', *Design Studies*, 28(5), pp. 463–483. doi: 10.1016/j.destud.2007.02.004.
- Pellegrini, A. D. and Smith, P. K. (eds) (2005) *The Nature of Play, Philosophic Inquiry in Sport*.
- Penuel, W. R. *et al.* (2007) 'What makes professional development effective? Strategies that foster curriculum implementation', *American Educational Research Journal*, 44(4), pp. 921–958. doi: 10.3102/0002831207308221.
- Popkewitz, T. S. (1999) 'A Social Epistemology of Education', in Popkewitz, T. S. and Fendler, L. (eds) *Critical Theories in Education: Changing Terrains of Knowledge and Politics*. New York, New York, USA: Routledge, pp. 17–42.
- Postma, D., Spreen, C. A. and Vally, S. (2015) 'Education for Social Change and Critical Praxis in South Africa', *Education as Change*, 19(2), pp. 1–8. doi: 10.1080/16823206.2015.1085609.

- Puenteadura, R. R. (2012) 'Building upon SAMR', *Retrieved May*. Available at: <http://hippasus.com/rrpweblog/archives/2012/09/03/BuildingUponSAMR.pdf>.
- Puenteadura, R. R. (2013a) 'Paths to Technology Integration: SAMR & TPCK in Context', p.
- Puenteadura, R. R. (2013b) 'SAMR: Getting to Transformation', *Retrieved May*. Available at: <http://www.hippasus.com/rrpweblog/archives/2013/04/16/SAMRGettingToTransformation.pdf%5Cnpapers3://publication/uuid/6AD583B3-7F64-4EA7-9B0D-81E438A9DDB6>.
- Punie, Y., Bocconi, S. and Kamylyis, P. (2012) 'In-depth Key Elements for Developing Creative Classrooms', *eLearning Papers*, (September), pp. 1–13. doi: 10.2791/90566.
- Putnam, R. T. and Borko, H. (2000) 'What Do New Views of Knowledge and Thinking Have to Say About Research on Teacher Learning?', *Educational Researcher*, 29(1), pp. 4–15. doi: 10.3102/0013189X029001004.
- Reay, D. (2004) "'It's all becoming a habitus": beyond the habitual use of habitus in educational research', *British Journal of Sociology of Education*, 25(4), pp. 431–444. doi: 10.1080/0142569042000236934.
- Reeves, T. C. (2006) 'Design Research from the Technology Perspective', in van den Akker, J. J. H. et al. (eds) *Educational Design Research*. London: Routledge, pp. 86–109.
- Reeves, T. C., McKenney, S. and Herrington, J. (2011) 'Publishing and perishing: The critical importance of educational design research', *Australasian Journal of Educational Technology*, 27(1), pp. 55–65. doi: <http://www.ascilite.org.au/ajet/ajet27/reeves.html>.
- Reeves, T. C. and Reeves, P. M. (2015) 'Educational Technology Research in a VUCA World', *Educational Technology*, (March-April), pp. 26–30.
- Rega, I. and Van Zyl, I. J. (2011) 'ICT attitudes in educational practice: a qualitative perspective Technological', in *Rethinking Education in the Knowledge Society*. Ascona, Switzerland.

Reid, J.-A. and Wood, D. (2016) 'Practice Play in Learning to Teach: Performing a Teaching Body ..... 147 Jo-Anne Reid and Denise Wood', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 147–164.

Runco, M. A. and Jaeger, G. J. (2012) 'The Standard Definition of Creativity', *Creativity Research Journal*, 24(1), pp. 92–96. doi: 10.1080/10400419.2012.650092.

SACE (2014) 'IQMS Personal Growth Plans and Developmental Needs of Educators'. Department of Basic Education, Republic of South Africa. Available at: [http://sace.org.za/assets/documents/uploads/sace\\_87052-2016-08-31-IQMS and Developmental Needs.pdf](http://sace.org.za/assets/documents/uploads/sace_87052-2016-08-31-IQMS and Developmental Needs.pdf).

Samuel, M. (2008) 'Accountability to whom? For what? Teacher identity and the Force Field Model of teacher development', *Perspectives in Education*, 26(June), pp. 3–16. Available at: [http://reference.sabinet.co.za/sa\\_epublication\\_article/persed\\_v26\\_n2\\_a2](http://reference.sabinet.co.za/sa_epublication_article/persed_v26_n2_a2) (Accessed: 12 August 2014).

Schaefer, C. E. (2003) *Play Therapy with Adults*. Edited by C. E. Schaefer. Hoboken, New Jersey: John Wiley & Sons, Inc.

Schaefer, C. E. and Kaduson, H. G. (eds) (2006) *Contemporary play therapy: theory, research and practice*. New York and London: Guilford Press.

Seale, C. (2011) *Researching Society and Culture 3rd Edition*. 3rd edn. Edited by C. Seale. London, UK: SAGE.

Sharples, M. *et al.* (2009) 'New Modes of Technology-enhanced Learning : Opportunities and challenges A Harnessing Technology research project by the University of Nottingham and Sero', (November), pp. 1–53.

Sherman, K. and Howard, S. K. (2012) 'Teachers ' Beliefs about First- and Second-Order Barriers to ICT Integration : Preliminary Findings from a South African Study', in *Society for Information Technology and Teacher Education International Conference*, pp. 2098–2105.

Shulman, L. S. (1987) 'Knowledge and teaching: foundations of the new reform', *Harvard Educational Review*, pp. 1–21. doi: 0017-8055/87/0200/0001.

Sicart, M. (2014) *Play Matters, Playful Thinking Series*. Edited by J. Juul, G. Long, and W. Uricchio. Cambridge, Massachusetts: The MIT Press. doi: 10.1017/CBO9781107415324.004.

Silverman, D. (2010) *Doing qualitative research: a practical handbook*. 2nd edn. London, UK: SAGE.

Silverman, D. (Ed) (2004) *Qualitative Research: Theory, Method and Practice (Second Edition)*. Edited by D. (Ed) Silverman. London, UK: SAGE Publications Ltd. doi: 10.1007/s13398-014-0173-7.2.

Silverman, D. and Marvasti, A. (2008) 'Doing Qualitative Research', *Nursing Research*, p. 555. doi: 10.1097/00006199-199507000-00011.

Sloane, F. (2006) 'Normal and design sciences in education: Why both are necessary', in van den Akker, J. J. H. et al. (eds) *Educational Design Research*. London and New York: Routledge, pp. 19–44.

Somekh, B. (2007) *Pedagogy and Learning with ICT: researching the art of innovation*. London, UK: Routledge.

Spaull, N. (2013) *South Africa's Education Crisis : The quality of education in South Africa 1994-2011*. Parktown, Johannesburg.

Steinar, K. (1996) 'Ch 7: The Interview Situation Ch 8: The quality of the Interview', in *Interviews: An Introduction to Qualitative Research Interviewing*. London: SAGE.

Sternberg, R. J. (2006) 'The Nature of Creativity', *Creativity Research Journal*, 18(1), pp. 87–98. doi: 10.1207/s15326934crj1801\_10.

Sutton-Smith, B. (1999) 'Evolving a Consilience of Play Definitions: Playfully', in Reifel, S. (ed.) *Play & Culture Studies, Vol 2*. Vol 2. Austin, Texas: Ablex Publishing Corporation.

Sutton-Smith, B. (2001) *The Ambiguity of Play, Quality Quantity*. United States of America: Harvard University Press. doi: 10.1111/1469-7610.t01-5-00086.

Talbert, J. E. (2010) 'Professional Learning Communities at the Crossroads: How Systems Hinder or Engender Change', in Hargreaves, A. et al. (eds) *Second International Handbook of Educational Change*. Dordrecht, Heidelberg, London, New York: Springer.

Tarling, I. and Ng'ambi, D. (2016) 'Teachers pedagogical change framework: A diagnostic tool for changing teachers' uses of emerging technologies', *British Journal of Educational Technology*, 47(3), pp. 554–572. doi: 10.1111/bjet.12454.

Taylor, N. (2008) 'What's wrong with South African schools?', in *What's Working in School Development*, pp. 1–30. Available at: <http://jet.org.za/events/conferences/What works in school development/Papers/Taylor Whats wrong with SA schools JET Schools Conf final.pdf>.

Tearle, P. (2004) 'A theoretical and instrumental framework for implementing change in ICT in education', *Cambridge Journal of Education*, 34(3), pp. 331–351. doi: 10.1080/0305764042000289956.

Tennant, M. (2005) 'Transforming Selves', *Journal of Transformative Education*, 3(2), pp. 102–115. doi: 10.1177/1541344604273421.

Thomson, P. (2008) 'Field', in Grenfell, M. (ed.) *Pierre Bourdieu: Key Concepts*. Durham: Acumen Publishing Limited, pp. 67–84. Available at: <http://universitypublishingonline.org/ref/id/acumen/CBO9781844654031>.

Tinsley, R. and Lebak, K. (2009) 'Expanding the Zone of Reflective Capacity: Taking separate journeys together', *Networks*, 11(2), pp. 1–11. Available at: <http://journals.library.wisc.edu/index.php/networks/article/view/190/404>.

Tondeur, J., Forkosh-Baruch, A., Prestridge, S., Albion, P. and Edirisinghe, S. (2016) 'Responding to Challenges in Teacher Professional Development for ICT Integration in Education', 19, pp. 110–120.

Tondeur, J., van Braak, J., Ertmer, P. and Ottenbreit-Leftwich, A. (2016) 'Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence', *Educational Technology Research and Development*, pp. 1–41. doi: 10.1007/s11423-016-9481-2.

Tondeur, J., Van Braak, J. and Valcke, M. (2007) 'Towards a typology of computer use in primary education', *Journal of Computer Assisted Learning*, 23(3), pp. 197–206. doi: 10.1111/j.1365-2729.2006.00205.x.

Torrance, E. P. (1972a) 'Can we teach children to think creatively?', in *The annual meeting of the American Educational Research Association*. Chicago, Illinois: Georgia University, Athens, Department of Educational Psychology, p. 42. doi: ED419696.

Torrance, E. P. (1972b) 'Predictive Validity of the Torrance Tests of Creative Thinking', *The Journal of Creative Behavior*, 6(4), pp. 236–262. doi: 10.1002/j.2162-6057.1972.tb00936.x.

Torrance, E. P. (1993) 'Understanding creativity: where to start?', *Psychological Inquiry*, 4(3), pp. 232–234. doi: 10.1007/s10734-011-9485-0.

Trevitt, C. and Perera, C. (2009) 'Self and continuing professional learning (development): issues of curriculum and identity in developing academic practice', *Teaching in Higher Education*, 14(March 2015), pp. 347–359. doi: 10.1080/13562510903050095.

Tusting, K. (2012) 'Learning accountability literacies in educational workplaces: situated learning and processes of commodification', *Language and Education*, 26(2), pp. 121–138. doi: 10.1080/09500782.2011.642879.

Twining, P., Raffaghelli, J., Albion, P. and Knezek, D. (2013) 'Moving education into the digital age: The contribution of teachers' professional development', *Journal of Computer Assisted Learning*, 29(5), pp. 426–437. doi: 10.1111/jcal.12031.

van den Akker, J. J. H. (1999) 'Principles and Methods of Development Research', in van den Akker, J. J. H. et al. (eds) *Design approaches and tools in education and training*. Kluwer Academic Publishers, pp. 1–14. doi: 10.1557/JMR.1996.0030.

van den Akker, J. J. H., Gravemeijer, K., McKenney, S. and Nieveen, N. (2006) *Educational design research*. Edited by J. J. H. van den Akker et al. London: Routledge

van den Akker, J. J. H. (2010) *Building bridges: how research may improve curriculum policies and classroom practices, Beyond Lisbon 2010: Perspectives from research and development for education policy in Europe*.

Vandeyar, T. (2014) 'Policy intermediaries and the reform of e-Education in South Africa', *British Journal of Educational Technology*, 46(2), pp. 344–359. doi: 10.1111/bjet.12130.

Veletsianos, G. (2010) *Emerging Technologies in Distance Education*. Edited by G. Veletsianos. Edmonton, Canada: AU Press, Athabasca University.

Vetter, A. (2012) 'Teachers as Architects of Transformation : The Change Process of an Elementary-School Teacher in a Practitioner Research Group', *Teacher Education Quarterly*, 39(1), pp. 27–49. Available at: <http://www.jstor.org/stable/23479561>.

Wagner, B. and McLaughlin, K. (2015) 'Politicising the psychology of social class: The relevance of Pierre Bourdieu's habitus for psychological research', *Theory & Psychology*, 25(2), pp. 202–221. doi: 10.1177/0959354315580606.

Walker, D. (2006) 'Toward productive design studies', in van den Akker, J. J. H. et al. (eds) *Educational Design Research*. London: Routledge, pp. 9–18.

Walton, M. and Pallitt, N. (2012) "'Grand Theft South Africa": games, literacy and inequality in consumer childhoods', *Language and Education*, pp. 1–18. Available at: <http://www.tandfonline.com/doi/abs/10.1080/09500782.2012.691516> (Accessed: 17 November 2013).

Warschauer, M. (2002) 'Reconceptualising the digital divide', *First Monday*, 7(7).

Warschauer, M. (2003) *Technology and Social Inclusion*. Cambridge, Massachusetts: MIT Press.

Watson, C. (2014) 'Effective professional learning communities? the possibilities for teachers as agents of change in schools', *British Educational Research Journal*, 40(1), pp. 18–29. doi: 10.1002/berj.3025.

Watson, D. M. (2001) 'Pedagogy before technology: Re-thinking the relationship between ICT and teaching', *Education and Information technologies*, 6(4), pp. 251–266. Available at: <http://link.springer.com/article/10.1023/A:1012976702296> (Accessed: 25 November 2013).

WCED (2011) '*Khanya Project*'. Available at: <http://www.khanya.co.za/projectinfo/?catid=32>.

Weeks, F. H. (2012) 'The quest for a culture of learning : a South African schools perspective', *South African Journal of Education*, 32(1), pp. 1–14.

Wenger, E., McDermott, R. and Snyder, W. M. (2002) '*Cultivating Communities of Practice*'. 2002, Boston, Mass: Harvard Business School ... Boston, Massachusetts: Harvard Business School Press. Available at: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Cultivating+communities+of+practice#2> (Accessed: 12 August 2014).

Western Cape Education Department (2012) *WCED Vision for e-Education*.

Wong, S. and Logan, H. (2016) 'Play in Early Childhood Education: An Historical Perspective', in Brabazon, T. (ed.) *Play: A Theory of Learning and Change*. Heidelberg, New York, Dordrecht, London: Springer, pp. 7–26.

World Economic Forum (2014) *Global Information Technology Report 2014*, Weforum. Available at: <http://reports.weforum.org/global-information-technology-report-2014/>.

Yilmaz, F. G. K. and Keser, H. (2016) 'The Impact of Reflective Thinking Activities in E-Learning: A Critical Review of the Empirical Research', *Computers & Education*, 95. doi: 10.1016/j.compedu.2016.01.006.

Zhao, C.-M., Kuh, G. D. and Carini, R. M. (2005) 'A Comparison of International Student and American Student Engagement in Effective Educational Practices', *The Journal of Higher Education*, 76(2), pp. 209–231. doi: 10.1353/jhe.2005.0018.

Zhao, Y., Pugh, K., Sheldon, S. and Byers, J.L. (2002) 'Conditions for classroom technology innovations', *Teachers College Record*, 104(3), pp. 482–515. doi: 10.1111/1467-9620.00170.

Zhao, Y. and Cziko, G. A. (2001) 'Teacher Adoption of Technology: A Perceptual Control Theory Perspective', *Journal of Teacher Education*, 9(1), pp. 5–30.

## Appendix A) Hyperlinks

Links to online resources in the thesis in the order of appearance.

Online resource	Long URL
<a href="https://sites.google.com/view/isabeltarlingphddata/home">Accompanying website</a>	<a href="https://sites.google.com/view/isabeltarlingphddata/home">https://sites.google.com/view/isabeltarlingphddata/home</a>
<a href="https://docs.google.com/forms/d/e/1FAIpQLScGOWIXd6L2H7YcEJw887GR2MfFDORIL9EbkmASFfggaDiVJA/viewform">ePlay MakerSpace Concept Map Scoring</a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLScGOWIXd6L2H7YcEJw887GR2MfFDORIL9EbkmASFfggaDiVJA/viewform">https://docs.google.com/forms/d/e/1FAIpQLScGOWIXd6L2H7YcEJw887GR2MfFDORIL9EbkmASFfggaDiVJA/viewform</a>
<a href="https://docs.google.com/forms/d/e/1FAIpQLSf2vKH7izJ6LVZEIW7mvsWzOZ1CMjq4I9dWttJCjPHiKqK54Q/viewform">ePlay MakerSpace: Measuring creativity in artifacts</a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLSf2vKH7izJ6LVZEIW7mvsWzOZ1CMjq4I9dWttJCjPHiKqK54Q/viewform">https://docs.google.com/forms/d/e/1FAIpQLSf2vKH7izJ6LVZEIW7mvsWzOZ1CMjq4I9dWttJCjPHiKqK54Q/viewform</a>
<a href="https://docs.google.com/forms/d/e/1FAIpQLSesgUU0ILAZ2r-egQV4EBGJH3kaf2-T2KL6SI1I-52ALdZhMg/viewform?usp=sf_link">CTLI ICT Integration: Course Reflections</a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLSesgUU0ILAZ2r-egQV4EBGJH3kaf2-T2KL6SI1I-52ALdZhMg/viewform?usp=sf_link">https://docs.google.com/forms/d/e/1FAIpQLSesgUU0ILAZ2r-egQV4EBGJH3kaf2-T2KL6SI1I-52ALdZhMg/viewform?usp=sf_link</a>
<a href="https://docs.google.com/forms/d/e/1FAIpQLSc_L0T3rkLuGUJxecXOaknCfdA-uhmkOP2556K0rxuUfCm9gQ/viewform">Formative Evaluation of ePlay Design</a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLSc_L0T3rkLuGUJxecXOaknCfdA-uhmkOP2556K0rxuUfCm9gQ/viewform">https://docs.google.com/forms/d/e/1FAIpQLSc_L0T3rkLuGUJxecXOaknCfdA-uhmkOP2556K0rxuUfCm9gQ/viewform</a>
<a href="https://docs.google.com/forms/d/e/1FAIpQLSdQkN-h2div3w7FjLtsj55-kmmRd4CBLH4qhQ3F3DV8p92u2w/viewform">Formative Evaluation for Participants</a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLSdQkN-h2div3w7FjLtsj55-kmmRd4CBLH4qhQ3F3DV8p92u2w/viewform">https://docs.google.com/forms/d/e/1FAIpQLSdQkN-h2div3w7FjLtsj55-kmmRd4CBLH4qhQ3F3DV8p92u2w/viewform</a>
<a href="https://docs.google.com/document/d/1ImjAdmU2sHnZlQDRtuDnl1x2hToNagNMObjClwkWloA/edit?usp=sharing">Second draft of the IP Language course framework</a>	<a href="https://docs.google.com/document/d/1ImjAdmU2sHnZlQDRtuDnl1x2hToNagNMObjClwkWloA/edit?usp=sharing">https://docs.google.com/document/d/1ImjAdmU2sHnZlQDRtuDnl1x2hToNagNMObjClwkWloA/edit?usp=sharing</a>
<a href="https://docs.google.com/presentation/d/1Wfbhidgw7lB1Hyt6Vm_VlgY3TuL6DkepotzkDzly9aw/edit?usp=sharing">Planning notes for ePlay MakerSpace IP Language session</a>	<a href="https://docs.google.com/presentation/d/1Wfbhidgw7lB1Hyt6Vm_VlgY3TuL6DkepotzkDzly9aw/edit?usp=sharing">https://docs.google.com/presentation/d/1Wfbhidgw7lB1Hyt6Vm_VlgY3TuL6DkepotzkDzly9aw/edit?usp=sharing</a>

<a href="#"><u>ICT Integration IP Language</u></a>	<a href="https://docs.google.com/presentation/d/1BPQMEdoyjnEEsck67X239AjD4WyHzQHiAPrDJPaxffw/edit?usp=sharing"><u>https://docs.google.com/presentation/d/1BPQMEdoyjnEEsck67X239AjD4WyHzQHiAPrDJPaxffw/edit?usp=sharing</u></a>
<a href="#"><u>Anansi and the Sky Kingdom</u></a>	<a href="https://youtu.be/4RHQYctGYkU"><u>https://youtu.be/4RHQYctGYkU</u></a>
<a href="#"><u>G/Form: Evaluating an Advert</u></a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLSc43IYPgfnmJrkRA5mvG6l0zwwZqSyvkrGNkPPaj2tYFbNR6A/viewform"><u>https://docs.google.com/forms/d/e/1FAIpQLSc43IYPgfnmJrkRA5mvG6l0zwwZqSyvkrGNkPPaj2tYFbNR6A/viewform</u></a>
<a href="#"><u>Roadmap to Change</u></a>	<a href="https://docs.google.com/presentation/d/1pJvHYno2Q49wqzD4SMOXSk5CJYH a1GXBARWMqa0FL0/edit?usp=sharing"><u>https://docs.google.com/presentation/d/1pJvHYno2Q49wqzD4SMOXSk5CJYH a1GXBARWMqa0FL0/edit?usp=sharing</u></a>
<a href="#"><u>Formative Evaluation of ePlay MakerSpace Context, Participants, Design and Enactment</u></a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLSc LOT3rkLuGUJxecXOaknCfdA-uhmkOP2556K0rxuUfCm9gQ/viewform"><u>https://docs.google.com/forms/d/e/1FAIpQLSc LOT3rkLuGUJxecXOaknCfdA-uhmkOP2556K0rxuUfCm9gQ/viewform</u></a>
<a href="#"><u>PhD Evaluating ePlay MakerSpace participants after interviews (Responses)</u></a>	<a href="https://docs.google.com/spreadsheets/d/1muqTSRvHSt10LTjCNbEkv-igqNzrGXkwu1WCQzPIBk/edit?usp=sharing"><u>https://docs.google.com/spreadsheets/d/1muqTSRvHSt10LTjCNbEkv-igqNzrGXkwu1WCQzPIBk/edit?usp=sharing</u></a>
<a href="#"><u>ICT Integration FP ePlay MakerSpace</u></a>	<a href="https://docs.google.com/presentation/d/1IREgoIPZoNC1AynRJCMUB4Q3242R8TuPaYCD59JrLr4/edit?usp=sharing"><u>https://docs.google.com/presentation/d/1IREgoIPZoNC1AynRJCMUB4Q3242R8TuPaYCD59JrLr4/edit?usp=sharing</u></a>
<a href="#"><u>FP teachers' created artifacts</u></a>	<a href="https://docs.google.com/presentation/d/1KHA YDH6gggrR2lATwihmxGnGm1FXKgDlt qHfC88MM/edit?usp=sharing"><u>https://docs.google.com/presentation/d/1KHA YDH6gggrR2lATwihmxGnGm1FXKgDlt qHfC88MM/edit?usp=sharing</u></a>
<a href="#"><u>Reflecting on Day 2 of the Foundation Phase ICT Integration Course</u></a>	<a href="https://docs.google.com/forms/d/e/1FAIpQLSe8jQGLoMHhpaXcjd8FdvOL3ezrd2qpZBy-v0hyHzTPtNM8-Q/viewform"><u>https://docs.google.com/forms/d/e/1FAIpQLSe8jQGLoMHhpaXcjd8FdvOL3ezrd2qpZBy-v0hyHzTPtNM8-Q/viewform</u></a>
<a href="#"><u>Singapore's 21st century learning strategies</u></a>	<a href="https://www.google.co.za/url?sa=t&amp;rct=j&amp;q=&amp;esrc=s&amp;source=video&amp;cd=1&amp;cad=rja&amp;uact=8&amp;ved=0ahUKEwi9x7OewdzXAhUHCCAKHW9jBv4QtwIjZAA&amp;url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DMP_lK7ghGw4&amp;usq=AOvVaw3LfNS6w61OXF0zR7eaeRXS"><u>https://www.google.co.za/url?sa=t&amp;rct=j&amp;q=&amp;esrc=s&amp;source=video&amp;cd=1&amp;cad=rja&amp;uact=8&amp;ved=0ahUKEwi9x7OewdzXAhUHCCAKHW9jBv4QtwIjZAA&amp;url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DMP_lK7ghGw4&amp;usq=AOvVaw3LfNS6w61OXF0zR7eaeRXS</u></a>

<a href="#"><u>Vang die monster</u></a>	<a href="https://drive.google.com/file/d/0B3_7dcMw10ZJdU9aT3JKM1pmYXM/view"><u>https://drive.google.com/file/d/0B3_7dcMw10ZJdU9aT3JKM1pmYXM/view</u></a>
<a href="#"><u>Analysis of Data</u></a>	<a href="https://docs.google.com/presentation/d/1g0uY6QNBIUbLn5eGekhBQA6rXuIPm_UfD7FS4PT_YNg/edit?usp=sharing"><u>https://docs.google.com/presentation/d/1g0uY6QNBIUbLn5eGekhBQA6rXuIPm_UfD7FS4PT_YNg/edit?usp=sharing</u></a>

## Appendix B) Concept Mapping Protocol

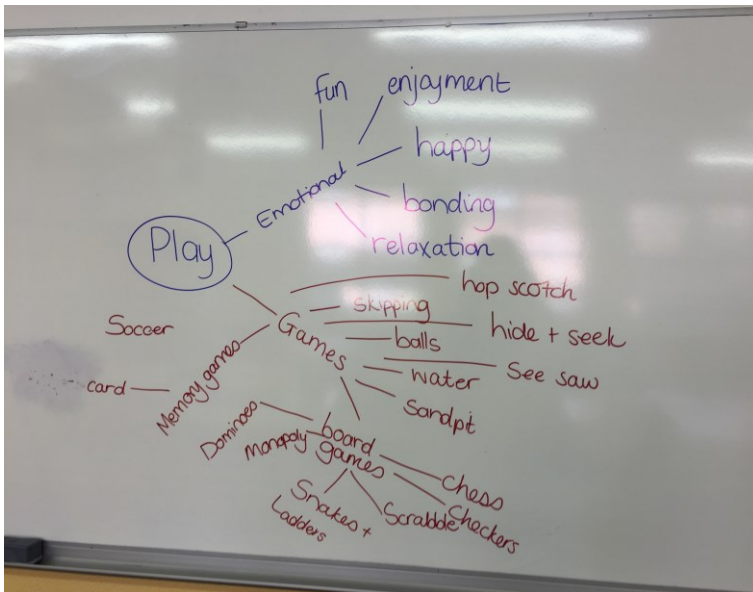


Figure A Collaboratively developed concept map in the Foundation Phase in ePlay MakerSpace

### Step 1) Word-Association with 'Play'

Concept maps start with a word-association (WA) activity as a free-writing or brainstorming task. Participants use word-association to brainstorm as many words as possible relating to a specific topic. As an introduction to WAs, participants brainstorm a relatively neutral word, 'sandpit' and teachers call out words they associated with it. Thereafter, they are provided as standard white sheet of A4 photocopy paper and asked to write any and all words that come to mind, within 60 seconds, regarding the word 'play'. The play WA familiarises teachers with the process of WA, and also the format the time, written activity, using the relatively neutral concept, play.

### Step 2) Word-association with 'ICT Integration in Education'

After the 'play' WA, participants are more familiar with the WA process and can engage with the research tool more meaningfully. The facilitator asks them to flip over the A4 pages on which they created the 'play' WA. On the back of their sheets, they write all the words they

associate with 'ICT Integration in Education'. They are given 5 minutes for this activity. The term ICT is used because this term is commonly included in discourse in the field of education in South Africa, rather than ETs.

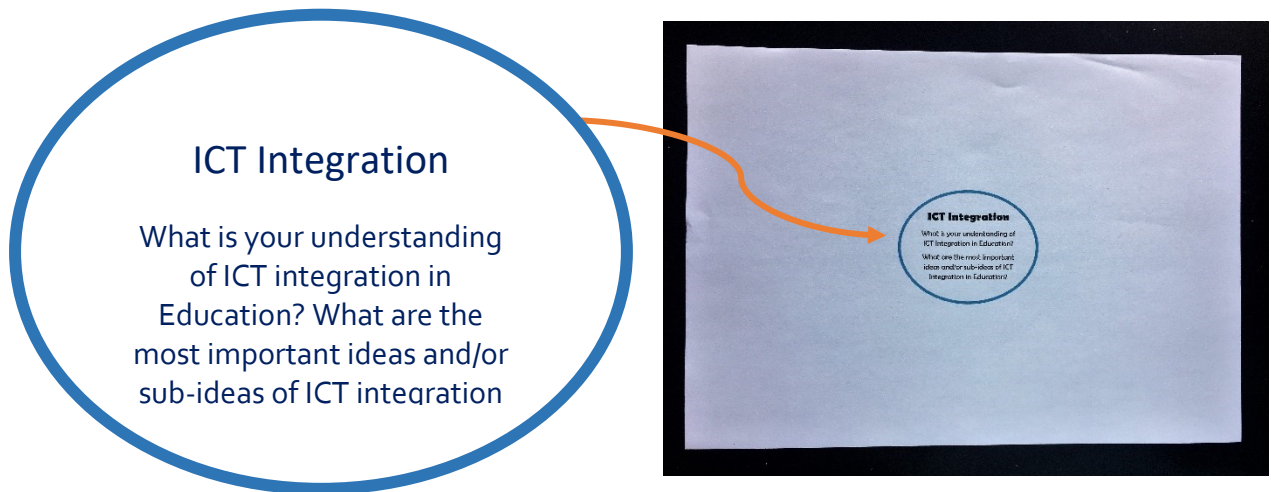
### Step 3) Introducing Concept Mapping

Since many teachers may be familiar with mind-maps, but not concept maps, the purpose and use of concept maps is made explicit as a means 'to visualise internal learning and thinking processes'. The facilitator uses a shared-writing pedagogy to model the use and creation of a CM. Participants are asked to call out words they generated in the 'play' WA activity. The facilitator asks teachers to identify possible ways to group or classify the words called out by their colleagues. Using shared-writing techniques, the facilitator creates a concept map on the whiteboard / flip-chart to model the creation of the concept map from the concepts suggested by participants. Links between concepts or relationships are explicitly made with linking-lines to connect nodes on the concept map. While doing this, these terms are introduced and the links made, using different colours. This modelled process is purposefully messy, includes frequent rubbings-out and re-positioning of items. In creating the concept map, the facilitator makes explicit this messy process. Where possible, visuals and colours are used to show relationships or represent thoughts or ideas. An example of this a collaboratively developed CM of Play is included in Figure 5A above.

### Step 4) Participants create their own concept maps for 'ICT Integration in Education'

One of the pitfalls Besterfield-Sacre, Shuman and Wolfe (2004) identified in scoring and analysing CMs, is participants' inconsistent use of a standard format. This makes it almost impossible to score CMs consistently. In keeping with the convention of comparability (Benney and Hughes, 1956), CMs needed to be created using a standard format, in order to consistently score different CMs created by teachers from diverse contexts. CM are however inherently unpredictable and format free so a standard format is not advisable as it would potentially constrain the free flow of thought. To overcome this, a central blue node was created with the words *'ICT Integration: What is your understanding of ICT Integration*

*in Education? What are the most important ideas and/or sub-ideas in ICT Integration in Education?’ and in centre of a white A4 sheet of paper as shown in Figure 6.*



*Figure B Centre circle on Concept Maps*

The design of the centre node with the writing prompt is meant to surreptitiously encourage teachers to use the CM format modelled with the 'Play' CM on the whiteboard, without the facilitator having to explicitly state this as a requirement. In doing this, teachers' thinking and conceptual knowledge is at the forefront of this activity, without them having to adhere to a potentially unfamiliar format and fear that they may 'get it wrong'. Similarly, instead of conducting this activity using an ET tool, the highly-familiar paper-based format was chosen to introduce to prevent the use of the tool constricting the free-flow of thought.

#### Concept Mapping on Day 3 of the ePlay MakerSpace

CMs are created during the introductory session on Day 1 of the ePlay MakerSpace. Once completed, teachers write their names on their sheets and the CM and WA pages are collected. Teachers are reassured that each page is coded and therefore anonymised. Thereafter the CMs and WAs coded, scanned and/or photographed, and stored digitally.

At the end of Day 3, teachers CMs are returned to them and they are asked to create a new CM after their three days in the ePlay MakerSpace, or to add to their existing CM. The CMs are then re-scanned and electronically stored.

## Iterative development of scoring instruments for concept maps

In keeping with the principle of comparability, concept maps should be scored using a standard scoring system. The scoring system used in this study was iteratively designed and developed using the DBR iterative cycle.

The prototype CM scoring instrument was developed combining Besterfield-Sacre, Shuman and Wolfe’s (2004) scoring rubric for engineering education, and various other scholars’ work (Novak and Cañas, 2006, 2008; Novak, 2010; Nelson, Lesseig and Slavit, 2016). This prototype used a system of counting nodes, branches and cross-links, and counting the highest hierarchical level that was achieved on each CM to score it. The different element for scoring are described in Table A.

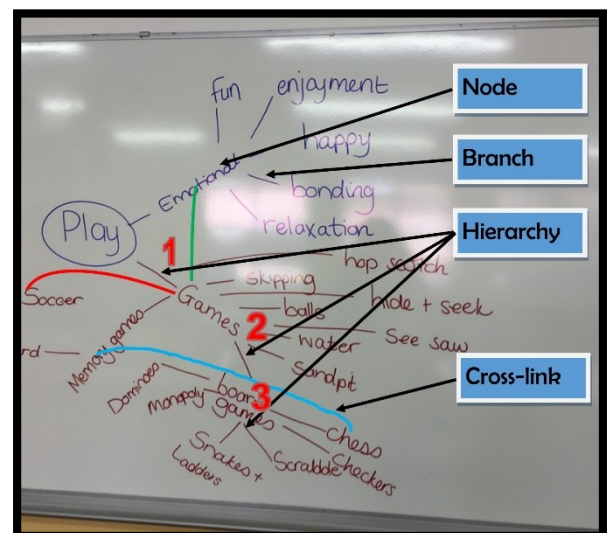


Figure C The elements of a concept map visually represented

Table A Element Descriptors for a Concept Map

Element	Definition
<b>Concepts</b> represent (major) ideas	Concepts are represented by <b>NODES</b> on the concept map, the main ideas or thought groupings
<b>Relationships</b> indicate the extent of domain knowledge	connecting lines and linking words between two concepts, between a concept and an example, or between examples
<b>Branching</b> represent progressive differentiation in the knowledge domain	concepts or examples that elaborate on or further develop concepts or examples
<b>Hierarchies</b> represent knowledge subsumption	connections among concepts and examples, from general to specific
<b>Cross-links</b> reflect the extent of knowledge integration and synthesis	connections between a segment of one hierarchy and a segment from another hierarchy
<b>Examples</b> represent specificity of knowledge	specific events or objects that are judged as valid instances of a concept

Phase 1 scoring however only captured a very basic understanding of the CM. CMs are scored low when only a few nodes are included (like spokes on a wheel), assuming that such CMs display a low conceptual understanding. Other CMs with more nodes, branches, hierarchies and cross-links, are assumed to have a higher conceptual understanding. The prototype scoring instrument withholds all value judgement on the validity of concepts included in the CM or how they are linked, providing quantitative data but not qualitative insight. Hence, a more holistic scoring instrument was designed to capture the strengths and weaknesses of concepts and propositions included in CMs.

The second generation of the CM scoring instrument developed a rubric to capture the meaning of concepts and propositions on CMs. In order to provide valid and comparable findings, the CM scoring instrument needed to avoid subjectively assigning value to concepts or propositions, and instead needed to consistently apply the same scoring tool in the same way achieving statistically comparable results, regardless of the subjectivities of the person scoring or their interpretation of the concepts and propositions. Drawing from Besterfield-Sacre *et al.*'s (2004) work, a scoring rubric was created (see **Error! Reference source not found.**) to assesses:

- a. the comprehensiveness with which CMs address ETs in education and how ETs can be in integrated in education;
- b. the organisational structure of the CM (correlating to the prototype scoring tool); and
- c. the correctness of the information supplied. To assess this last aspect, it is therefore

*Table C Rubric for assessing concept maps*

	<b>1</b>	<b>2</b>	<b>3</b>
<b>Comprehensiveness</b> Knowledge about ICT in Education, related topics, integration principles and pedagogies	Map lacks subject definition, knowledge is simple and/or limited. No evidence of ICT pedagogies or integration principles in map.	Map contains adequate knowledge definition with a broad scope of factors to do with ICT in education, but limited evidence of ICT pedagogies or integration principles, which suggests a somewhat narrow understanding of the ICT Integration in teaching and learning.	Map very broadly defines ICT in education factors that impact this, and importantly addressed ICT pedagogies and integration principles including a focus on Learning needs, engaging learning in knowledge production, fostering interaction and e-assessment.
<b>Organisational structure</b> Branch definition and cross-links / feedback loops reveal integration of conceptual knowledge	The map is arranged with concepts only linearly connected. The few (or no-connections) between/within branches indicate limited or no integration of concepts.	The map is fairly well organised with some between/within branch connections. Only 1 or 2 cross-links and/or feedback loops between branch items pointing to possible conceptual integration.	The sophisticated branch structure of the map is well defined and branches are systematically placed. Branches are connected to show 3+ cross-links and/or feedback loops, indicating evidence of good concept integration.
<b>Correctness</b> Conforming to or agreeing with established knowledge relating to ICT Integration in Teaching and Learning practice	The map is naive and contains misconceptions about ICT integration and/or inappropriate words or terms. The map documents an inaccurate understanding of certain or all aspects of ICT integration into teaching and learning practices.	There are some inaccuracies regarding ICT integration into teaching and learning practices and/or inappropriately linked branch items.	The map integrates concepts accurately and reflects an accurate and sophisticated understanding of ICT integration principles, pedagogies and branch items are appropriately linked.

necessary to have an assessor with a relatively high level of expertise in ETs in education to conduct the assessment.

A third iteration of the CM scoring instrument followed. The ePlay MakerSpace process is theoretically and conceptually focused on achieving TDL-change, transforming teachers' dispositions of reproduction and replication, to dispositions to create and innovate. It occurred that creativity and innovation could potential be measured in the CMs. Torrance (1972a, 1993), widely regarded as the 'father of creativity', developed a number of tests to measure creativity potential, which have been validated numerous times (Kim, 2006, 2011a; Sternberg, 2006).

Drawing from these authors' work, the measures for creativity are described as follows:

- **Fluency:** the ability to produce a large number of ideas in words, images or actions.
- **Flexibility:** the ability to produce various ideas, drawings, representations or relevant ideas from a variety of domains, and the ability to easily shift between domains.
- **Originality:** the ability to produce novel, unique or uncommon ideas that are less obvious or unexpected.
- **Elaboration:** the ability to develop, embellish or elaborate ideas, with added detail for example.
- **Abstractness:** the ability to sense the essence of an issue and apply a level of abstraction
- **Resistance to premature closure:** the capacity to keep an open mind, identify unanswered questions or unresolved issues, and to work on a problem from a variety of perspectives.

The creativity measured, provided the thought-seed to create a thought-experiment, surmising that perhaps the CMs could be scored, using the above measures of creativity, to provide an indication of teachers' possible growing dispositional of creativity over the three days of the ePlay MakerSpace. Using the six measures and descriptions for creativity (Torrance, 1972b, 1993; Munro, 2001; Kim, 2006, 2011a; Sternberg, 2006), the rubric for assessing creativity evident in the development of teachers' concept maps, was developed (see Table B). The three phases of the concept map scoring instrument are documented on page W1.2 on the website. The results for the scoring is also included on the the W1.2.

In order for the CM scoring tools to provide valid results, the tool was tested with three colleagues from the University of Cape Town (UCT). The three colleagues tested the usability, validity and consistency with which the three rubrics and measures for flexibility, fluency and originality could be applied. They are part of the Education Technology department at the University of Cape Town, and can be considered experts in the field, especially when using the second generation scoring instrument to determine the correctness of the information provided in teachers' CMs. The three colleagues accessed the same five CMs and using the G/Form, scored these using the rubrics in the online form. The results from the three trials were compared and analysed in order to elaborate and refine scoring questions to reflect a more consistent understanding of the scoring topics and

options. This analysis, comparable to Bateson and Martin's (2013), revealed the measures of fluency, flexibility and originality were consistently and similarly scored by the different colleagues, who also suggested these scores be used rather than the scores for elaboration, abstraction and premature closing. The iterative development and refinement of the CM scoring tool increased the interpretive validity thereof, and increased the validity of findings drawn from the scoring of the CMs.

*Table C Rubric for measuring creativity in concept maps*

Creativity measured in Concept Map	1	2	3
<b>Fluency</b>	Concept map includes between 1 - 5 relevant ideas or responses produced as nodes (spokes on a wheel)	Between 5 - 9 relevant ideas or responses produced as nodes or possibly developed as branches.	More than 10 relevant ideas / responses produced as nodes and developed in different branches.
<b>Flexibility</b>	Concept map focuses on 1 - 3 different categories of ETs in education.	Concept map includes between 3 - 6 different categories relating to ETs in education.	Concept maps includes 7 or more different categories relating to ETs in education.
<b>Originality</b>	All concepts included are well-known and commonly associated with ETs in Education.	One or two uncommon ideas, less obvious or unexpected concepts or relations identified.	Three or more uncommon ideas, less obvious or unexpected connections, relationships or concepts included.
<b>Elaboration</b>	Only key points included as nodes around central circle with no embellishments, details or elaborations of these.	Between 1 - 3 branches and /or 1-3 hierarchy levels added to one or two nodes to elaborate or add detail to the concept map.	Nodes are developed with multiple branches (4+) and hierarchies (4+) included on various nodes to add detail and elaborate ideas.
<b>Abstractness</b>	No abstraction evident in concept map; only physical or observable concepts identified, making use instead of many examples, tools or products.	One or two instances of abstraction included in concept map in terms of larger, overarching abstractions of phenomena, accompany listed examples, tools or products.	Three or more (or all) physical and/or observable phenomena grouped or classified in terms of abstractions and where tools or examples are listed, these are on branches hierarchically removed from the abstract nodes.
<b>Resistance to premature closure</b>	No unanswered questions or unresolved issues identified on concept map; integration viewed from educators' perspective.	One or two unanswered questions or unresolved issues identified; integration viewed from educators' and one other perspective.	Three or more unanswered questions or unresolved issues and multiple perspectives relating to ET integration identified on concept map .

## Appendix C) Evaluating Participation

Score achieved	1	2	3
Taking ownership of the process	... are fixated on the constraints, challenges and problems in their educational contexts rather than seeing what opportunities these may offer; this limits their ability to take ownership of the play and change process.	... take partial ownership of the process and start to see what opportunities can be exploited in their everyday contexts to integrate emerging technologies into their teaching and learning, taking ownership of the play and change process.	... enthusiastically takes ownership of the play and change process, not only exploiting opportunities in their everyday contexts, but suggesting ways to increase access to emerging technologies and/or connectivity, and make institutional change.
Level of engagement	...remain unengaged in the process and makes only vague / unenthusiastic attempts to build or make the structures suggested, or make excuses why they would 'do it later'.	... engage in the process and in making or building the structures suggested but only do what is required and do not venture to explore other tools, processes or applications.	... are highly engaged, start building and making structures before these have been fully introduced and go on to explore the other tools, processes or applications individually or in groups.
Commitment and enthusiasm	... lack commitment or enthusiasm to the process which may be evident in their body language, speech or lack of participation in group discussions, and their unwillingness to share their work; they may frequently ask to leave or make excuses why they can't stay past a goal time before the end of the session.	... are committed to the process and participate with some enthusiasm; they are positive and upbeat in the session and do what is required; they share their work and make a few comments during discussions; when it is time for a break or end of day, they drop everything and leave almost immediately.	... are highly committed to learning & the process, and participate with great enthusiasm in the activities & group discussions; they enthusiastically share their work and processes with others and are usually the last to leave the room for a break or at the end of the day/session.
Empowerment in terms of: · Relationships · Reciprocity · Responsibility	...no or limited collaboration or dialogue with other participants; unwillingness to consider egalitarian role division and/or accept guidance from others, or to take responsibility.	... wants to mainly collaborate with participants they already know, refrains from engaging with 'others'; willing to consider egalitarian role division, accepts guidance and takes some responsibility.	... very open to collaboration and dialogue with anyone in the group, actively supports egalitarian role division and asks for guidance / support and once received, shares learning with others; takes personal responsibility.
Creativity displayed	... no or limited display of flexibility, originality, fluency, or elaboration.	... displayed some flexibility, fluency, originality and elaboration.	... displayed extensive flexibility, originality, fluency and elaboration.
Reflective process	... makes no or limited attempts to reflect on their participation, own practice, or learning; shares no or minimal reflections in group.	... reflects briefly on the process, tools used and/or structures built, but little about their own learning; shares some of this in group.	... reflects at length on process, tools used, their own and others' construction and learning, and shares openly with the group.

<p>Perceived satisfaction with process:  <b>observed in comments, body language and facial expressions.</b></p>	<p>... appears to be disappointed or unsatisfied with the process: negative, pessimistic or critical comments, apathetic or aggressive body language and indifferent or irritable facial expressions.</p>	<p>... appears satisfied with the process: mostly positive, optimistic comments but also includes one or two criticisms; somewhat confident body language and open facial expressions.</p>	<p>... extremely satisfied with process: profusely thanks facilitators &amp; hands out many compliments, exclamations of surprise and obviously derives pleasure from activities, interactions and learning.</p>
<p><b>TOTAL SCORE:</b></p>			

# Appendix D) Evaluating the model

	1	2	3
<b>Practicality</b>	Participants were unsatisfied with the design or elements thereof, and found it impractical and not useful to their con-	Participants were satisfied with the design or elements thereof. They note the practicality and usefulness of particular aspects to	Participants are extremely satisfied with the design or elements thereof and enthusiastically implement it in their contexts.
	The design fails to address the realistic needs of the participants and cannot be immediately implemented into T&L'ing	The design satisfies many of the realistic needs of the participants and 50%+ of it can be implemented into T&L'ing practices.	The design is immediately implementable in the context since it almost completely addresses realistic needs of the participants.
<b>Relevance</b>	The design only met 33% or less of participants' goals, needs and priorities.	The design met up to 66% of participants' goals, needs and priorities.	The design exceeded participants' expectations and met almost all of their priorities and goals.
	The design failed to meet institutional goals and priorities as reflected in the institutional organisers' comments and re-	The design generally met the institutional goals and priorities as reflected in the institutional organisers' comments and reflec-	The design exceeded institutional goals and priorities as reflected in institutional organiser's comments and reflections.
<b>Sustainability</b>	The design cannot be sustained over time as it may be too costly or time-consuming.	The design can be sustained over time with minor adjustments. It is neither too costly nor to time-consuming.	The design can effectively be implemented without changing anything, including time, effort and resources needed to enact it.
	Skill transfer is vested in one person and has not been initiated.	Skill transfer has been initiated and potential facilitators have been identified.	Skill transfer has been successfully initiated and the training of future facilitators has begun.
<b>Effectiveness</b>	The design addresses less than 33% of the requirements in the design brief and therefore does not meet the majority of the	The design addresses up to 66% of the requirements in the design brief and meets many (2/3) of the design goals.	The design address the majority (more than 67%) of the requirements of the design brief and meets the majority of the design
	Measured against the design principles identified for e-Play and Teaching Change, the design addresses 33% or less of	Measured against the design principles identified for e-Play and Teaching Change, the design addresses up to 66% of these.	Measured against the design principles identified for e-Play and Teaching Change, the design addresses more than 67% of
	The investment of time, effort and resources is not justified.	The investment of time, effort and resources is justified.	The investment of time, effort and resources is more than justified.
<b>Content Validity</b>	The design makes use of dated knowledge.	The design makes use of up to date knowledge that is a re-formulation of previously developed knowledge.	The design makes use of state-of-the-art knowledge that is fresh, cutting-edge and highly relevant.
<b>Construct Validity</b>	The various design components are not linked to each other.	The various design components are linked to each other but not consistently.	The various design components are consistently linked to each other.

# Appendix E) Data analysis process

## Phase 1 Analysis

Phase 1 analysed individual data sources including teachers created artifacts, the textual data from concept maps (CMs) and Word-Associations (WAs) and Edmodo posts, transcriptions of group and individual written reflections, and the interview data. The preparation and analysis of data in Phase 1 occurred between July and September 2016.

During Phase 1 the individual data sources were quantitatively analysed to provide refined data sources for the identification of emergent themes in Phase 2 analysis. Table provides a summary of the quantitative data analysis techniques used in Phase 1. The individual source data analysis processes are recorded in detail on the website W1.2 and summarized in the [G/Slide presentation: Analysis of data](#) (link embedded).

Wherever possible, all data analysis outcomes were visually represented for visual comparison, contrast and evaluation in Phase 2 analysis. The visual representation also reduced the magnitude of data produced, to manageable proportions.

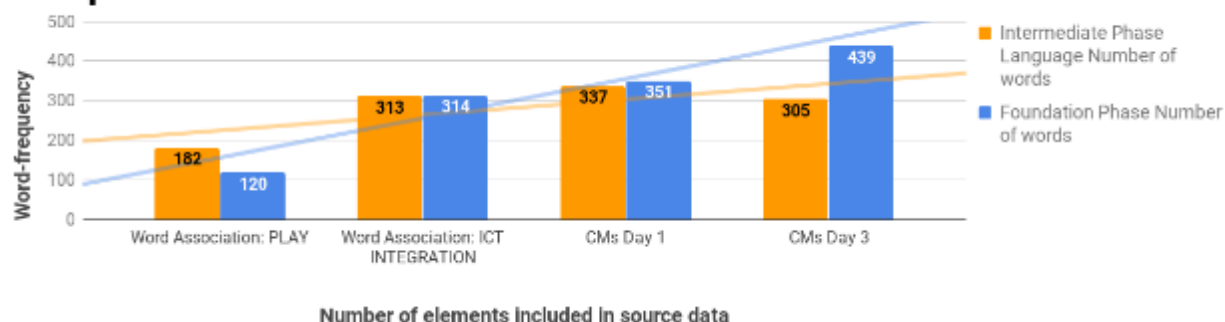
*Table C Phase 1 analysis tools and outcomes*

<b>Data Source</b>	<b>Analysed using...</b>	<b>Outcome</b>
<i>Concept map textual data including WAs, and Day 1 and 3 CMs</i>	Word-frequency analysis in Nvivo11; repeated using wordclouds.com and G/Sheets	Refined word-frequency lists without duplicates, and using standard spelling of words
<i>Teachers' created artifacts</i>	Measuring the creativity in teachers created artifacts using rubrics in G/Sheets	Column charts indicating creativity in teachers' Day 1 and 3 CMs, and the artifacts they created in the sessions

<i>Teachers' transcribed group and individual written course reflections</i>	The chart function in G/Sheets for numeric data.  Content analysis using word-frequency analysis in Nvivo11 and wordclouds.com	Charts indicating teachers' feedback of facilitation, venue and equipment.  Wordclouds indicating word-frequency and preliminary codes in Nvivo11
<i>Edmodo and interview transcripts</i>	Content analysis in Nvivo11	Preliminary codes

Where possible, data was compared as source data and averaged data, since the number of teachers in each iteration differed: IP Language group (26) and FP (15) - one teacher did not give permission for her artifacts to be used. For example, a comparison of the number of words included in teachers' concept maps (CMs) for Day 1 and 3, in both iterations, based on source data does not fully capture the significantly higher number of words produced by FP teachers on average, than IP Language teachers in every activity. Only once the average number of words per teacher was established, and visually represented, could the two charts be effectively compared as included in **Error! Reference source not found.D** and Figure EE. The visual representations indicate the noteworthy increase by FP teachers from

**Comparison of the number of words included in Iteration 1 & 2 CM data**



*Figure DComparison between the number of words produced in Iteration 1 and 2 CM Data*

their first Play WAs on Day 1, to their Day 3 CMs, correlating to the significantly higher creativity scores in terms of fluency and flexibility in FP teachers’ artifacts.

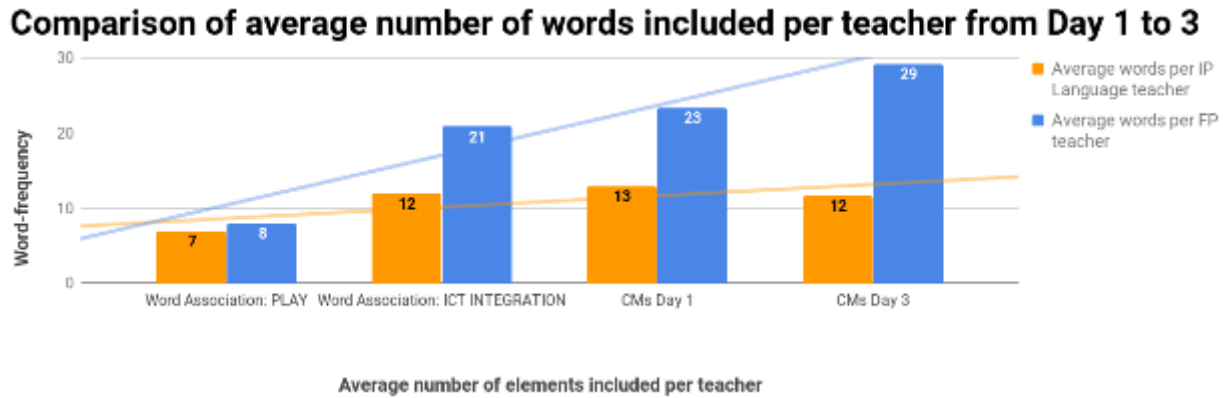


Figure E Comparison between average number of words produced per teacher in Iteration 1 and 2 CM data

The validity of the analysis processes and outcomes from Phase 1 directly impact the validity of findings from Phase 2, and ultimately Phase 3. If findings from Phase 1 can be trusted, Phase 2 and 3 can proceed from a trusted foundation – although the opposite is also true. Tools to conduct word-frequency analysis of textual data, to measure creativity in teachers’ artifacts, and score concept map data, had to yield valid and trustworthy results. Consequently, these tools were iteratively designed, trialled and refined following the DBR-methodology. The refinement of the word-frequency analysis, for instance, was independently repeated using G/Sheets and Nvivo11 at different times, with different processes, to ensure comparability of findings. (The iterative development and refinement process is described in detail in the [G/Slide presentation: Analysis of Concept Maps.](#)) However, the development and refinement of the creativity measure, and the exclusion of the concept map scoring tools, is described more extensively herein.

The measurement of creativity in teachers’ artifacts drew from existing research in the field (Torrance, 1972b, 1993; Amabile, 1982; Kim, 2006, 2011a; Sternberg, 2006). The tools used to score CMs were iteratively developed from existing instruments developed in fields as diverse as engineering and education (Besterfield-Sacre *et al.*, 2004; Novak and Cañas, 2006,

2008; Novak, 2010; Nelson, Lesseig and Slavit, 2016). Initially, the CM data was measured only according to the way the above-mentioned researchers scored it. However, unconvinced that the results were indicative of any major finding(s), I re-evaluated the purpose and outcomes of the CM scoring and analysis process to identify un-thought of ways of looking at the problem. In the thought-experiment that followed, I argued that since the focus of the ePlay MakerSpace process is to nurture creativity, a potentially meaningful contribution from the concept map data would be an indication of creativity in each concept map, and particularly measuring any change in CMs from Day 1 to 3. Following this argument, and since CMs are created by teachers, I argued that these could also be evaluated using the same tools used to measure creativity in the other created artifacts. Subsequently, a rubric to measure creativity in teachers' CMs was iteratively designed, developed and tested (Appendix B documents the process).

The iterative testing of the CM measurement of creativity rubric, produced encouraging results. However, in developing this tool, I acknowledging the many boundaries I was crossing in relation to tools and fields, and critically, the need to produce valid results. The tool needed to be validated for the results to be trustworthy. Accordingly, I trialled the tools asking colleagues in the field to score the same five CMs using the CM scoring tool and the rubric for measuring creativity (Appendix B) included in a G/Form. Colleagues' CM scores for the creativity in terms of originality, fluency and flexibility achieved highly comparable results, while the measurement of elaboration, abstractness and resistance to premature closing differed significantly. The first version of the creativity measure rubric, despite being framed in the same style as that used by Torrance, did not provide a standard measure that adequately described scores for creativity, leading to the large variance in results. The measures of fluency, flexibility and originality on the other hand, yielded significantly higher consistency of measurement, and different colleagues' results were repeatedly the same. This indicated internal construct validity of the items incorporated in the rubric for originality, fluency and flexibility, and how these were interpreted. Since originality, flexibility and fluency to measure creativity is used by other researchers (Bateson and Martin, 2013), only these three measures were included in subsequent rubrics.

The iterative process to refine the rubric to measure creativity and score concept maps, was vital to achieve interpretive and theoretical validity in subsequent phases of analysis. However, I remain unconvinced by the outcomes of the CM scoring instrument, and will continue to develop this instrument in future. Consequently, while I include the results of this in the website, and since the scoring results did not impact the overall analysis, these were not included in the Phase 2 and 3 analyses. The trialled and refined rubric for measuring creativity in artifacts and CMs, yielded valid and trustworthy results and are included in the Phase 2 and 3 analyses. This is in addition to the preliminary analyses of textual elements from the CMs, Edmodo posts, teachers' transcribed group and written individual reflections, and interview transcripts.

## Phase 2 Analysis

The second phase of data analysis drew on findings from Phase 1 analyses using Nvivo11 and G/Sheets. The aim of Phase 2 analysis was three-fold: to identify emergent themes from individual data sources, to compare these themes, and to identify emergent themes across all sources.

The Phase 2 analysis took place between September 2016 and February 2017 using primarily Nvivo11, but also G/Sheets. Each data source was read on average three times to identify and elaborate emergent codes. During the first reading, a code was assigned to every emergent theme that presented from the data, using this function in Nvivo11. A coding rule-book was kept in my research diary to document the coding rules as these emerged for each coding incident (examples of these emergent coding rules are included in the [G/Slide presentation: Analysis of data](#) - slide 11). Generating coding rules in this way increased uniformity of coding all data sources similarly. Although I returned to previously coded data sources once a new coding rule had been established, and recoded, the uniformity of coding was however a concern. A second reading of the data therefore focused on uniformly applying the generated coding rules to all the data sources, and where necessary elaborating or refining these coding rules. This yielded 91 coding options, with 26 main coded items and various sub-coded items for many of these. A third reading of the

data sources did not identify any further codes or refine the existing coding rules. This signalled the conclusion of this part of the analysis.

A second tool, [G/Sheets: PhD Concept Map Scores](#) was used to analyse the CM textual data in June/July 2017, to confirm that the emergent themes from Nvivo11 and been fully refined. During Phase 1 analysis, the textual data from FP and IP Language teachers' CMs, generated 2361 words. These words were inserted to wordclouds.com to generate word-frequently wordlists. However, the wordlists contained many duplicates, misspelt words or irregular versions of the same word. Hence, the wordlists were copied to the G/Sheet: [PhD Concept Map Scores](#) (link embedded), and refined using the generated rules for removing duplicates and refining textual data ([G/Slide: Analysis of Concept Maps](#), slide 4). This generated a refined word lists in G/Sheets with 810 words. Similar to the Nvivo11 coding process, the wordlist in G/Sheets was repeatedly read to identify emergent themes, coding rules and refinements to the rules and themes. Twelve emergent themes were generated in this way. Each was placed as a heading to a column in the G/Sheet and the content of the word-lists placed in the corresponding column. Some words could however be placed in more than one column depending on the different meanings of the word. I subsequently referred to the original placement of the word in the teacher's CM to identify collocated words to the word in question. In many instances the collocated words provided insight into the author's intended meaning and I could place the word with some confidence in the appropriate column. Where the collocation of words did not sufficiently reveal the author's intent, the word was placed in more than one column depending on different meanings and colour coded for easy reference to indicate duplications in the emergent codes. After completing this process, I read through the wordlists two more times to ensure words were sufficiently coded to the correct emergent codes. After the second reading, no words were moved to different columns, signalling the completion of this process.

The Phase 2 content analysis generated 91 thematic codes in Nvivo11, and 12 codes in G/Sheets, which were analysed according to the analytic frame. The G/Sheet codes, prefixed with a (G), were compared to the 91 codes generated in Nvivo11 and prefixed (N). The (G)codes correlated to the (N)codes, confirming the validity of the Nvivo11 codes as the

standard, and that no further codes would likely emerge. Subsequently, the codes for each analytic unit were visually represented using branched Level 1, 2 and 3 coding system—these charts are included on slides 27 - 35 in the [G/Slide: Analysis of data](#).

The codes that emerged were compared to the analytic frame developed in Chapter 3 and visually represented on Slide 24 as indicated in Figure . Each code that emerged corresponded to a different aspect of field, capital, habitus, teachers’ experience of the ePlay MakerSpace and change. Using the visual representations of codes corresponding to each unit, the different codes within each of the four analytic units were analysed to identify patterns, similarities and relationships. Different questions emerged after analysing the codes in relation to the analytic units of habitus, field and capital, change, and teachers’ experience of the course. These questions were captured on Slide 40 – 45. In addition, the questions raised meta-questions across analytic units, in preparation for Phase 3’s social topology analysis (see slides 36 – 42). The generated analytic questions served as a guide with which to initiate Phase 3 analysis, and concluded the Phase 2 analysis process.

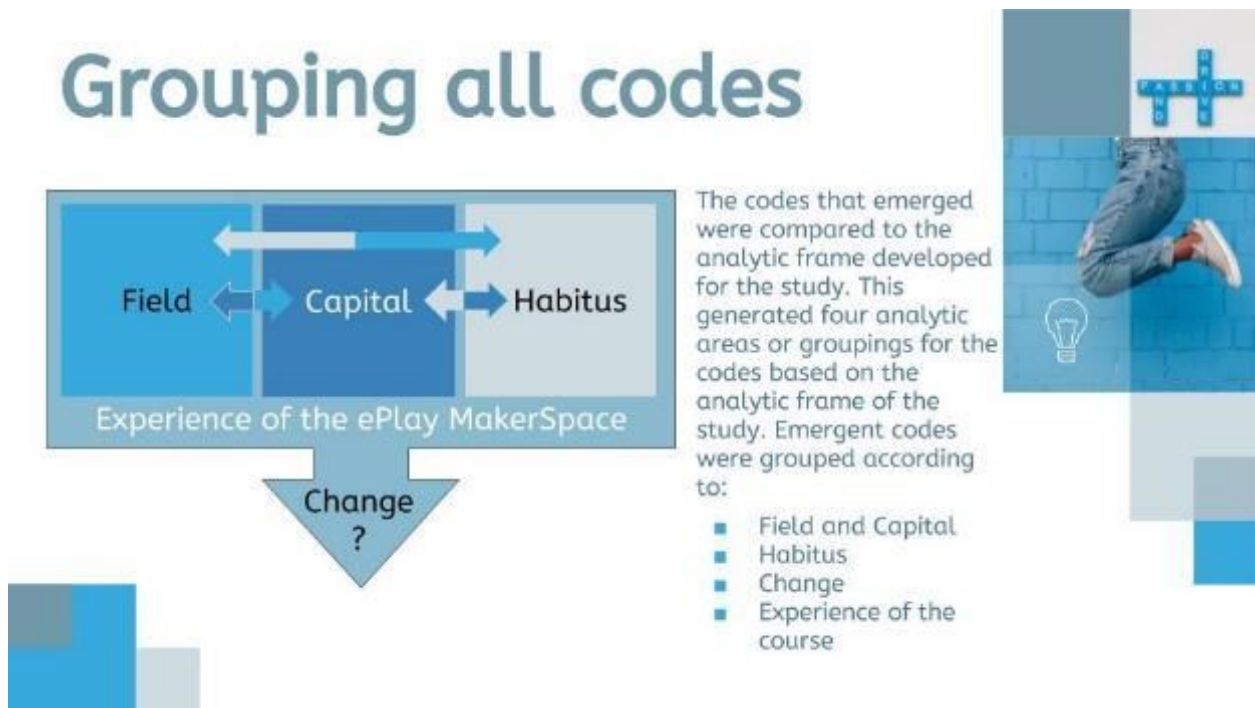


Figure F Phase 3 analysis of data